BULLETIN 2024

CHULA ENG ACTNOW

FACULTY OF ENGINEERING
CHULALONGKORN UNIVERSITY

FOR USE BY
ENGINEERING STUDENTS
HAVING ID.NO. 67X XXXXX XX
UNTIL THEIR GRADUATION

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APPENDIX

UNIVERSITY CALENDAR
ACADEMIC YEAR 2024

First Semester

First day of classes	Monday, August 5, 2024
Midterm Examinations (if any)	Monday, September 23 – Friday, September 27, 2024
Close of first semester activities	Sunday, October 27, 2024
Last day of classes	Friday, November 22, 2024
Final Examinations	Monday, November 25 – Monday, December 9, 2024
Close of first semester	Wednesday, December 11, 2024

Second Semester

First day of classes	Monday, January 6, 2025
Midterm Examinations (if any)	Monday, March 3 – Friday, March 7, 2025
Close of first semester activities	Sunday, March 30, 2025
Last day of classes	Friday, April 25, 2025
Final Examinations	Monday, April 28 – Wednesday, May 14, 2025
Close of first semester	Thursday, May 15, 2025

Summer Session

First day of classes	Monday, June 2, 2025
Last day of classes and Examinations	Friday, July 18, 2025
Close of summer session	Saturday, July 19, 2025
Last day of Academic Year	Friday, August 1, 2025

ADMINISTRATION
FACULTY BOARD

Dean of the Faculty :

Assoc. Prof. Dr. Witaya Wannasuphoprasit

Associate Dean

Assoc. Prof. Dr. Nopdanai Ajavakom
Assist. Prof. Dr. Surat Kwanmuang
Assoc. Prof. Dr. Sawekchai Tangaramvong
Prof. Dr. Chalermchon Satirapod
Assist. Prof. Dr. Falan Srisuriyachai
Asst. Prof. Phongphaeth Pengvanich
Assoc. Prof. Dr. Atiwong Suchato
Prof. Dr. Pisut Painmanakul

Assistant Dean

Assoc. Prof. Dr. Boonchai Lertnuwat
Assist. Prof. Dr. Channarong Banmongkol
Assoc. Prof. Dr. Charusluk Viphavakit
Assoc. Prof. Dr. Natt Leelawat
Assist. Prof. Dr. Supattra Visessri
Asst. Prof. Jirapon Khamwannah
Dr.Tanawat Tangjarusritaratorn
Dr.Machigar Ongtang
Asst. Prof. Pet Pakchotanon (Techarat)

Head of Department of Civil Engineering

Prof. Dr.Kasem Choocharukul

Head of Department of Electrical Engineering

Assoc. Prof.Dr. Chaodit Aswakul

Head of Department of Mechanical Engineering

Assoc. Prof.Dr. Angkee Sripakagorn

Head of Department of Industrial Engineering

Assoc. Prof. Dr. Angsumalin Senjuntichai

Head of Department of Chemical Engineering

Assoc. Prof. Dr. Soorathep Kheawhom

Head of Department of Mining and Petroleum Engineering

Assoc. Prof. Dr. Jirawat Chewaroungroaj

Head of Department of Environmental and Sustainable Engineering

Assoc. Prof. Dr. Jenyuk Lohwacharin

Head of Department of Survey Engineering

Assoc. Prof. Dr. Somchai Kriengkraiwasin

Head of Department of Metallurgical Engineering

Assist. Prof. Dr. Suvanchai Pongsugitwat

Head of Department of Computer Engineering

Assist. Prof. Dr. Attawith Sudsang

Head of Department of Nuclear Engineering

Assoc. Prof. Phannee Saengkaew (Acting)

Head of Department of Water Resources Engineering

Asst. Prof. Pongsak Suttinon

Elected Members of the Board:

Assoc. Prof. Dr. Thanyarat Singhanart
Assoc. Prof. Dr. Thanarat Chalidabhongse
Assoc. Prof. Dr. Wanchalerm Pora
Assoc. Prof. Dr. Boonchai Sangpetngam
Assoc. Prof. Dr. Somboon Rassame
Assist. Prof. Dr. Chaiyaporn Puprasert
Assist. Prof. Dr. Piyatida Ruangrassamee
Assist. Prof. Dr. Poom Luangjarmekorn
Assist. Prof. Dr. Nattaporn Tonanon
Dr. Chaichoke Viphasa

Program Director of International School of Engineering

Assoc. Prof. Dr. Sawekchai Tangaramvong (Acting)

Program Director of The Regional Centre for Manufacturing Systems Engineering

Assoc. Prof. Dr. Chuvej Chansa-ngavej

Acting Director of Biomedical Engineering Program

Assist. Dr.Pakpum Somboon

Director of Defense Engineering and Technology Program

Assist. Prof. Panyawat Wangyao

Program Director of Innovative Engineering for Sustainability

Assoc. Prof. Dr. Sawekchai Tangaramvong

Registrar :

Assist. Prof. Dr. Channarong Banmongkol

FACULTY OF ENGINEERING
OBJECTIVE

It is the objective of the Faculty to educate engineering students both in the fundamental and professional knowledge, and to train the students in the analysis and synthesis of engineering systems. It is expected that our graduates should possess the ability to function effectively both as individual and in a team. Initiative, self-confidence and perseverance are the desired quality in our graduates. It is also our objective to instill the sense of professional and social responsibility an d integrity in the students during the course of instruction.

ACTIVITIES

Education :

The Faculty of Engineering prepares men and women for professional careers in engineering and for responsible positions of a technical and semitechnical character in industry, commerce, education, and government.

At present, the Faculty of Engineering offers courses leading to Bachelor, Master, and Doctoral degrees in Engineering, Master degree in Science as well as Graduate Diploma. The curricula are administered by the departments shown below.

Department	B.Eng	M. Eng.	M.Sc.	D.Eng /Ph.D.	D.Sc
- Civil Engineering	✓	✓	-	✓ (International Program)	-
- Electrical Engineering	✓	✓	-	✓	-
- Mechanical Engineering	✓	✓	-	✓	-
- Industrial Engineering	✓	✓	-	✓	-
- Chemical Engineering	✓	✓	-	✓	-
- Chemical and Process Engineering (International Program)	✓	-	-	-	-
- Mining and Petroleum Engineering	✓	✓ (International Program)	-	✓ (International Program)	-
- Environmental Engineering	✓	✓	-	✓	-
- Survey Engineering	✓	✓	-	✓	-
- Metallurgical Engineering	✓	✓	-	✓	-
- Computer Engineering	✓	✓	✓	✓	-
- Nuclear Engineering	✓	✓	✓	✓	-
- Water Resources Engineering	-	✓	✓	✓	✓
- Regional Centre For Manufacturing Systems	-	□ (International Program)	-	-	-
- Automotive Design and Manufacturing Engineering (International Program)	✓	-	-	-	-
- Nano Engineering (International Program)	✓	-	-	-	-
- Aerospace Engineering (International Program)	✓	-	-	-	-
- Information and Communication Engineering (International Program)	✓	-	-	-	-
- Robotics and Artificial Intelligence Engineering (International Program)	✓	-	-	-	-
- Biomedical Engineering	-	✓	✓	-	✓
- Defense Engineering and Technology	-	✓	-	-	-
- Innovative Engineering for Sustainability	-	-	✓	-	-

Details of the graduate degrees in Engineering can be found in the h andbook on Graduate Studies.

Research

The current development in Engineering, Science and Technology is a result of extensive research endeavors worldwide. Recognizing the vast impact of research on engineering education and on the industrial development as a whole, the Faculty of Engineering is determined to drive itself to be a research-oriented one. Faculties are encouraged to engage actively in research activities. Inevitably, engineering students, at one stage of their education at the Faculty, can learn from the research projects in which they participate. A strong emphasis is placed in research because the key element to a better understanding of engineering necessitates that practical work and research be conducted in order to complement theoretical studies. Students also gain 'hands-on experience'. Research is a source of learning and transferring of knowledge by the principles of academic freedom.

Services

The Faculty provides academic services to the public in the form of seminars, training courses, technical conferences, continual education and technical consultancy in all engineering disciplines. The array of equipment at the Faculty of Engineering are also utilized to service small, medium and multi-national industries in Thailand as well as other governmental agencies in the form of material and product testing.

SERVICES AND FACILITIES

Campus

The University compound is located between Phya Thai and Henry Dunant Road in Bangkok, a city of more than eight million people. The Faculty of Engineering occupies a large section on the south of the campus. These include four main office and classroom buildings which house a large library and an auditorium of 600 seats. Other buildings are Department of Civil, Electrical, Mechanical, Industrial, Chemical, Mining and Petroleum, Environmental, Survey, Computer, Nuclear Technology, Water Resources, The Regional centre for Manufacturing Systems Engineering and International office.

Laboratories

The Faculty has well-equipped laboratory facilities for conducting experiment associated with classroom courses in various departments. Facilities of testing according to industrial standards and facilities of testing for student thesis, dissertation, and for faculty research are also provided.

The Engineering Library

Located on the 3rd floor of the Engineering building #3 is our newly renovated Engineering Library, equipped with state-of-the art multimedia system for digital online searching services, modernized study areas and seminar rooms. It also contains a collection of more than 60,000 volumes of technical literatures, text-books, standard books as well as audio visual tape, CD-ROM multimedia and 95 periodicals which cover practically all branches of engineering

Engineering Computer Center

Engineering Computer Center (ECC) was established in 1984 to provide and support computer services and related facilities which concentrate on engineering applications. The ECC provides not only computing facilities for training of engineering students and for research and development in various engineering disciplines, but also some specific engineering applications and professional services to industrial sectors such as Database applications, Computer Aided Design, Finite Element Analysis, Mathematics related applications, System Simulations, etc.

The ECC is one of the largest faculty-level computer center in Thailand. The facilities include various models and sizes of Computer Servers, Engineering Workstations both UNIX and Windows-based, network printing, and Web-based learning facilities. All of these facilities are connected to the Chulalongkorn University Network (ChulaNet) and wirelessly to the ChulaWiFi which provides free internet access to students and personnel throughout the university campus. Chulalongkorn University is a member of the eduroam, a secure, world-wide roaming access service developed for the international research and education community. Every student and staff can connect to the Internet via any eduroam-enabled network when you roam to other eduroam member sites. Please refer to http://eduroam.uni.net.th and http://www.eduroam.org for more details.

Accommodations

Chulalongkorn University provides five dormitories for unmarried students. Two for Thai male, two for Thai female, and one for international students. Private accommodation may also be found in the nearby area.

Scholarships and Financial Aids

A number of scholarships are available for needy students with good academic and behavior records or outstanding in his/her field of study. Financial aids are also provided for students with urgent financial problems.

University Healthcare

The University maintains a clinic where medical care for minor illness and injuries is provided for students free of charge. The Health Center is located at Jamjuree 9 Building. The center is open every weekday from 8.00 a.m. to 4.00 p.m.

Reserve Officer Training Corp (ROTC) Program

Students of Chulalongkorn University are eligible to apply for training in the Reserve Officer Training Corp Program. Male students who do not participate in the program, or have not completed the third year of the program, may apply for deferment of conscription for military service.

ADMISSION REQUIREMENTS

To be eligible for admission to Faculty of Engineering an applicant must meet the following requirements :

1. He/she must hold a Mathayom Suksa 6 (Grade 12) certificate from a High-School or other equivalent which the University recognizes as being acceptable,

2. He/she must have passed the competitive entrance examination held annually by the Commission On Higher Education.

GENERAL REGULATIONS

Registration

Students must register at the time appointed to enroll according to academic calendar in each year. Late registration will be penalized by additional fees.

Student Advisors

Each student will be assigned to a faculty advisor after notification of his/her admission, throughout his/her academic program. The student must consult and seek approval from his/her advisor in all matters of program planning for his/her study before registration.

Grading System

The quality of the student's work will be evaluated as follows :

GRADE	DEFINITION	GRADE POINT
A	Excellent	4.0
B+	Very Good	3.5
B	Good	3.0
C+	Fairly Good	2.5
C	Fair	2.0
D+	Poor	1.5
D	Very Poor	1.0
F	Fail	0.0

In addition, the following letter symbols may also given :

I (Incomplete)
P (In progress)
S (Satisfactory)
U (Unsatisfactory)
V (Visitor)
W (Withdrawn)
M (Missing)
X (No report)

Academic Performance Evaluation and Disqualification

One lecture or discussion-hour per week in a semester is equal to one Unit of Credit. Three hours of Laboratory work per week in a semester are also equivalent to one Unit of Credit.

The overall scholastic performance of a student is average and expressed in a semester as a Grade-Point Average (GPA) and annually as a Cumulative Grade-Point Average (GPAX). The GPA is obtained by the sum of the products of grade points and units of credit divided by the total units of credit for which grades A,B+,B,C+,C,D+,D and F in each semester are received. Grades P,S,U,V,W,M and X are disregarded in the computation for GPA.

The grade I (Incomplete) may be replaced if the student completes his/her work of that course with the approval of the instructor within the second week of the subsequent semester. If the work is not done or un-approved within this limit of time, the grade I will be automatically converted to grade F.

A student may repeat his/her course only for the course which he/she has received a grade D+,D, F, or U. When a course is repeated, the units of credit shall be counted toward a degree only once, but the student's Grade-Point Average will be computed on the total number of credits attempted. To be qualified for graduation, a student must pass all the required courses with the Cumulative Grade-Point Average of at least 2.00. An undergraduate student who receives his/her Cumulative Grade-Point Average less than 2.00 will be classified as on academic probation. This probation can be removed when that student can increase his/her GPAX greater than or equal to 2.00.

An undergraduate student will be disqualified for further registration in the Faculty when

(a) his/her GPAX falls less than 1.50 at the end of any semester except for the first semester, or

(b) his/her GPAX is less than 1.80 for two consecutive semesters during his/her academic probation, or

(c) his/her GPAX is less than 2.00 for four consecutive semesters during his/her academic probation.

(d) his/her GPAX is less than 2.00 or the number of total credits is less than the course's requirement within 16 semesters for four-academic years

Adding or Dropping Courses

A request for adding or dropping courses after registration must be approved by the student's advisor. For the withdraw, the request must be approved by the dean of Faculty as well.

Adding courses can be made within the first two weeks of a regular semester or within the first week of a summer semester.

Dropping courses can be made within the first six weeks of a regular semester or within the first two weeks of summer semester. Any attempt to drop courses after these periods shall be considered as withdraw which these courses will be shown in the student's transcript of record with the letter symbol "W".

Class Attendance

A minimum attendance for class participation of students is 80 percent, otherwise he/she will not be allowed to attend an examination.

Graduation Honors

There are two classes of honors. The first class honors is awarded to graduates who received a Bachelor of Engineering with cumulative grade-point average is equal to or higher than 3.60 in four academic years and never receive grade F and U in any subject. Similarly requirements apply to those who received the second class honors, except the cumulative grade-point average is equal to or higher than 3.25.

Gold medal will be awarded to the outstanding student who has completed all the curriculum requirements with the highest ranking among the students of the same professional for the same academic year in addition to his/her first class honors.

TUITION AND FEES

Tuition fees :

Thai Students Undergraduate Programs

Regular semester	25,500 baht per semester
Summer session	6,375 baht per session

Thai Students Graduate Programs

Regular semester	33,500 baht per semester
Summer session	8,375 baht per session

Foreign Students Undergraduate Programs

Regular semester	79,500 baht per semester
Summer session	44,630 baht per session

Foreign Students Graduate Programs

Regular semester	93,500 baht per semester
Summer session	49,440 baht per session

Notes : The rates for special programs are set separately. Details may be requested directly from each program.

LIST OF DEPARTMENTS

Code No.	Name
2101	Department of Civil Engineering
2102	Department of Electrical Engineering
2103	Department of Mechanical Engineering
2104	Department of Industrial Engineering
2105	Department of Chemical Engineering
2106	Department of Mining and Petroleum Engineering
2107	Department of Environmental Engineering
2108	Department of Survey Engineering
2109	Department of Metallurgical Engineering
2110	Department of Computer Engineering
2111	Department of Nuclear Engineering
2112	Department of Water Resources Engineering
2163	The Regional Centre for Manufacturing Systems Engineering
2141	Nano Engineering (International Program)
2142	Automotive Design and Manufacturing Engineering (International Program)
2143	Information and Communication Engineering (International Program)
2145	Aerospace Engineering (International Program)
2147	Robotics and Artificial Intelligence Engineering (International Program)
2185	Chemical and Process Engineering (International Program)

CURRICULUM INFORMATION

Faculty of Engineering offers the programs leading to Bachelor degrees in Civil Engineering, Electrical Engineering, Mechanical Engineering, Naval Architecture and Marine Engineering, Automotive Engineering, Industrial Engineering, Chemical Engineering, Mining and Petroleum Engineering, Environmental Engineering, Survey Engineering, Metallurgical Engineering, Computer Engineering, and Nuclear Engineering, Nowadays, we provide the international programs in Nano Engineering, Automotive Design and Manufacturing Engineering, Information and Communication Engineering , and Aerospace Engineering. The student is required to select a program of study after he/she has completed his/her second semester, except for international program, and some specific programs.

General Education		**(30 Credits)**
Social Science*		3 credits
Humanities*		3 credits
Science and Mathematics*		3 credits
Interdisciplinary*		3 credits
English		12 credits
General Education, Special		6 credits
2100111	Exploring Engineering World (compulsory)	3 credits
21xxxxx	General Education, Special	3 credits

*The subject should be chosen from the list approved by General Education Office except English.

AI-Digital Big Data **(6 Credits)**

Interdisciplinary and 21ST Century Skills **(6 Credits)**

Basic Science and Mathematics	**(18–30 Credits)**
Mathematics (2301107–108, and/or 2301207, and/or 2603284)	6–12 credits
Physics (2304103–104, 2304183–184)	8 credits
Chemistry (2302127, 2302163)	4 credits

Basic Engineering		**(9–26 Credits)**
2100301	Eng Practice	2 credits
2103106	Eng Drawing	3 credits
2103213	Eng Mechanics I**	3 credits
2109101	Eng Materials	3 credits
2110101	Comp Prog	3 credits

Program Core Courses

Each Program has its area of concentration which is composed of compulsory courses and approved electives. The total number of core course credit of each program is about 40–75 credits.

Approved Electives

Each engineering curriculum offers some approved electives. All elective courses must be chosen from departmentally approved list.

Free Electives

A student has a free selection of courses of 3–6 credits which are offered by any faculty in the University.

The total number of credits for graduation from The Faculty of Engineering must not be less than the amount of the credits which are specified by each curriculum.

Each undergraduate is required to undertake a minimum of six weeks practical training in industry as the part of the course 2100301 Engineering Practice, which is offered for the third year student in the summer session, before graduation. Work in the laboratory is also brought into sharper focus by the fourth year senior project. The engineering project work, which is aimed at providing the student with experience similar to those of practicing engineers, is a compulsory course of all departments

Type 1.1

(**Department of Civil Engineering / Electrical Engineering / Mechanical Engineering / Industrial Engineering / Chemical Engineering / Mining and Petroleum**)

(**This type is assigned to the first-year students meanwhile do not belong to any Department**)

FIRST YEAR CURRICULUM

FIRST SEMESTER

GROUP I			GROUP II		
COURSE NO.	**SUBJECT**	**CREDITS**	**COURSE NO.**	**SUBJECT**	**CREDITS**
2103106	ENG DRAW	3	2109101	ENG MATERIALS	3
2301107	CALCULUS I	3	2110101	COMP PROG	3
2302127	GEN CHEM	3	2301107	CALCULUS I	3
2302163	GEN CHEM LAB	1	2304103	GEN PHYS I	3
2304103	GEN PHYS I	3	2304183	GEN PHYS LAB I	1
2304183	GEN PHYS LAB I	1	5500111	EXP ENG I	3
5500111	EXP ENG I	3	2100111	EXPL ENG WORLD	3
		17			***19***

SECOND SEMESTER

GROUP I			GROUP II		
2100111	EXPL ENG WORLD	3	2103106	ENG DRAW	3
2109101	ENG MATERIALS	3	2301108	CALCULUS II	3
2110101	COMP PROG	3	2302127	GEN CHEM	3
2301108	CALCULUS II	3	2302163	GEN CHEM LAB I	1
2304104	GEN PHYS II	3	2304104	GEN PHYS II	3
2304184	GEN PHYS LAB II	1	2304184	GEN PHYS LAB II	1
5500112	EXP ENG II	3	5500112	EXP ENG II	3
		19			***17***

TOTAL COMMON CREDITS = 36

* **2109101 ENG MATERIALS is set as a general education, special course for students of Department of Civil Engineering / Electrical Engineering / Mining and Petroleum**

Type 1.2
(**Department of Metallurgical Engineering**)

FIRST YEAR CURRICULUM

FIRST SEMESTER

GROUP I			**GROUP II**		
COURSE NO.	**SUBJECT**	**CREDITS**	**COURSE NO.**	**SUBJECT**	**CREDITS**
2103106	ENG DRAW	3	*2109101	ENG MATERIALS	3
2301107	CALCULUS I	3	2301107	CALCULUS I	3
2302127	GEN CHEM	3	2304103	GEN PHYS I	3
2302163	GEN CHEM LAB	1	2304183	GEN PHYS LAB I	1
2304103	GEN PHYS I	3	5500111	EXP ENG I	3
2304183	GEN PHYS LAB I	1	2100111	EXPL ENG WORLD	3
5500111	EXP ENG I	3	xxxxxxx	General Education	3
		17			***19***

SECOND SEMESTER

GROUP I			**GROUP II**		
2100111	EXPL ENG WORLD	3	2103106	ENG DRAW	3
*2109101	ENG MATERIALS	3	2301108	CALCULUS II	3
2301108	CALCULUS II	3	2302127	GEN CHEM	3
2304104	GEN PHYS II	3	2302163	GEN CHEM LAB I	1
2304184	GEN PHYS LAB II	1	2304104	GEN PHYS II	3
5500112	EXP ENG II	3	2304184	GEN PHYS LAB II	1
xxxxxxx	General Education	3	5500112	EXP ENG II	3
		19			***17***

TOTAL COMMON CREDITS = 36

* **2109101 ENG MATERIALS is set as a general education, special course**

Type 2
(**Department of Survey Engineering**)

FIRST YEAR CURRICULUM

FIRST SEMESTER

GROUP I			**GROUP II**		
COURSE NO.	**SUBJECT**	**CREDITS**	**COURSE NO.**	**SUBJECT**	**CREDITS**
2103106	ENG DRAW	3	*2110101	COMP PROG	3
2301107	CALCULUS I	3	2301107	CALCULUS I	3
2304103	GEN PHYS I	3	2304103	GEN PHYS I	3
2304183	GEN PHYS LAB I	1	2304183	GEN PHYS LAB I	1
*2104201	ENG STAT I	3	5500111	EXP ENG I	3
5500111	EXP ENG I	3	2100111	EXPL ENG WORLD	3
		16			***16***

SECOND SEMESTER

GROUP I			**GROUP II**		
2100111	EXPL ENG WORLD	3	2103106	ENG DRAW	3
2301108	CALCULUS II	3	2301108	CALCULUS II	3
2304104	GEN PHYS II	3	*2104201	ENG STAT I	3
2304184	GEN PHYS LAB II	1	2304104	GEN PHYS II	3
*2110101	COMP PROG	3	2304184	GEN PHYS LAB II	1
5500112	EXP ENG II	3	5500112	EXP ENG II	3
		16			***16***

TOTAL COMMON CREDITS = 32

* **2110101 COMP PROG is set as a general education, special**

Type 3.1
(**Department of Computer Engineering**)

FIRST YEAR CURRICULUM

FIRST SEMESTER

GROUP I			**GROUP II**		
COURSE NO.	**SUBJECT**	**CREDITS**	**COURSE NO.**	**SUBJECT**	**CREDITS**
2304103	GEN PHYS I	3	2110101	COMP PROG	3
2304183	GEN PHYS LAB I	1	2301107	CALCULUS I	3
2301107	CALCULUS I	3	2304103	GEN PHYS I	3
2110101	COMP PROG	3	2304183	GEN PHYS LAB I	1
2100111	EXPL ENG WORLD	3	*2110215	PROG METH I	3
5500111	EXP ENG I	3	2302127	GEN CHEM	3
			2302163	GEN CHEM LAB I	1
			5500111	EXP ENG I	3
		16			***20***

SECOND SEMESTER

GROUP I			**GROUP II**		
*2110215	PROG METH I	3	*2110221	COMP ENG ESS	3
*2110221	COMP ENG ESS	3	2301108	CALCULUS II	3
2301108	CALCULUS II	3	2304104	GEN PHYS II	3
2302127	GEN CHEM	3	2304184	GEN PHYS LAB II	1
2302163	GEN CHEM LAB I	1	2100111	EXPL ENG WORLD	3
2304104	GEN PHYS II	3	5500112	EXP ENG II	3
2304184	GEN PHYS LAB II	1			
5500112	EXP ENG II	3			
		20			***16***

TOTAL COMMON CREDITS = 36

* **2110101 COMP PROG is set as a general education, special**
* **2110215 PROG METH I is set as required courses**

Type 3.2
(**Department of Nuclear Engineering**)

FIRST YEAR CURRICULUM

FIRST SEMESTER

GROUP I			**GROUP II**		
COURSE NO.	**SUBJECT**	**CREDITS**	**COURSE NO.**	**SUBJECT**	**CREDITS**
2301107	CALCULUS I	3	*2109101	ENG MATERIALS	3
2302127	GEN CHEM	3	2110101	COMP PROG	3
2302163	GEN CHEM LAB	1	2301107	CALCULUS I	3
2304103	GEN PHYS I	3	2304103	GEN PHYS I	3
2304183	GEN PHYS LAB I	1	2304183	GEN PHYS LAB I	1
5500111	EXP ENG I	3	5500111	EXP ENG I	3
xxxxxxx	General Education	3	2100111	EXPL ENG WORLD	3
		17			***19***

SECOND SEMESTER

GROUP I			**GROUP II**		
2100111	EXPL ENG WORLD	3	2301108	CALCULUS II	3
*2109101	ENG MATERIALS	3	2302127	GEN CHEM	3
2110101	COMP PROG	3	2302163	GEN CHEM LAB I	1
2301108	CALCULUS II	3	2304104	GEN PHYS II	3
2304104	GEN PHYS II	3	2304184	GEN PHYS LAB II	1
2304184	GEN PHYS LAB II	1	5500112	EXP ENG II	3
5500112	EXP ENG II	3	xxxxxxx	General Education	3
		19			***17***

TOTAL COMMON CREDITS = 36

* **2109101 ENG MATERIALS is set as a general education, special**

DEPARTMENT OF CIVIL ENGINEERING

The department's curriculum is designed to provide the students with broad educational and professional perception as well as to enhance their effectiveness as practitioners and researchers in the field of modern civil engineering, which includes planning, analysis, design and construction of buildings, bridges, foundations, dams, hydraulic structures, and transportation facilities. It contains courses in mathematics, related basic sciences, fundamentals of general engineering and specific civil engineering subjects. Besides, the students are required to fulfill selected courses in English, humanities, and social sciences to broaden their outlooks in their future careers.

Laboratories in various divisions and research units of the department are set up to supplement classroom work and to facilitate the study of advanced topics.

The department offers a 4-year undergraduate program leading to the Bachelor of Engineering degree as well as graduate programs for Master and Doctor of Engineering degrees.

HEAD :

Boonchai	Stitmannaithum,	D.Eng. (Tokyo)

PROFESSORS :

Akhrawat	Lenwari,	Ph.D. (Chula)
Anat	Ruangrassamee,	Ph.D. (Tokyo Tech)
Boonchai	Stitmannaithum,	D.Eng. (Tokyo)
Boonchai	Ukritchon,	Sc.D. (MIT)
Jaroon	Rungamornrat,	Ph.D. (UT Austin)
Kasem	Choocharukul,	Ph.D. (Purdue)
Saksith	Chalermpong,	Ph.D. (UC Irvine)
Suched	Likitlersuang,	D.Phil. (Oxford)
Supot	Techavorasinskun,	D.Eng. (Tokyo)
Teerapong	Senjuntichai,	Ph.D. (Manitoba)
Thanyawat	Pothisiri,	Ph.D. (UI Urbana-Champaign)
Tospol	Pinkaew,	D.Eng. (Tokyo)
Veerasak	Likhitruangsilp,	Ph.D. (Michigan)
Withit	Pansuk,	Ph.D. (Hokkaido)

ASSOCIATE PROFESSORS :

Boonchai	Sangpetngam,	Ph.D. (Florida)
Charinee	Limsawasd,	Ph.D. (Florida International)
Chatpan	Chintanapakdee,	Ph.D. (UC Berkeley)
Jittichai	Rudjanakanoknad,	Ph.D. (UC Berkeley)
Manoj	Lohatepanont,	Sc.D. (MIT)
Nakhon	Kokkaew,	Ph.D. (Columbia)
Noppadon	Jokkaw,	Ph.D. (Chula)
Phoonsak	Pheinsusom,	D.Eng. (Tokyo)
Pitcha	Jongvivatsakul,	Ph.D. (Tokyo Tech)
Sawekchai	Tangaramvong,	Ph.D. (UNSW)
Sorawit	Narupiti,	Ph.D. (Michigan State)
Tidarut	Wisuthseriwong,	Ph.D. (Hokkaido)
Tirawat	Boonyatee,	D.Eng. (Kyoto)
Vachara	Peansupap,	Ph.D. (RMIT)
Watanachai	Smittakorn,	Ph.D. (Colorado State)

ASSISTANT PROFESSORS :

Chayut	Ngamkhanong,	Ph.D. (Birmingham)
Manop	Kaewmoracharoen,	Ph.D. (Iowa State)
Tanate	Srisirirojanakorn,	Ph.D. (UI Urbana-Champaign)
Veerayut	Komolvilas,	D.Eng. (Yokohama National)
Pongsun	Bunditsakulchai,	D.Phil. (Tohoku)

CIVIL ENGINEERING CURRICULUM
FIRST YEAR CURRICULUM

COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER	
2100201	INTRO TO AI	3
2101252	STAT CE	3
2103213	ENG MECH I	3
2112342	PRIN HYDROLOGY	3
2301207	CALCULUS III	3
5500208	COM PRES SKLL	3
		18
	FOURTH SEMESTER	
2100202	INTRODUCTION TO DATA SCIENCE AND BIG DATA	3
2101202	MECH MAT I	3
2101253	APP MATH CE	3
2101254	GEOL CE	2
2108298	SURVEYING	3
2112347	FUND HYDRAULICS	2
xxxxxxx	GENERAL EDUCATION	3
		19
	FIFTH SEMESTER	
2101313	STRUCT ANAL	3
2101315	CIV ENG MAT	3
2101321	SOIL MECHS	3
2101322	SOIL MECHS LAB	1
2101337	TRANS ENG	3
2112344	HYDRAULIC LAB I	1
5500308	TECH WRIT ENG	3
		17

COURSE NO.	SUBJECT	CREDITS
	SIXTH SEMESTER	
2101314	STRUCT DESIGN I	3
2101338	HIGHWAY ENG	3
2101421	GEO ENG DES CONS	3
2112440	HYDRAULIC ENG	3
2108306	FLD PRAC TOPO SURV	1
2100223	ENTREPRENEURSHIP AND New VENTURE CREATION	3
xxxxxxx	GENERAL EDUCATION	3
		19
	SUMMER SEMESTER	
2100301	ENG PRACTICE	2
		2
	SEVENTH SEMESTER	
2101408	STRUCT DESIGN II	3
2101456	CONSTRUCTION COST ESTIMATING AND SUPERVISION	3
xxxxxxx	GENERAL EDUCATION	3
xxxxxxx	GENERAL EDUCATION	3
xxxxxxx	FREE ELECTIVES	3
		15
	EIGHTH SEMESTER	
2101454	CONST MANAGEMENT	3
2101491	CIVIL ENGINEERING CAPSTONE PROJECT	3
2101499	CIVIL ENG PROJECT	3
or 2100499	ENG PROJ	3
xxxxxxx	FREE ELECTIVES	3
		12

TOTAL CREDITS FOR GRADUATION = 138

CIVIL ENGINEERING

NAME OF THE MASTER'S DEGREE

: Master of Engineering

: M. Eng.

NAME OF THE DOCTORAL DEGREE

: Doctor of Philosophy

: Ph.D.

ADMISSION

To be eligible for admission to the M.Eng. program, an applicant must meet two basic requirements:

1. Hold a Bachelor's degree in Civil Engineering or equivalent.

2. Have other qualifications as prescribed by the regulations of the Graduate School or the committee of the program considers acceptable for admission.

To be eligible for admission to the Ph.D. program, an applicant must meet two basic requirements:

1. Hold a Bachelor's Degree in Civil Engineering or equivalent with a minimum of second-class honor (GPA > 3.25/4.00) for Option 3; or hold a Master's Degree in Civil Engineering or equivalent with good academic records for Option 2 and excellent academic records for Option 1.

2. Have other qualifications as prescribed by the regulations of the Graduate School or the committee of the program considers acceptable for admission.

DEGREE REQUIREMENTS

An acceptable thesis of not less than 12 credits, together with 9 credits of core courses plus 15 credits of elective courses are required for the Master's degree.

A student who has fulfilled the requirements of the Master's program with a passing grade point average of not less than 3.00, passing English examination and a minimum of one published technical paper. A period of study of not more than 8 regular semesters will be awarded the degree of Master of Engineering.

An acceptable dissertation of not less than 60 credits for Option 1 and 48 credits of Option 2 and Option 3 together with 12 credits of elective courses for Option 2 for or 9 credits of core courses plus 15 credits of elective courses for Option 3 are required for the Ph.D. Degree.

A student must fulfill the requirements of the Graduate school by passing the English examination and publishing technical papers in international peer – reviewed journals. The maximum period of study is 5 academic years for Option 1 and Option 2 and 8 academic years for Option 3.

COURSE REQUIREMENTS

A student must choose his major area of study from one of the followings:

1) Core Courses

Structural Engineering –STR (6 Credits)

2101601	Advanced Structural Theory	3(3-0-9)
2101602	Introduction to Solid Mechanics	3(3-0-9)

Geotechnical Engineering –GEO (9 Credits)

2101621	Foundation Engineering	3(3-0-9)
2101637	Advanced Soil Mechanics	3(3-0-9)
2101835	Earth and Retaining Structures	3(3-0-9)

Transportation Engineering –TRN (6 Credits)

2101660	Transportation Systems	3(3-0-9)
2101663	Research Methodology in Transportation	3(3-0-9)

Construction Engineering and Management –CEM (9 Credits)

2101690	Construction Methods and Equipment	3(3-0-9)
2101692	Analytical Methods in Construction Management	3(3-0-9)
2101870	Construction Project Management	3(3-0-9)

2) Elective Courses

Students must contact academic advisor to enroll elective courses. All elective courses with the code 21015xx do not comply with the requirements for a Ph.D. degree

Structural Engineering –STR (18 Credits)

2101510	Computer Methods for Civil Engineering	3(3-0-9)
2101512	Advanced Concrete Technology	3(3-0-9)
2101546	Introduction to Finite Element Method	3(3-0-9)
2101566	Dynamics of Structures	3(3-0-9)
2101606	Dynamics and Vibrations	3(3-0-9)
2101611	Matrix Analysis of Structures	3(3-0-9)
2101614	Behavior of Steel Structures	3(3-0-9)
2101616	Plasticity in Reinforced Concrete	3(3-0-9)
2101618	Finite Element Method for Civil Engineers	3(3-0-9)
2101619	Seismic Design of Structures	3(3-0-9)
2101680	Applied Mathematics I	3(3-0-9)
2101701	Special Topics in Structural Engineering I	3(3-0-9)
2101702	Special Topics in Structural Engineering II	3(3-0-9)
2101799	Boundary Integral Equation Method for Applied Mechanics	3(3-0-9)
2101800	Advanced Solid Mechanics	3(3-0-9)
2101801	Fracture Mechanics	
2101804	Behavior of Reinforced Concrete Structures	3(3-0-9)
2101806	Numerical and Approximate Methods for Structural Engineering	3(3-0-9)
2101810	Fire Safety Design of Structures	3(3-0-9)
2101818	Life Cycle of Concrete Structures	3(3-0-9)

Geotechnical Engineering –GEO (15 Credits)

For the elective course of 15 credits, students are required to choose 9 credits from Group 1 and 6 credits either from Group 1 or Group 2, based on the approval of their advisor.

Group 1

2101524	Computer Programming and Computer Tools for Graduate Research	3(3-0-9)
2101534	Computer Application for Geotechnical Engineering	3(3-0-9)
2101535	Tunnel Engineering	2(2-0-6)
2101624	Elasticity in Soil Mechanics	3(3-0-9)
2101632	Rock Mechanics	3(3-0-9)
2101634	Plasticity in Soil Mechanics	3(3-0-9)
2101636	Interpretation of Field Exploration and Soil Testing	3(3-0-9)
2101639	Special Study in Soil Engineering	3(3-0-9)
2101820	Geo-environment Engineering	3(3-0-9)
2101821	Deep Foundation Design	3(3-0-9)
2101824	Finite Element Method in Geotechnical Engineering	3(3-0-9)
2101831	Engineering Ground Modification	3(3-0-9)
2101832	Engineering Geophysics	3(3-0-9)
2101833	Soil Dynamics and Earthquake Engineering	3(3-0-9)

Group 2

2101512	Advanced Concrete Technology	3(3-0-9)
2101546	Introduction to Finite Element Method	3(3-0-9)
2101557	Pavement Design	3(3-0-9)
2101561	Railway Track Engineering	3(3-0-9)
2101606	Dynamics and Vibrations	3(3-0-9)
2101619	Seismic Design of Structures	3(3-0-9)
2101804	Behavior of Reinforced Concrete Structures	3(3-0-9)

Transportation Engineering–TRN (15 Credits)

2101520	Statistical Methods for Transportation Analysis	3(3-0-9)
2101552	Fundamentals of Road Safety	3(3-0-9)
2101553	Public Transit Systems Planning and Operations	3(3-0-9)
2101554	Evaluation of Transportation Project and Policy	3(3-0-9)
2101555	Travel Behavior Survey and Analysis	3(3-0-9)
2101556	Air Transportation System	3(3-0-9)
2101557	Planning and Management of Airport System	3(3-0-9)
2101558	Transportation and Logistics System Optimization	3(3-0-9)
2101559	Traffic Engineering	3(3-0-9)
2101561	Railway Track Engineering	3(3-0-9)
2101568	Railway Infrastructure Asset Management	3(3-0-9)
2101569	Train-Track Interaction	3(3-0-9)
2101666	Intelligent Transportation Systems	3(3-0-9)
2101741	Traffic Simulation	3(3-0-9)
2101742	Advanced Transportation and Logistics System Optimization	3(3-0-9)
2101743	Impact Analysis of Transportation and Logistics System	3(3-0-9)
2101744	Transportation and Logistics Infrastructures	3(3-0-9)
2101745	Transportation Operations	3(3-0-9)
2101841	Special Studies in Transportation Engineering	3(3-0-9)

Construction Engineering and Management–CEM (15 Credits)

2101535	Tunnel Engineering	3(3-0-9)
2101550	Civil Engineering Project Planning	3(3-0-9)
2101580	Construction information Management	3(3-0-9)
2101590	Construction Techniques and Productivity	3(3-0-9)
2101621	Foundation Engineering	3(3-0-9)
2101649	Probability Statistics and Decision for Civil Engineering	3(3-0-9)
2101691	Special Studies	3(3-0-9)
2101694	Contracting in Construction Business	3(3-0-9)
2101695	Computer Applications in Construction	3(3-0-9)
2101697	Infrastructure Planning and Management	3(3-0-9)
2101698	Construction Business Management	3(3-0-9)
2101831	Engineering Ground Modification	3(3-0-9)
2101871	Risk Management in Civil and Environmental Engineering Systems	3(3-0-9)
2101873	Special Topics in Construction Engineering and Management	3(3-0-9)
2601511	Financial and Managerial Accounting	3(3-0-9)
2604501	Financial Management	3(3-0-9)

3) Thesis and Seminar

2101793	Graduate Seminar in Civil Engineering	3(3-0-9)
2101811	Thesis	12 credits
2101828	Dissertation	48 credits
2101829	Dissertation	60 credits
2101894	Doctoral Dissertation Seminar	0(0-0-0)
2101897	Qualifying Examination	0(0-0-0)

PROGRAM OF STUDY (CIVIL ENGINEERING)

Year	Semester	M.Eng.	Ph.D. (Option 1)	Ph.D. (Option 2)	Ph.D. (Option 3)
1	1	Core Courses 6 credits (STR, TRN) Core Courses 9 credits (GEO, CEM) Elective Courses 6 credits (STR, TRN) Elective Courses 3 credits (GEO, CEM)	Dissertation 10 credits	Elective Courses 6 credits Dissertation 8 credits	Core Courses 6 credits (STR, TRN) Core Courses 9 credits (GEO, CEM) Elective Courses 6 credits (STR, TRN) Elective Courses 3 credits (GEO, CEM)
	1	Elective Courses 12 credits Elective Courses 12 credits	Dissertation 10 credits	Elective Courses 6 credits Dissertation 8 credits	Elective Courses 12 credits Elective Courses 12 credits
2	1	Thesis 6 credits	Dissertation 10 credits	Dissertation 8 credits	Dissertation 6 credits
	2	Thesis 6 credits	Dissertation 10 credits	Dissertation 8 credits	Dissertation 6 credits
3	1		Dissertation 10 credits	Dissertation 8 credits	Dissertation 6 credits
	2		Dissertation 10 credits	Dissertation 8 credits	Dissertation 6 credits
4	1				Dissertation 6 credits
	2				Dissertation 6 credits
5	1				Dissertation 6 credits
	2				Dissertation 6 credits

COURSE DESCRIPTIONS

2101202 Mechanics of Materials I 3(3-0-6)

Fundamental concepts of stress and strain; axially loaded members; torsion; shear force; bending moment in beams; deflection of beams; stresses in beams; composite beams; unsymmetrical bending; buckling of columns; combined stresses and Mohr's circle; failure criterion.

2101252 Statistics for Civil Engineering 3(3-0-6)

Necessity of statistical methods in civil engineering; probability theory; random variables; probability distribution models in civil engineering; statistical estimation and hypothesis testing in civil engineering; applications of regression analysis in civil engineering.

2101253 Applied Mathematics for Civil Engineers 3(3-0-6)

Condition: Prerequisite 2301207

Introduction to linear algebra, matrices and matrix operations, linear and nonlinear algebraic equations, eigen value problems; Fourier and Laplace transforms, series representation of functions, ordinary differential equations and partial differential equations; introduction to vector calculus, vector fields, differential and integral operators, integral theorems and applications; introduction to optimization problems; introduction to numerical techniques and the theory of approximations, and applications in civil engineering.

2101254 Geology for Civil Engineers 2(2-0-4)

A general survey of geology with particular reference to civil engineering; common rock forming minerals; general characteristics and origins of rocks; features of the earth and geological process; structural features of the earth's crust; geology of water supply, reservoirs and dam sites, erosion and flood control; river and harbor improvement; geological factors affecting quarrying, tunneling, landslide, land subsidence, foundations and building materials.

2101313 Structural Analysis 3(3-0-6)

Condition: Co-requisite 2101202

Introduction to structural analysis; degree of statical indeterminacy and stability of structures; analysis of statically determinate structures for reactions, internal forces, displacements, and rotations; introduction to analysis of structures by flexibility and stiffness methods; analysis of structures under moving loads; analysis of structures by computer software

2101314 Structural Design I 3(2-3-4)

Condition: Co-requisite 2101313

Concrete and reinforcement; design code; loads such as gravity load, wind load, and earthquake load; fundamental behavior in axial load, flexural load, torsional load, shear load, bond, and combined actions; design of structural reinforced concrete members; practice in design and detailing

2101315 Civil Engineering Materials 3(2-3-4)

Fundamental behaviors and properties, introduction to inspection and testing of various civil engineering materials such as cement, aggregates and admixtures, mix design, fresh and hardened concrete, highway materials, others civil engineering materials.

2101321 Soil Mechanics 3(3-0-6)

Condition: Prerequisite 2101254 or 2106296

Soil formation, index properties and classification of soil, compaction, permeability of soil and seepage problems, principle of effective stresses within a soil mass; stress distribution, compressibility of soil, shear strength of soil, earth pressure theory, slope stability, bearing capacity.

2101322 Soil Mechanics Laboratory 1(0-3-0)

Condition: Concurrent 2101321

Soil exploration; index properties of soils; permeability; compaction; CBR; stress-strain behavior of soils; shear strength and one dimensional consolidation.

2101337 Transportation Engineering 3(3-0-6)

Introduction to transportation engineering; principles and concepts of transportation including transportation demand and supply; fundamental traffic operations and transportation system analysis; transportation economics, and transportation planning concepts.

2101338 Highway Engineering 3(2-3-4)

Condition: Prerequisite 2101337

Historical development of highways; highway administration; principles of highway planning and traffic analysis; geometric design and operations; highway finance and economic; introduction to pavement design; highway materials; construction and maintenance of highways.

2101408 Structural Design II 3(2-3-4)

Condition: Prerequisite 2101313

Design of timber and steel structures under loads such as gravity load, wind load, and earthquake load; tension and compression members; beams; beam- columns; built- up members; plate girders; connections; practice in design and detailing; design of structures by computer software

2101421 Geotechnical Engineering Design and Construction 3(3-0-6)

Condition: Prerequisite 2101321

Criteria in geotechnical engineering design; Terzaghi's bearing capacity formula design and construction of shallow foundation; design and construction of pile foundation and construction control; design and construction of retaining structures, sheet piles and diaphragm walls for excavation and filling; design of caisson and construction method; slope stability.

2101454 Construction Management 3(3-0-6)

Condition: Consent of Faculty

Project delivery systems; project organization; site layout; project planning; modern construction technology;

critical path method (CPM); resource management; progress measurement; cash flow analysis, construction equipment; construction laws; construction safety; quality control systems.

2101456 Construction Cost Estimating and Supervision 3(3-0-6)

Condition: Consent of Faculty

Principle of construction engineering; construction materials and methods; construction productivity; principle of cost estimating; approximate and detailed estimating; quantity takeoff; methods of measurement; labor and equipment costing.

2101491 Civil Engineering Capstone Project 3(0-6-3)

Civil Engineering Capstone Project develops the project-based learning method. It constructs the students' active learning experience through the systemic pedagogy, including data collection, synthesis and analytic, leading toward the design and development of solutions to the broad problems encountered in civil engineering fields, such as structure, transportation, geotechnical and construction management. Real-world civil engineering projects are designed to enhance the effective group work and collaboration in multi-disciplinary areas (e.g., architectural and system engineering designs). The learning method focuses on the up-to-date engineering equipment and software, communication and life-long learning competencies.

2101499 Civil Engineering Project 3(0-6-3)

Condition: Prerequisite 2100499

Student shall carry out a practical project of interest on problems in various fields of civil engineering. The project is to be proposed by the student group and approved by the instructor and the Department. The work must be completed within one semester. A complete written report and a final oral examination are required.

2101510 Computer Methods for Civil Engineers 3(3-0-9)

.Review of computer programming and structural analysis; basic numerical methods for linear and nonlinear systems; software packages for structural analysis and design; emphasis on civil engineering applications

2101512 Advanced Concrete Technology 3(3-0-9)

Review of concrete technology; improvement of concrete's quality by pozzolanic materials, mineral and chemical admixtures; high-performance concrete; fiber reinforced concrete; polymer concrete; durable concrete and other special concrete; repair and strengthening of concrete structures.

2101520 Statistical Methods for Transportation Analysis 3(3-0-9)

Transportation analysis; linear regression analysis; discrete outcome analysis; ordered outcome analysis; discrete choice analysis

2101524 Computer Programming and Computer Tools for Graduate Research 3(3-0-9)

Object-oriented programming, event driven and GUI programming, data flow programming for data acquisition and automatic control in laboratory; use of MATLAB and Maple software, numerical algorithm for linear and nonlinear problems.

2101534 Computer Application for Geotechnical Engineering 3(3-0-9)

Computer application for analyzing shallow foundation, slope stability, deformation and stability problems; analysis of tunnel lining and tunnel deformation due to adjacent construction activities.

2101535 Tunnel Engineering 3(3-0-9)

History of tunneling; soil tunneling methods; types of linings and face support; stand-up times and tunnel man's ground classification; groundwater control and soil modification methods; lining behavior and design; ground movements and changes of pore water pressure caused by tunnel construction; field observations, monitoring, and instrumentation; building distortion/damage and relation to ground movements; fundamentals of tunnel engineering related to soil types and construction techniques; design of tunnel lining in various subsoil conditions; applications and techniques of tunnel construction for infrastructure systems.

2101546 Introduction to Finite Element Method 3(3-0-9)

Weak form of governing differential equations, weighted residual method, variational principle, equivalence between weak and strong forms, weak-form solution and its uniqueness; Galerkin approximation, space of test and trial functions, basis functions, quality and convergence of approximate solutions; finite element approximation, element-based shape functions, element stiffness matrix and load vector, matrix assembly procedure, treatment of boundary conditions, convergence of finite element solution; introduction to finite element method to two- and three-dimensional boundary value problems; applications of available finite element packages to various boundary value problems in civil engineering

2101550 Civil Engineering Project Planning 3(3-0-9)

Principles of civil engineering project planning; analysis of technical requirements; financial and economic feasibility studies; capital budgeting; social, political and environmental impact assessment; fundamental decision analysis.

2101552 Fundamentals of Road Safety 3(3-0-9)

Road safety dimensions; causes of road crashes; safety of vulnerable road users; road safety indicators; statistical methods in traffic safety analysis; safety management system; road safety audit; countermeasures.

2101553 Computer Applications in Transportation 3(3-0-9)

Analytical methods applied to modern transportation engineering; statistical analysis probability distributions, and random variables; descriptive statistics; data manipulation; data visualization) with R; applied numerical methods; programming; roots and optimization; linear algebraic equation and matrices with MATLAB.

2101554 Evaluation of Transportation Project and Policy 3(3-0-9)

Understanding money and its management; engineering economic decisions; time value of money; interest rate; inflation; evaluating business and engineering assets; depreciation and income taxes; project cash-flow analysis; project uncertainty; financial statement; evaluation of transportation projects and financing alternatives.

2101555 Travel Behavior Survey and Analysis 3(3-0-9)

Dimensions and characteristics of travel; travel demand; theories of travel behavior; methodologies of travel survey; theory of sampling; analytical methods in travel behavior research.

2101556 Air Transportation System 3(3-0-9)

Introduction to air transportation; air transportation economics; air transportation supply: network and carrier; air transportation demand; passenger and cargo; air transportation planning and management; air transportation infrastructure.

2101557 Pavement Design 3(3-0-9)

Principles of pavement including pavement types; pavement deterioration and key factors; wheel loads and environment; mechanistic behavior of flexible and rigid pavements; pavement materials and testing; design methods of flexible and rigid pavement; pavement condition survey; pavement strengthening design

2101558 Transportation and Logistics System Optimization 3(3-0-9)

Introduction to modeling and operations research; linear programming; sensitivity analysis; integer programming; network optimization; heuristics; queuing system; applications of these tools to transportation and logistics problems.

2101561 Railway Track Engineering 3(3-0-9)

Principles of railway track structures; track alignment and geometry design; general knowledge of wheel and rail; structural gauge and loading gauge; cross sections of track structures; components of railway track and track structures; structural behaviours and calculation of forces acting on track structures; track degradation; track inspection and maintenance.

2101566 Dynamics of Structures 3(3-0-9)

Analysis of structural systems with single and multi-degree of freedom; equations of motions; free and forced vibrations; vibration natural frequencies and mode shapes of structures; numerical evaluation of dynamic response; response spectrum; modal response history and response spectrum analysis; response of inelastic SDF system; building codes related seismic design of structures.

2101567 Rail Transport System 3(3-0-9)

Historical development of railways; train service types and their characteristics; knowledge of components in railway system including rolling stocks, infrastructure railway track, electrification, signaling; spacing train and train time tabling; safety and system maintenance; railway administration.

2101567 Railway Infrastructure Asset Management 3(3-0-9)

Principle of railway infrastructure asset management; Reliability, Availability, Maintainability, and Safety; Life Cycle Assessment; concept of maintenance policy and maintenance planning; designing condition- based asset performance indicator.

2101569 Train-Track Interaction 3(3-0-9)

Introduction to the train-track interaction; the principle of wheel-rail interface; effects and consequent defects on rails, track components, and track structure due to train loads; passenger comfort and safety during train operations; track condition monitoring; defects mitigation solutions.

2101580 Construction Information Management 3(3-0-9)

Basic concepts of construction information, information flow in construction, construction information models, construction information management, computer programs for construction information management.

2101590 Construction Techniques and Productivity 3(3-0-9)

Construction Processes, materials, tools, equipment; construction productivity; modern construction techniques; equipment in building and infrastructure works.

2101601 Advanced Structural Theory 3(3-0-9)

Structural modeling, mathematical equations to analyze structures, analysis of determinate and indeterminate structures to determine deformations and internal forces, analysis of 2D/3D trusses and frames by flexibility and stiffness methods

2101602 Introduction to Solid Mechanics 3(3-0-9)

Review of mathematical background; field quantities in solid mechanics and their basic properties; field equations; work and energy principles; formulations and solutions of boundary value problems; fundamental problems in solid mechanics and solution techniques

2101606 Dynamics and Vibrations 3(3-0-9)

Dynamic system modeling; equation of motion; analysis of systems with single and multi-degree of freedom; free and forced vibration; determination of natural frequencies of structures; distributed mass system; response spectrum method; dynamic analysis using numerical techniques; basic principles of non-linear system.

2101611 Matrix Analysis of Structures 3(3-0-9)

Matrix procedures for analysis of planar and space truss, beams, frames under static and quasi-static loading; stiffness and flexibility methods; computer application; non-prismatic members; introduction to non-linear analysis of structures.

2101614 Behavior of Steel Structures 3(3-0-9)

Basic behavior of structural steel members and frames; use and limitations of the design specifications; fundamental knowledge on behavior and design of composite steel-concrete structures.

2101616 Plasticity in Reinforced Concrete 3(3-0-9)

Basic concepts of reinforced concrete, properties of concrete and steel, concrete elasticity, nonlinear- elastic fracture models, failure criteria of concrete, elastic perfectly plastic fracture models, limit analysis of perfect plasticity, plastic-fracture models, numerical analysis of elastoplastic fracture models

2101618 Finite Element Method for Civil Engineers 3(3-0-9)

Basic concepts of approximations; development of finite element equations from various principles; applications of finite element method to continuum mechanics problems; convergence and compatibility requirements; assemblage of elements and boundary conditions; structure of a typical finite element computer program; applications in civil engineering problems.

2101619 Seismic Design of Structures 3(3-0-9)

Fundamental of earthquake engineering; analysis of buildings subjected to earthquakes; seismic design codes for buildings; modeling of bridges for seismic design, analysis of bridges subjected to earthquakes; seismic design codes for bridges; seismic detailing

2101621 Foundation Engineering 3(3-0-9)

Application of soil mechanics to design shallow foundation, pile foundations, and braced excavations.

2101624 Elasticity in Soil Mechanics 3(3-0-9)

Vector and tensor analysis, Eigenvalue problem; introduction to continuum mechanics, stress-strain definition for small strain, equilibrium and compatibility equations, stress-strain relationship, Hooke's law, simple elastic model.

2101632 Rock Mechanics 3(3-0-9)

Physical properties and classification of intact rock; theories of rock failure; state of stress in the earth's crust; stresses and deformations around underground openings assuming elastic, plastic, and time-dependent behavior; effect of geologic discontinuities on rock strength; introduction to stability analyses in rock.

2101634 Plasticity in Soil Mechanics 3(3-0-9)

Introduction to plasticity theory, classical plasticity theory, yield surface and flow rule, classical elasto-plastic model, modern plasticity theory, critical state soil mechanics, critical state soil model, advanced soil model, bounding surface theory, multi yield surface theory, conventional method for plastic analysis, limit analysis, limit equilibrium, slip line method

2101636 Interpretation of Field Exploration and Soil Testing 3(2-3-7)

Site investigation for civil engineering, conventional and geophysics methods; laboratory and field works in soil sampling, classification and testing.

2101637 Advanced Soil Mechanics 3(3-0-9)

Soil classification, index properties, weight-volume relationship, permeability and seepage analysis, stress within soil mass, elastic solutions for stress, shear strength behaviour and Mohr-Coulomb failure criteria, stress paths, deformation behaviour, consolidation theory, secondary compression, settlement prediction.

2101639 Special Study in Soil Engineering 3(3-0-9)

Contemporary topics in geotechnical engineering.

2101660 Transportation Systems 3(3-0-9)

Introduction to transportation systems; types of transportation; modes of transportation; key characteristics of transportation modes; intermodal transportation; transportation system components and functions; policy context and transportation planning; decision making tools in transportation planning; general and mode-specific policy issues; green transportation and sustainability; mobility/accessibility; social, economic, and political issues; advance in transportation technology; transportation safety and social justice; special issues in transportation

2101663 Research Methodology in Transportation 3(3-0-9)

Mathematical and statistical methods for transportation analysis; basic probability models and statistical analysis; introduction to mathematical

programming; decision analysis, optimization and simulation.

2101666 Transportation Systems 3(3-0-9)

The use of advanced surveillance, navigation, communication, and computer technology to monitor, analyze, and improve the performance of transportation systems; enabling technologies; application of technology to monitoring, analysis, evaluation, and prediction of transportation system performance and behavior, feasibility studies; human factors and institutional issues.

2101680 Applied Mathematics I 3(3-0-9)

Ordinary differential equations; Fourier series; introduction to Fourier and Laplace transforms; some applications to boundary value problems; vector analysis; matrices and linear equations.

2101690 Construction Methods and Equipment 3(3-0-9)

Construction method in civil engineering; planning for earthwork construction; construction equipment cost; selecting of construction equipment; calculating of machine power; analysis of equipment productivity such as dozer, scrapers, excavator, truck and hauling equipment, finishing equipment, pile-driving equipment, belt-conveyer, aggregate production, asphalt mix production and placement, concrete equipment, and cranes.

2101691 Special Studies 3(3-0-9)

Individual's problem solving in civil engineering.

2101692 Analytical Methods in Construction Management 3(3-0-9)

Analytical methods applied to modern construction engineering and management from both owner's and contractor's views; civil engineering systems modeling and analysis; applications of systems analysis, deterministic and probabilistic models, decision analysis, mathematical programming, optimization techniques, simulation techniques, and computer programs for civil engineering systems simulation; other analytical tools for rational decision making in construction engineering and management from project inception to completion.

2101694 Contracting in Construction Business 3(3-0-9)

Fundamentals of contracting in public and private construction projects; different contracts in construction business; rights and obligations of construction contracting parties; provisions regarding payment, quality, time extension; arbitration.

2101695 Computer Applications in Construction 3(3-0-9)

A broad range of computer applications in construction with emphasis on construction engineering and management; computer hardware and software components, operating system, programming languages, and information technology; analysis, design, development, and implementation of microcomputer-based systems such as database, spreadsheet, computer aided design and virtual reality technology; the effective utilizations of various construction management software; concepts of decision support system.

2101697 Infrastructure Planning and Management 3(3-0-9)

An integrated approach to the planning, construction, operation, and maintenance of infrastructure through an understanding of the performance of infrastructure and life-cycle cost evaluation; approaches the management, available technologies, and decision supporting tools in infrastructure and facility planning and management; economic framework for identifying and analyzing investment and operations options; relevant issues such an environment, laws, and regulations.

2101698 Construction Business Management 3(3-0-9)

Construction organization strategic construction business development; marketing plan, operational plan, financial planning and business valuation, quality control and management; construction process improvement.

2101701 Special Topics in Structural Engineering I 3(3-0-9)

Fundamental and advanced topics in structural engineering

2101702 Special Topics in Structural Engineering II 3(3-0-9)

Essential and advanced topics in structural engineering

2101741 Traffic Simulation 3(3-0-9)

Traffic microsimulation fundamentals; the use of transportation and traffic simulation and modeling software; data collection and preparation; base model development; model calibration; interpretation of outputs; related statistical analysis.

2101742 Advanced Transportation and Logistics System Optimization 3(3-0-9)

Advanced optimization techniques for transportation and logistics networks; strength of mathematical formulation; large-scale optimization techniques: problem decomposition, row-and column-generation, branch-and-price-and-cut, genetic algorithms, and other state-of-the-art techniques.

2101743 Impact Analysis of Transportation and Logistics System 3(3-0-9)

Introduction to macroeconomics; measuring domestic output and national income; economic growth; business cycles, unemployment, and inflation; macroeconomic models and fiscal policy; foundations of input- output analysis; multipliers in the input- output model; linear

programming and goal programming; environmental input-output analysis.

2101744 Transportation and Logistics Infrastructures 3(3-0-9)

Concept of transportation and logistics infrastructure. planning, design and analysis of transportation and logistics infrastructure including bus and truck terminals, railway terminals, airports, ports, cross- border and multimodal transportation facilities. recent technology in transportation and logistics infrastructures.

2101745 Transportation Operations 3(3-0-9)

Introduction to traffic engineering and transportation operations, trajectories, cumulative plots, optimization, traffic flow theory, control, traffic measurement and observations, scheduled transportation systems; advanced problems in transportation and traffic operations.

2101793 Graduate Seminar in Civil Engineering 3(3-0-9)

Self-studies on the topics provided by the division; oral presentation of the study outcome in conjunction with technical papers as well as answers to technical questions and comments from the audience; special lectures by guest speakers.

2101799 Boundary Integral Equation Method for Applied Mechanics 3(3-0-9)

Description of general boundary value problems and basic governing field equations; development of Green's functions and their derivatives; Integral relations for field quantities; Standard integral equations for state variables and body flux; Singularity-reduced procedure and singularity-reduced boundary integral relations; special cases of cracks and dislocations; Boundary integral equation method, formulation of governing integral equations, boundary and solution approximations; evaluation of kernels, numerical integration, post-process.

2101800 Advanced Solid Mechanics 3(3-0-9)

Basic components in solid mechanics; formulations and solution methods for various problems in solid mechanics; current research and special topics in solid mechanics

2101801 Fracture Mechanics 3(3-0-9)

Linear elastic fracture mechanics, basic components, crack-front field, fracture parameters; introduction to nonlinear fracture mechanics; solution methods for fracture analysis; fracture properties and crack growth criteria; experimental studies of fracture; recent research topics in fracture mechanics.

2101804 Behavior of Reinforced Concrete Structure 3(3-0-9)

Behavior and strength of reinforced concrete structures subjected to flexure, shear, torsion, axial and eccentric loading; bond and anchorage; strut-and-tie model; serviceability; review of research and literature with emphasis on background, structural models, and criteria approach of design codes and specifications.

2101806 Numerical and Approximate Methods for Structural Engineering 3(3-0-9)

Introduction to numerical computing; numerical methods for system of linear equations; numerical methods for linear least square problems; numerical methods for eigen value problem; numerical methods for system of nonlinear equations; method of interpolation: numerical integration and differentiation; approximate method for boundary value and initial value problems; introduction to optimization; applications to structural engineering problems.

2101810 Fire Safety Design of Structures 3(3-0-9)

Fire safety engineering; behavior of natural fires; parametric fires and standard fires; properties of materials at elevated temperatures; analysis of structural members subjected to fires; design of steel and reinforced concrete structures for fire safety; assessment and repair of fire-damaged structures.

2101811 Thesis 12 Credits

THESIS

2101818 Life Cycle of Concrete Structures 3(3-0-9)

Life Cycle and structural performance; importance and necessity of maintenance of structures; concrete deterioration mechanism and its prediction; concrete evaluation; remedial measures; surface repair; strengthening and stabilization; examples of management system for maintenance.

2101820 Geo-Environment Engineering 3(3-0-9)

Solid wastes management, waste compositions, design and monitoring of landfills, contaminant transports, fate transports, and soil remediation techniques.

2101821 Deep Foundation Design 3(3-0-9)

Behavior of pile foundation, estimating pile capacity, driven and bored pile, grouting and non-grouting behavior, pile driving analysis, pile integrity and sonic logging test, pile load test, design of pile foundation, settlement analysis.

2101824 Finite Element Method in Geotechnical Engineering 3(3-0-9)

Basic mathematics and continuum mechanics; principles of finite element method, element discretisation, displacement functions and iso-parametric elements, element equation; numerical integration; direct stiffness assembly method; weighted residual and variational method; boundary conditions; solution methods; non-linear and dynamic problems.

2101831 Engineering Ground Modification 3(3-0-9)

Soil compaction, lime/ cement- soil mixing behavior, preloading and prefabricated vertical drain (PVD) techniques, cement and chemical grouting, cement columns, geotextile and geosynthetic.

2101832 Engineering Geophysics 3(3-0-9)

Application of elastic wave and electricity in ground prospecting, reflection survey, refraction survey, surface wave method; borehole method, down-hole, up-hole and cross hole; resistivity method for ground prospecting; electro-magnetic prospecting.

2101833 Soil Dynamics and Earthquake Engineering 3(3-0-9)

Earthquake mechanisms, earthquake magnitude and energy, strong ground motions, seismic hazard assessment, wave propagation theory, basic soil dynamics, effects of earthquakes in geotechnical aspects: liquefaction, dynamic bearing capacity and lateral earth pressure.

2101835 Earth and Retaining Structures 3(3-0-9)

Slope stability problems; methods of slope stability analysis; slope stability analysis under drained/undrained conditions and with/without groundwater seepage; field stability observations using geotechnical instruments; introduction to earth pressures; lateral earth pressures; lateral earth pressure theories; analysis and design of retaining wall.

2101841 Special studies in Transportation Engineering 3(3-0-9)

. Individual's problem solving in transportation engineering.

2101870 Construction Project Management 3(3-0-9)

Concept of construction project management, planning and scheduling techniques, estimating, and cost control techniques for construction projects; work breakdown structure; progress monitoring; construction resource management; project risk management; project quality control and quality assurance; new project management techniques.

2101871 Risk Management in Civil and Environmental Engineering Systems 3(3-0-9)

Fundamental concepts of risk, risk management process, risk identification, risk analysis, risk response, risk monitoring and evaluation, risk management tools and techniques, reliability of civil and environmental engineering system, risk-benefit assessment, acceptable risk, risk management system, applications and case studies in civil and environmental engineering systems.

2101873 Special Topics in Construction 3(3-0-9)

Advanced analytical techniques and tools as applied to construction engineering and management problems.

2101811 Thesis 12 Credits

2101828 Dissertation 48 Credits

2101829 Dissertation 60 Credits

2101894 Doctoral Dissertation Seminar 0(0-0-0)

2101897 Qualifying Examination 0(0-0-0)

PROGRAM OF STUDY (CIVIL ENGINEERING)
Master of Engineering Joint Degree Program in Railway Vehicles and Infrastructure Engineering
(International Program)

Railway Engineering is a multidisciplinary application field that involves the latest technologies of the domains of mechanical, electrical and civil engineering and information technologies. To meet the complexity and international character of this industry, the new Railway Vehicles and Infrastructure Engineering (RVIE) program follows a unique concept.

RVIE is a collaboration of TGGS, Chulalongkorn University and RWTH Aachen University to combine the best know-how into the three-year program that includes one full year of studies in Germany.

RVIE offers the choice of two majors:

- Railway Vehicles Engineering (RVE) – directed primarily at students with a background in Mechanical and Electrical Power Engineering
- Railway Infrastructure Engineering (RIE) – directed primarily at students with a background in Civil Engineering

RVIE is a 3-year program, awarding a M. Eng. Degree jointly issued by KMUTNB and Chulalongkorn University. You will study in Bangkok and Aachen, Germany:

1st year: coursework in Bangkok (both TGGS and Chula campuses)

2nd year: coursework in Aachen, Germany at RWTH Aachen University

3rd year: Industrial Internship and Master Thesis (either location)

The curriculum featuring 15 courses was designed to realize the interdisciplinary competence in both majors and full compatibility with the Rail-related studies at RWTH Aachen University. Based on the RVIE curriculum development survey made in 2018, rail companies in Thailand are looking for:

- engineers with fundamental knowledge about railway system
- with skills and experience from actual project work
- and with the intuition to develop new applications in the future

These requirements were used to align the learning outcomes of the program to ensure that RVIE graduates will have the right qualification as demanded by the future employers. On top of the courses provided by qualified lecturers and professors from TGGS, KMUTNB, CU, and RWTH Aachen university. Experts from the industry will also take part in giving lectures and advise students during their industrial internship and master thesis period.

RVIE Lecturers (CU):

Prof. Dr. Teerapong Senjuntichai
Prof.Dr. Tospol Pinkaew
Assoc. Prof. Dr. Boonchai Sangpetngam
Assoc. Prof. Dr.Charinee Limsawasd
Assoc. Prof. Dr.Chatpan Chintanapakdee
Assoc. Prof. Dr. Nakhon Kokkaew
Assoc. Prof. Dr. Thavatchai Tayjasanant
Asst. Prof. Dr. Nuksit Noomwongs
Asst. Prof.Dr. Chayut Ngamkhanong

RVIE Lecturers (TGGS):

Prof. Dr.-Ing. Christian Schindler (RWTH Aachen)
Asst. Prof. Dr. Kittichai Sojiphan
Asst. Prof. Dr.-Ing. Chayakorn Netramai
Asst. Prof. Dr.-Ing. Kumpanat Sirivedin
Dr.-Ing. Alexander Brezing

CIVIL ENGINEERING CURRICULUM
RAILWAY INFRASTRUCTURE ENGINEERING

	YEAR1,SEMESTER1			**YEAR1,SEMESTER2**	
COURSE NO.		**CREDITS**	**COURSE NO.**		**CREDITS**
2148621	RAMS RAIL APP	3	2148633	RAILWAY ELEC	3
2148622	FUND RAIL VEH DYNA	3	2148634	MAT CHARACTE	3
2148635	INFRA PLAN MANAG	3	2148636	RAILWAY TRACK ENG	3
2148637	RAIL TRANS SYS	3	2148XXX	ELECTIVE COURSE	3
2148XXX	ELECTIVE COURSE	3			
		15			**12**
	YEAR2,SEMESTER1			**YEAR2,SEMESTER2**	
2148624	TRA GUID TEC	3	2148623	PRIN RAIL VEH TEC	3
2148638	RAILWAY TIME OPER	2	2148639	RAILWAY CONT SYS	1
2148641	RAILWAY SYSTEMS	3	2148640	MOB RES TRAN MODEL	3
2148XXX	ELECTIVE COURSE	3			
		11			**7**
	YEAR3,SEMESTER1			**YEAR3,SEMESTER2**	
2148811	THESIS	12	2148642	INDUS INTER	4
		12			4

TOTAL CREDITS FOR GRADUATION = 61

RAILWAY VEHICLE ENGINEERING

	YEAR1,SEMESTER1			YEAR1,SEMESTER2	
COURSE NO.		**CREDITS**			
2148621	RAMS RAIL APP	3	2148625	ELE SYSTEMS	3
2148622	FUND RAIL VEH DYNA	3	2148626	STRUC DES METHOD	3
2148627	RAIL VEH VIBR DYN	3	2148628	HYDRA PNEUMATICS	3
2148XXX	ELECTIVE COURSE	3	2148XXX	ELECTIVE COURSE	3
		12			**12**

	YEAR2,SEMESTER1			YEAR2,SEMESTER2	
2148624	TRA GUID TEC	3	2148623	PRIN RAIL VEH TEC	3
2148631	RAIL VEH COMPON	3	2148629	MECH SYS VEH ENG	3
2148XXX	ELECTIVE COURSE	3	2148630	INTER COMBUS ENG I	3
			2148632	ELEC VEH/LIN DRI	3
		9			**12**

	YEAR3,SEMESTER1			YEAR3,SEMESTER2	
2148811	THESIS	12	2148642	INDUS INTER	4
		12			**4**

TOTAL CREDITS FOR GRADUATION = 61

COURSE DESCRIPTIONS

2148621 RAMS in Railway Applications 3(3-0-9)
RAMS RAIL APP

Reliability, Availability, Maintainability, Safety: RAMS- management as a product- lifecycle- oriented component of a holistic management process that addresses all aspects of complete rail- systems; RAMS- process and related approaches, lifecycle engineering principles, systems approach, design methodology, FMEA/ FMECA; RAMS standards (EN 50126) . RAMS- impacting factors: rail- system conditions, operating conditions, maintenance; human factors; specification of RAMS requirements; risk management: risk concept, risk analysis, hazard analysis, deterministic vs. probabilistic approaches, risk- reduction approaches, risk- acceptable criteria (ALARP GAMAP MEM); functional analysis; failure mode identification (functional and piece part failures) and effect analysis, criticality analysis; safety integrity, design for safety (fail- safe concepts and others) , design for maintainability; RAMS documentation.

2148622 Fundamentals of Rail Vehicle Dynamics
FUND RAIL VEH DYNA 3(3-0-9)

Concepts of forces and accelerations of a moving mass; applied on longitudinal, vertical and lateral dynamics of a rail vehicle; concepts of driving resistance: rolling resistance, drag, vehicle acceleration, inclines and declines; concepts of propulsion power demand calculations; overview of rail propulsion systems: combustion (diesel), electrical, alternative; overview of rail transmission systems; overview of rail brake systems (regulations, safety by redundant systems, technical concepts: mechanical, hydraulics, pneumatics electric brakes) , concepts of braking performance calculations; concepts of vibrations of single mass oscillators, resonance frequencies, damping; concepts of vibrations of double mass oscillators; suspension systems; vertical dynamics, vibration excitations from the track; vibration excitations from propulsion systems; vertical dynamics and driving comfort: the effect of vibrations on the human body, seating systems; introduction to multi-body models and simulations of rail suspensions; introduction to multi-body models and simulations of complete vehicles; lateral dynamics, derailing, cross-influences of longitudinal and lateral vehicle dynamics; introduction to wheel/ rail interactions.

2148623 Principles of Rail Vehicle Technology 3(3-0-9)
PRIN RAIL VEH TEC

Categorization of railway transport within the context of other transport systems; railway subsystems with a focus on vehicles; rail-guided vehicle systems in comparison with road vehicles; socio- economic challenges, contribution of railway to overall transport systems; overview of the rail industry. Laws and standards, mass transit and main line railway: technical specifications, layouts, vehicle and train configurations, principles of carrying, guiding and driving / braking; basic components of vehicle: track, wheel; wheel- track interactions: load transfer, traction and brake forces; driving resistance, traction force, energy demand and energy saving potential; transmission systems and elements; brake systems and components, breaking principles and methods.

2148624 Track Guiding Technology 3(3- 0- 9)
TRA GUID TEC

Tasks and elements of track guiding system: wheel/ rail and wheelset/ track in established configurations; derivation of conditions for geometrically ideal track guiding, detailed discussion of wheel to rail interface, resulting forces and moments effective on the wheel- pair; estimation of wheel/ rail wear, established proof of derailment safety in twisting track sections with quasi- static cornering; kinetics explanation of hunting oscillation of the wheelset according to Klingel, detailed calculations of contact surface and - pressure between wheel and rail according to the theory of Hertz, determination of the wheel/ rail contact point, analytical calculation of the so-called "visible" or "effective" wheel profile according to Borgeaud; equations of motion for the kinetics analysis of the movements of the wheelset and independently rotating wheel pairs; introduction to the numerical calculation of the vehicle run: multi- body simulations; modeling of the track condition as independent excitations of the wheelset; introduction to vibration analogy models for track, wheelset, undercarriage and entire rail vehicles.

2148625 Electric Drive Systems 3(3-0-9)
ELE SYSTEMS

Introduction to electrical drive systems, fundamental theory of mechanical motion, power electronics converters for electrical drives, DC drive system and its control, synchronous drive system and its control, induction drive system and its control, switched reluctance drive system and its control.

2148626 Structural Design Methodology 3(3-0-9)
STRUC DES METHOD

The course embeds quantitative methods of structural mechanics into the context of design methodology, thereby combining these with qualitative approaches to structural design. First part, design methodology: general design process acc. to VDI2221, methods for technical specification, functional decomposition, requirement engineering, conceptual design, evaluation and selection of technical concepts; taxonomy of design rules and principles according to Pahl and Beitz, selected examples thereof: force transmission, division of tasks, self-help, bistability, fault-free-design and others; introduction to computer- based topology

optimization. Second part, advanced concepts of structural mechanics for lightweight structures: energy principles, deformation of elastic systems, statically indeterminate structures (force method, method of consistent deformations) , force introduction and transmission, stability behavior of lightweight structures, buckling of trusses with and without plastic material behavior, Ritz-method for solving stability problems, stability of other structural elements; sandwich design, failure modes of sandwich materials, core and face materials.

2148627 Rail Vehicle Vibration Dynamics 3(3-0-9)
RAIL VEH VIBR DYN

General introduction to vibrations in rail vehicles, narrowed down to vertical and longitudinal dynamics; methods of vibration analysis; modeling of vibration systems, notation, examples; determining equations for single mass oscillators with base point displacement excitation; modeling of track irregularities in the displacement and frequency domain, response spectrums as functions of vehicle velocity and transfer path; assessment of the effects of vehicle vibrations. ; application examples of multiple –mass oscillator models; measures to improve vibration behavior of railway vehicles; railway trains as a chain of longitudinally oscillating masses.

2148628 Hydraulics and Pneumatics 3(3-0-9)
HYDRA PNEUMATICS

Introduction to hydraulics & pneumatics; development of hydraulic machines and applications; hydraulics systems and components; principles of hydraulic systems calculations; hydraulic fluids; pumps, valve types and their selection; design of hydraulic circuit diagrams, dimensioning calculation of hydraulic components, calculations of hydraulics system, examples. Fundamentals of pneumatics systems, pneumatic pumps and supply systems, pneumatic piping design, pneumatic components, calculation of pneumatic systems, design of pneumatics circuits, example of such.

2148629 Mechatronic Systems in Vehicle Engineering 3(3-0-9)
MECH SYS VEH ENG

Concept of structural testing and evaluation; destructive and non-destructive testing; structural models and components for testing; full scale testing; testing standards; equipment and measurement techniques; data analysis and evaluation of structural performance.

2148630 Internal Combustion Engines I 3(3-0-9)
INTER COMBUS ENG I

Classification, manufacturing processes, chemical structure and physical properties of fuels based on mineral oil; energy reserves, consumption and the energy industry; alternative fuels based on coal, natural gas and non-fossil sources of energy; energy flow in the combustion engine process: open cycle simulations, energy balance and definition of losses; heat flow in combustion engines: heat transfer mechanisms, calculation methods of heat transfer coefficients in the combustion chamber, conduction and heat transfer to the coolant; temperatures and thermal stresses of engine components, layout of combustion engines, rules of geometrical, mechanical and thermal similarity, indices and mechanical power limits; engine base data; typical plan of an engine development process; forces and moments in engines: gas forces and inertia forces, excitation by forces in crank drive mechanism; engine balancing; torsional vibration of crankshafts; engine components: requirements on crankshaft, connecting rod, piston, crankcase, cylinder head and liner; materials, concepts and specific design features; cooling and lubrication systems.

2148631 Rail Vehicles Components 3(3-0-9)
RAIL VEH COMPON

Introduction to the design of rail vehicles and main design restrictions, transportation tasks of different vehicle categories; discussion of the most important subsystems and functional groups: car bodies and their build types; undercarriage types including drive/ transmission configurations; drives and brakes; coupling elements such as springs, dampers, handlebars or guide elements; doors and footboards; joint transitions and vehicle couplings; windows and interior lighting; heating, air conditioning and ventilation systems; sanitary systems.

2148632 Electric Rail Vehicles, Linear Drives and Magnetic Levitation 3(3-0-9)
ELEC VEH/LIN DRI

Railways history, main propulsion systems of electric railways; system overview; drives: power converters, traction motors, transmissions; drive control; transformers; high voltage equipment; suspension systems; brakes; characteristics railway vehicles; light rail, metro; commuter rail, high speed trains; magnetic levitation systems / linear drives: overview and principles; Transrapid, Maglev; system design.

2148633 Railway Electrification 3(3-0-9)
RAILWAY ELEC

Electrical railway power supply systems; electric motor drive for electric railway; energy management in railway system; electromagnetic compatibility in railway system; case studies from Thailand and abroad.

2148634 Material Characterization 3(3-0-9)
MAT CHARACTE

Non destructive testing; mechanical property; hardness, computed tomography; ultrasonic; SEM/ EM; failure analysis; chemical composition analysis.

2148635 Infrastructure Planning and Management **3(3-0-9)**
INFRAS PLAN MANAG

An integrated approach to the planning, construction, operation, and maintenance of infrastructure through an understanding of the performance of infrastructure and life-cycle cost evaluation; approaches to management, available technologies, and decision supporting tools in infrastructure and facility planning and management; economic framework for identifying and analyzing investment and operations options; relevant issues such as environment, laws, and regulations.

2148636 Railway Track Engineering **3(3-0-6)**
RAILWAY TRACK ENG

Principles of railway track alignment and track structures; general knowledge of rolling stocks and locomotives; structural gauge and loading gauge; cross sections of track structures; horizontal and vertical alignment for intercity train, commuter train and metro; components of railway track and track structures; track structures design; track layouts in yards; signalling concept;, various types of stations: container yard, industry yard; track inspection and maintenance.

2148637 Rail Transport System **3(3-0-6)**
RAIL TRANS SYS

History of rail transport development; fundamental and characteristics of rail operation; rules of safety; composition of rail system; infrastructure; rolling stocks; signaling and communication; case studies of rail transport development in Thailand and neighboring countries.

2148638 Railway Timetabling and Operations **2(2-0-6)**
RAILWAY TIME OPER

Timetable construction; time/ distance/ track-occupancy diagrams and minimum headway times; capacity assessment with probabilistic methods; capacity assessment with simulation methods; railway control systems (railway operation centers, conflict solving, deadlock-avoiding); infrastructure modeling.

2148639 Railway Control Systems **1(1-0-3)**
RAILWAY CONT SYS

Risk analysis and risk acceptance models; train control systems; European Train Control System (ETCS); train protection and train control, radio systems; safety technology in railway crossings.

2148640 Mobility Research and Transport Modeling **3(3-0-9)**
MOB RES TRAN MODEL

Mobility – definitions and patterns: passenger transportation, freight traffic; impacts and trends; traffic management, transportation demand management, mobility management, ICT; empirical mobility research: methods and interpretation, fundamentals of empirical social research; theory of planned behavior; interaction of land use and mobility: land use patterns and modeling, types of transportation models, prognosis and scenario; macroscopic transportation modeling (4 step algorithm); microscopic transportation modeling; modeling of freight traffic, modeling and management of urban freight traffic.

2148641 Railway Systems **3(3-0-9)**
RAILWAY SYSTEMS

Comparison of railway vehicles and automotive engineering; elements and dimensioning of superstructures; dimensioning of alignment elements; construction of alignment in ground plan and elevation; design of railway stations; safety engineering; dimensioning of nodes/switches; minimum headway times; calculation of running times, introduction to timetable construction.

2148642 Industrial Internship **4(0-24-0)**
INDUS INTER

Apply the knowledge for solution or analysis of engineering problem in industry through internship in industrial environment. The student will submit the report to summarize the internship work content, deliverables and confirmed outcomes.

2148643 Vehicle Acoustics **3(3-0-9)**
VEHICLE ACOUSTICS

Introduction to technical acoustics; audiology, measuring of (airborne) sound; measuring of (structure-borne) sound and vibrations; legislative issues, accelerated pass-by noise measurement procedure (ISO 362); engine noise; noise and vibrations of drivetrain components; vibrations of vehicle drivetrains; road/tyre noise; noise and vibrations of brake systems; power steering noise; vehicle body noise and vibration; psychoacoustics, sound engineering.

2148644 Dynamics and Vibrations **3(3-0-9)**
DYNA VIBRA

Dynamic system modeling; equation of motion; analysis of systems with single and multi degree of freedom; free and forced vibration; determination of natural frequencies of structures; distributed mass system; response spectrum method; dynamic analysis using numerical techniques; basic principles of non- linear system.

2148645 Fundamentals of Internal Combustion Engines **3(3-0-9)**
FUND COMBUS ENG

Classification and characteristics of internal combustion engines, kinematics and forces of the internal combustion engine, mass forces of the displacement motor, thermodynamic fundamentals, characteristic parameters, process in gasoline/otto engines, process in

diesel engines, pollutant formation and exhaust after treatment.

2148646 Fundamentals of Electrical Power Engineering **3(3-0-9)**
FUND ELEC ENG

Introduction to power systems, sources of electric energy, load characteristics, electric power plants, basic power system calculation, electric power transmission, transmission line parameters, electric power distribution, power transformers, power system equipment.

2148647 Environmental Sustainability in Transport Engineering Engineering **3(3-0-9)**
ENV SUST TRAN ENG

Pollutants and pollutant sources: road vehicle emissions, railway train emissions, naval emissions, aircraft emissions; measurements and data analysis: concentration measurement of gases and particles, analysis of an air-quality data set; dry and wet deposition; mitigation and effects of air pollution: the role of vegetation, effects on humans and animals, plants, soil and groundwater, effects on material properties; control of emissions, legislation in EU, UK, US and Asia; noise: introduction to acoustics, environmental noise, noise sources; emissions from motor vehicles, railway and aircraft; measurement, prediction, propagation and control of noise in the contexts of road traffic, railway and airports; effects of noise on humans and animals; environmental assessment.

2148648 Quality Engineering for Railway Engineers **3(3-0-9)**
QUAL ENG RAIL ENG

The course provides the understand of quality infrastructure (QI) and quality engineering (QE) in railway industry and their tools such as Metrology, Standard, Testing and Quality assurance (MSTQ). Theory of the MSTQ and hand-on practices in railway cases. Case study in implementing of MSTQ in railway industrial for trouble shooting and development. Necessary skills in quality engineering and management for professional career.

2148649 Advanced Special Topics in Rolling Stock Engineering **3(3-0-9)**
ADV TOP ROLL ENG

The course focuses on current interest and approaches in research and development of rolling stock engineering. Study and investigate special problems assigned by the instructors. Analyze and determine possible solutions to the problems in written report and presentation. The topic selected can be extended for master degree thesis.

2148650 Computer Aided Engineering Tools I **3(3-0-9)**
COM AIDED ENG I

A series of examined modules to give students the necessary CAE tool technical skills needed for practical use in other courses, research and thesis work, and in preparation of industrial application. The software could be either commercial or non-commercial packages, more than one package, and selected according to the overall program needs and balanced between current industry and research market requirements.

2148651 Computer Aided Engineering Tools II **3(3-0-9)**
COM AIDED ENG II

Continues from Computer Aided Engineering Tools I, by deepening skills and/or using different packages. A series of examined modules to give students the necessary CAE tool technical skills needed for practical use in other courses, research and thesis work, and in preparation of industrial application. The software could be either commercial or non-commercial packages, more than one package, and selected according to the overall program needs and balanced between current industry and research market requirements.

2148652 Finite Element Method **3(3-0-9)**
FIN ELEM METHOD

Overview of numerical methods; finite elements for 2D trusses, beams, 2D and 3D continua; matrix methods (force and displacement method); stiffness matrix for springs, rods, 2D trusses, bending of beams, 2D elastic continua; mass matrices for dynamic analysis; triangle element, higher order (quadratic and cubic) displacement functions; quadrilateral elements (Lagrange and serendipity elements); Isoparametric elements; elements for 3D analysis (tetrahedron, cube). The course will include the use of non-commercial and/or commercial software.

2148653 Mechanical Behaviour and Degradation **3(3-0-9)**
MECH BEHA DEGRA

Stress and strain; elastic properties; yielding; material behavior with plastic deformation; fracture; crack growth; fatigue; creep; wear; failure analysis; life assessment for engineering components.

2148654 Vehicle Crash and Human Body Simulation Techniques **3(3-0-9)**
VEHI HUM SIMU TECH

Accidental reconstruction and analysis; kinematics of vehicle impact; simulation of side impact and frontal collision; principle of human body simulation; pedestrian and occupant simulation.

2148655 Advanced Special Topics in Railway Track Engineering **3(3-0-9)**
ADV TOP RAIL ENG

The course focuses on current interest and approaches in railway track research and development. Study and investigate special problems assigned by the instructors. Analyze and determine possible solutions to the problems in written report and presentation. The topic selected can be extended for master degree thesis.

2148656 Probability Statistics and Decision for Civil Engineering **3(3-0-9)**
PRO STAT DEC ENG

Elements of probability theory; common probability models; probabilistic models and observed data; elementary Baysian decision theory; analysis of independent random process.

2148657 Computer Programming and Computer Tools for Graduate Research **3(3-0-9)**
COM PROG/TOOL RESE

Object-oriented programming using C++, event driven and GUI programming, data flow programming for data acquisition and automatic control in laboratory; use of MATLAB and Mathematica, numerical algorithm for linear system, numerical algorithm for non-linear system.

2148658 Finite Element Method for Civil Engineers **3(3-0-9)**
FIN ELE METH ENG

Basic concepts of interpolation; finite element interpolation; introduction to the finite element techniques in mechanics; development of elements from various principles and application of the method to static continuum problems; convergence and compatibility requirements; assemblage of elements and boundary conditions; structure of a typical finite element computer program; introduction to the treatment of dynamics and stability and extension of the method to generalized field problem; application in civil engineering problems.

2148659 Structural Testing and Evaluation **3(3-0-9)**
STRU TEST EVALUA

Concept of structural testing and evaluation; destructive and non-destructive testing; structural models and components for testing; full scale testing; testing standards; equipment and measurement techniques; data analysis and evaluation of structural performance.

2148811 Thesis **12(0-48-0)**

Research in an interesting topic in Automotive Engineering. The student will submit the thesis to summarize the thesis work content, deliverables and confirmed outcomes.

DEPARTMENT OF ELECTRICAL ENGINEERING

The undergraduate curriculum is designed to provide students with a broad and firm foundation in physical science and electrical engineering, which is essential for an electrical engineering pursuing his/her career as a practitioner or researcher..

Electrical engineering courses begin in the sophomore year with electric circuits, electrical machines and electromagnetic. During the junior year, the students have to study further fundamental subjects related to electrical power, electronics, communications, and control systems. Courses in engineering mathematics are also included in the curriculum to strengthen the students' ability in analysis. During the senior year, students can select their specialization by taking subjects from the approved elective list as well as the Electrical Engineering Project.

Laboratory works in various disciplines of electrical engineering are included in the curriculum. The objective of these courses is to develop the students' skills in operating test equipment, resourcefulness in solving practical problems, and ability to analyze test results.

The Department of Electrical Engineering offers two graduate programs leading to the degree of Master of Engineering and the degree of Doctor of Philosophy.

For Master degree, the applicant must hold a Bachelor's Degree either in Electrical Engineering or in related fields of study and must also meet the requirements of the Graduate School.

The program consists of 36 credits, of which 36, 24 and 12 of required credits are for Master's Degree thesis for students in "Plan A1" and "Plan A2" (research-based study programs and professional-based study programs), respectively. And the remaining credits are from courses according to the students' selected research clusters.

The major requirement consists of 6 research clusters namely: (1) Bioelectronics, (2) Power and Energy, (3) Data Analytics, (4) Control and Embedded Systems, (5) Advanced Materials and Devices, and (6) Telecommunication, Networking and Systems.

For Ph.D. Program, the applicant must meet one of the following requirements:

1. The applicant who holds a Bachelor's Degree in Electrical Engineering must obtain the second honor degree or the minimum 3.25 grade point average and must also meet the requirement of the Graduate School.

2. The applicant who holds a Master's Degree in Electrical Engineering must obtain good or excellent in master thesis and must also meet the requirement of the Graduate School.

Moreover, each Ph.D. student has to pass the following requirements in order to achieve his or her study:

Ph.D. program 1 (from Master, research only): The applicant who holds a Master's Degree with 3.5 grade point average or higher must take credits from the seminar and listed elective courses with the approval of the major advisor. In addition to fulfilling the course requirement, the student is required to submit a thesis of 60 credits, satisfactorily pass an oral examination and one part or more of the thesis has been accepted to be published in international journal.

Ph.D. program 2 (from Master, research and coursework): The applicant who holds a Master's Degree with grade point average less than 3.5 is required to pass at least 12 credits from the listed elective courses with the approval of the major advisor and the seminar courses. In addition to fulfilling the course requirement, the student is required to submit a thesis of 48 credits, satisfactorily pass an oral examination and one part or more of the thesis has been accepted to be published in international journal.

Ph.D. program 3 (from Bachelor, research and coursework):The applicant who holds a Bachelor's degree is required to pass 24 credits from the listed elective and the seminar courses with the approval of the major advisor. In addition to fulfilling the course requirement, the student is required to submit a thesis of 48 credits, satisfactorily pass an oral examination and one part or more of the thesis has been accepted to be published in international journal.

HEAD :

Naebboon	Hoonchareon,	Ph.D. (Purdue)

PROFESSORS :

Boonchai	Tacha-amnart,	D.Eng.(Kyoto)
Bundhit	Eua-arporn,	Ph.D. (London)
David	Banjerdpongchai,	Ph.D. (Stanford)
Songphol	Kanjanachuchai,	Ph.D.(Cambridge)

ASSOCIATE PROFESSORS :

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Chanchana	Tangwongsan,	Ph.D. (Wisconsin)
Chaodit	Aswakul,	Ph.D. (London)
Charnchai	Pluempitiwiriyawej,	Ph.D. (Carnegie Mellon)
Cherdkul	Sopavanit,	M.Eng. (Chula)
Duang-rudee	Worasucheep,	Ph.D. (Stanford)
Jitkomut	Songsiri	Ph.D. (UCLA)
Kulyos	Audomvongseree,	D.Eng. (Tokyo)
Lunchakorn	Wuttisittikulkij,	Ph.D. (Essex)
Naebboon	Hoonchareon,	Ph.D. (Purdue)
Nisachon	Tangsangiumvisai,	Ph.D. (London)
Sotdhipong	Phichaisawat,	Ph.D. (Brunel, UK)
Supavadee	Aramvith,	Ph.D. (Washington)
Supatana	Auethavekiat	Ph.D. (Tokyo)
Surachai	Chaitusaney	Ph.D. (Tokyo)
Surapong	Suwankawin,	Ph.D. (Chula)
Suwit	Kiravittaya,	Ph.D. (Chula)
Thavatchai	Tayjasanant,	Ph.D. (Alberta)
Wanchalerm	Pora,	Ph.D. (London)
Watcharapong	Khovidhungij,	Ph.D. (UCLA)

ASSISTANT PROFESSORS :

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Arporn	Teeramongkonrasmee,	Ph.D. (Chula)
Channarong	Banmongkol,	D.Eng. (Nagoya)
Chanin	Wissawinthanon,	Ph.D. (Minnesota)
Manop	Wongsaisuwan,	D.Eng. (Tokyo Tech)
Panuwat	Janpugdee	Ph.D. (Ohio State)
Pasu	Kaewplang,	Ph.D. (Chula)
Somboon	Sangwongwanich,	D.Eng. (Nagoya)
Suchin	Arunsawatwong,	Ph.D. (Manchester)
Suree	Pumrin,	Ph.D. (Washington)
Widhyakorn	Asdornwised,	D.Eng. (Chula)

LECTURERS :

Boonchuay	Supmonchai,	M.Eng. (Chula)
Chalermchai	Himwas,	Ph.D. (Grenoble Alpes)
Hadsakoon	Boriphonmongkol,	M.Eng. (Chula)
Jakapan	Lee,	M.Eng. (Tokyo Tech)
Napong	Panitantum,	Ph.D. (Oregon State)
Pisitpol	Chirapngsananurak	Ph.D. (Texas)
Sawit	Na Songkhla,	Ph.D. (Tokyo Tech)
Teerapol	Silawan,	Ph.D. (Chula)

ELECTRICAL ENGINEERING CURRICULUM
FIRST YEAR CURRICULUM

COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER	
2102203	PROBABILITY AND STATISTICS FOR ELECTRICAL ENGINEERING	3
2102204	DIFFERENTIAL EQUATIONS AND TRANSFORMS	3
2102206	INTRODUCTION TO ELECTRICAL ENGINEERING	1
2102208	PROGRAMMING FOR ELECTRICAL ENGINEERING	3
2102210	CIRCUIT THEORY I	3
2103213	ENGINEERING MECHANICS I	3
xxxxxxx	GENERAL EDUCATION I	3
		19
	FOURTH SEMESTER	
2102205	ELEMENTARY LINEAR ALGEBRA AND APPLICATIONS	3
2102211	ELECTRICAL CIRCUIT LABORATORY	1
2102221	ENGINEERING ELECTROMAGNETICS	2
2102241	DIGITAL SYSTEMS	2
2102281	PROPERTIES OF ELECTRICAL AND ELECTRONIC MATERIALS	2
5500208	COMMUNICATION AND PRESENTATION SKILLS	3
xxxxxxx	GENERAL EDUCATION II	3
		16
	FIFTH SEMESTER	
2102332	LINEAR CONTROL SYSTEMS I	3
2102351	FUNDAMENTAL OF ELECTRICAL POWER ENGINEERING AND SMART GRID	2
2102352	FUNDAMENTALS OF POWER ENGINEERING LABORATORY	1
2102372	PRINCIPLES OF COMMUNICATION	2
2102XXX	COMPULSORY ELECTIVE (IT)	3
xxxxxxx	GENERAL EDUCATION III	3
xxxxxxx	GENERAL EDUCATION IV	3
		17

COURSE NO.	SUBJECT	CREDITS
	SIXTH SEMESTER	
2102311	ELECTRICAL MEASUREMENT AND INSTRUMENTATION	**3**
2102341	ELECTRONIC CIRCUITS	2
2102399	CAPSTONE PROJECT	2
2102xxx	EE COMPULSORY ELECTIVES	6
xxxxxxx	FREE ELECTIVE I	3
		16
	SUMMER SEMESTER	
2100301	ENGINEERING PRACTICE	2
	SEVENTH SEMESTER	
2102491	ELECTRICAL ENGINEERING PRE-PROJECT	1
2102xxx	EE COMPULSORY ELECTIVE	3
2102xxx	EE COMPULSORY ELECTIVE (LAB)	1
2102xxx	EE ELECTIVE	3
210xxxx	COMPULSORY ELECTIVE (MULTIDISCIPLINARY & 21st CENTURY)	3
5500308	TECHNICAL WRITING FOR ENGINEERING	3
		14
	EIGHTH SEMESTER	
2102499	ELECTRICAL ENGINEERING PROJECT	3
2102xxx	EE ELECTIVE	3
210xxxx	COMPULSORY ELECTIVE (MULTIDISCIPLINARY & 21st CENTURY)	3
xxxxxxx	FREE ELECTIVES II	3
		12

TOTAL CREDITS FOR GRADUATION = 132

ELECTRICAL ENGINEERING CURRICULUM
FIRST YEAR CURRICULUM (POWER)

COURSE NO.	SUBJECT	CEDITS
	THIRD SEMESTER	
2102203	PROBABILITY AND STATISTICS FOR ELECTRICAL ENGINEERING	3
2102204	DIFFERENTIAL EQUATIONS AND TRANSFORMS	3
2102206	INTRODUCTION TO ELECTRICAL ENGINEERING	1
2102208	PROGRAMMING FOR ELECTRICAL ENGINEERING	3
2102210	CIRCUIT THEORY I	3
2103213	ENGINEERING MECHANICS I	3
xxxxxxx	GENERAL EDUCATION I	3
		19
	FOURTH SEMESTER	
2102205	ELEMENTARY LINEAR ALGEBRA AND APPLICATIONS	3
2102211	ELECTRICAL CIRCUIT LABORATORY	1
2102221	ENGINEERING ELECTROMAGNETICS	2
2102241	DIGITAL SYSTEMS	2
2102281	PROPERTIES OF ELECTRICAL AND ELECTRONIC MATERIALS	2
5500208	COMMUNICATION AND PRESENTATION SKILLS	3
xxxxxxx	GENERAL EDUCATION II	3
		16
	FIFTH SEMESTER	
2102253	ELECTRICAL MACHINE I AND LABORATORY	4
2102332	LINEAR CONTROL SYSTEMS I	3
2102372	PRINCIPLES OF COMMUNICATIONS	2
2102XXX	COMPULSORY ELECTIVE (IT)	3
xxxxxxx	GENERAL EDUCATION III	3
xxxxxxx	GENERAL EDUCATION IV	3
		18

COURSE NO.	SUBJECT	CREDITS
	SIXTH SEMESTER	
2102311	ELECTRICAL MEASUREMENT AND INSTRUMENTATION	**3**
2102341	ELECTRONIC CIRCUITS	2
2102399	CAPSTONE PROJECT	2
2102xxx	EE COMPULSORY ELECTIVES	6
xxxxxxx	FREE ELECTIVE I	3
		16
	SUMMER SEMESTER	
2100301	ENGINEERING PRACTICE	2
	SEVENTH SEMESTER	
2102491	ELECTRICAL ENGINEERING PRE-PROJECT	1
2102xxx	EE COMPULSORY ELECTIVES	9
2102xxx	EE COMPULSORY ELECTIVE (LAB)	1
210xxxx	COMPULSORY ELECTIVE (MULTIDISCIPLINARY & 21st CENTURY)	3
5500308	TECHNICAL WRITING FOR ENGINEERING	3
		17
	EIGHTH SEMESTER	
2102499	ELECTRICAL ENGINEERING PROJECT	3
2102xxx	EE COMPULSORY ELECTIVES	6
210xxxx	COMPULSORY ELECTIVE (MULTIDISCIPLINARY & 21st CENTURY)	3
xxxxxxx	FREE ELECTIVES II	3
		15

TOTAL CREDITS FOR GRADUATION = 139

ELECTRICAL ENGINEERING CURRICULUM
FIRST YEAR CURRICULUM (COMMUNICATION)

COURSE NO.	SUBJECT	CEDITS
	THIRD SEMESTER	
2102203	PROBABILITY AND STATISTICS FOR ELECTRICAL ENGINEERING	3
2102204	DIFFERENTIAL EQUATIONS AND TRANSFORMS	3
2102206	INTRODUCTION TO ELECTRICAL ENGINEERING	1
2102208	PROGRAMMING FOR ELECTRICAL ENGINEERING	3
2102210	CIRCUIT THEORY I	3
2103213	ENGINEERING MECHANICS I	3
xxxxxxx	GENERAL EDUCATION I	3
		19
	FOURTH SEMESTER	
2102205	ELEMENTARY LINEAR ALGEBRA AND APPLICATIONS	3
2102211	ELECTRICAL CIRCUIT LABORATORY	1
2102221	ENGINEERING ELECTROMAGNETICS	2
2102241	DIGITAL SYSTEMS	2
2102281	PROPERTIES OF ELECTRICAL AND ELECTRONIC MATERIALS	2
5500208	COMMUNICATION AND PRESENTATION SKILLS	3
xxxxxxx	GENERAL EDUCATION II	3
		16
	FIFTH SEMESTER	
2102332	LINEAR CONTROL SYSTEMS I	3
2102351	FUNDAMENTAL OF ELECTRICAL POWER ENGINEERING AND SMART GRID	2
2102352	FUNDAMETALS OF POWER ENGINEERING LABORATORY	1
2102372	PRINCIPLES OF COMMUNICATIONS	2
2102XXX	COMPULSORY ELECTIVE (IT)	3
xxxxxxx	GENERAL EDUCATION III	3
xxxxxxx	GENERAL EDUCATION IV	3
		17

COURSE NO.	SUBJECT	CREDITS
	SIXTH SEMESTER	
2102311	ELECTRICAL MEASUREMENT AND INSTRUMENTATION	**3**
2102341	ELECTRONIC CIRCUITS	2
2102399	CAPSTONE PROJECT	2
2102xxx	EE COMPULSORY ELECTIVES	6
xxxxxxx	FREE ELECTIVE I	3
		16
	SUMMER SEMESTER	
2100301	ENGINEERING PRACTICE	2
	SEVENTH SEMESTER	
2102491	ELECTRICAL ENGINEERING PRE-PROJECT	1
2102xxx	EE COMPULSORY ELECTIVES	9
2102xxx	EE COMPULSORY ELECTIVE (LAB)	1
210xxxx	COMPULSORY ELECTIVE (MULTIDISCIPLINARY & 21st CENTURY)	3
5500308	TECHNICAL WRITING FOR ENGINEERING	3
		17
	EIGHTH SEMESTER	
2102499	ELECTRICAL ENGINEERING PROJECT	3
2102xxx	EE ELECTIVES	6
210xxxx	COMPULSORY ELECTIVE (MULTIDISCIPLINARY & 21st CENTURY)	3
xxxxxxx	FREE ELECTIVES II	3
		15

TOTAL CREDITS FOR GRADUATION = 138

Electrical Engineering
Compulsory Elective Courses

Category	Power and Energy	Advanced Communication	Signal and Control System	Smart Devices and Material
EE Compulsory Elective (A student must select 1 field with a minimum of 9 lecture credits and 1 lab credit.)	2102253 Electrical Machines I and Laboratory (4) 2102360 Electrical Power System I (3) 2102446 Fundamental of Power Electronics (3) 2102456 Electrical System Design (3) 2102457 Fundamental of Light and Lighting (3) 2102458 High Voltage Engineering I (3) 2102459 High Voltage Engineering Laboratory (1) 2102461 Electrical Power Systems II (3) 2102463 Electrical Power System Protection (3) 2102464 Fundamentals of Electric Motor Drives (3) 2102465 Electrical Power Laboratory (1) 2102466 Introduction to Active Distribution Networks (3) 2102467 Electric Vehicles, Energy Storage Systems and Grid Integration (3) 2102548 Switched-Mode Electrical Power Processing (3)	2102322 Telecommunication Transmission (3) 2102420 Principles of Antennas (3) 2102421 Principles of Microwave Engineering (3) 2102425 Data Communications (3) 2102472 Fundamental of Digital Communication (3) 2102473 Communication Engineering Laboratory (1) 2102522 Internet Technology and Applications (3) 2102525 Network Management and Design (3) 2102526 Mobile Communications and Networking (3) 2102527 Traffic Engineering and Analysis and Simulation (3) 2102541 IoT Fundamentals (3) 2102571 Multimedia Communication (3) 2102577 Telecommunication Networks (3) 2102579 Optical Fiber Communication and Components (3)	2102423 Digital Signal Processing (3) 2102432 Linear Control System II (3) 2102433 Digital Control Systems (3) 2102435 Industrial Automation (3) 2102436 Control and Instrumentation Laboratory (1) 2102500 Linear Algebra for Electrical Engineering (1) 2102501 Random Processes for Electrical Engineering (2) 2102503 Time Series Analysis (1) 2102504 Introduction to Mathematical Analysis (3) 2102508 Optimization Concepts and Applications (1) 2102509 Introduction to Optimization Techniques (2) 2102510 Linear Programming (1) 2102511 Optimization Methods for Engineering and Machine Learning (2) 2102513 Basic Image Processing (1) 2102514 Advanced Image Processing (2) 2102515 Digital Video Processing (2) 2102516 Adaptive Signal Processing (1) 2102517 Wavelet Transform (1) 2102518 Neural Networks and Deep Learning (1) 2102519 Reinforcement Learning and Applications (1) 2102521 System Identification (2) 2102523 Estimation Theory (2) 2102535 Nonlinear Control System (3) 2102575 Statistical Inference and Modeling (3) 2301308 Functions of a Complex Variable (3)	2102385 Semiconductor Devices I (3) 2102444 Introduction to Embedded Systems (3) 2102447 Electronics Engineering Laboratory (1) 2102488 Semiconductor Devices II (3) 2102489 Principle of Analog Circuit Design (3) 2102541 IoT Fundamentals (3) 2102547 Analog Integrated Circuits (2) 2102583 Introduction to Quantum Mechanics (3) 2102585 Biomaterial Science (3) 2102589 Laser Engineering (3) 2102611 Medical Instrumentation (3) 2102663 Solar Cell Technology (3) 2102682 Solid-State Physics for Electronics Engineers (3)
Multidisciplinary & 21st Century (At least 6 credits)	2100223 Entrepreneurship and New Venture Creation (3) / 2100224 Technopreneurship (3) / 2100225 Design Thinking Principle (3) / 2100226 Problem Solving Principle (3) / 2102466 Introduction to Active Distribution Networks (3) / 2102467 Electric Vehicles, Energy Storage Systems and Grid Integration (3) / 2102525 Network Management and Design (3) /			

	2102526 Mobile Communications and Networking (3)
IT (At least 6 credits and a student must select 2102208)	2100201 Introduction to Artificial Intelligence (3) / 2100202 Introduction to Data Science and Big Data (3) / 2102208 Programming for Electrical Engineering (3)

Notes In case, the student choose 2102466, 2102467, 2102525 and/or 2102526, he/she can declare them only in one category.

Electrical Engineering
Elective Courses

Category	Power and Energy	Advanced Communication	Signal and Control System	Smart Devices and Material
Elective (At least 6 credits in any fields)	2102552 Introduction to Distributed Generation (3) 2102553 Fundamentals of Electromagnetic Compatibility (3) 2102554 Power Quality in Smart Grids (3) 2102557 Advanced High-Voltage Engineering Applications (3) 2102559 Energy Management Systems In Smart Grids (3) 2102754 Electric Field Analysis in High Voltage Engineering (3)	2102506 Finite Element Analysis for Electrical Engineers (3)	2102512 Heuristic Optimization (2) 2102549 Introduction to Computer Vision (2)	2102542 Digital Circuit Design (2) 2102544 Advanced Embedded Systems (3) 2102580 Semiconductor Technology: Fabrication and Characterization (3) 2102582 Photonic Devices in Optical Communication Systems (3) 2102587 Sensor Technology and Applications (3) 2102668 Biosensor (3)

Notes The compulsory elective courses can be selected as elective courses.

See the complete list of EE elective courses from the announcement of Electrical Engineering Department.

Electrical Engineering (Power) and Electrical Engineering (Communication)
Compulsory Elective Courses

Category	Electrical Engineering (Power) Track	Electrical Engineering (Communication) Track
EE Compulsory Elective (A student must take at least 21 lecture credits and 1 lab credit in the selected track.)	2102360 Electrical Power System I (3) 2102446 Fundamental of Power Electronics (3) 2102456 Electrical System Design (3) 2102458 High Voltage Engineering I (3) 2102459 High Voltage Engineering Laboratory (1) 2102461 Electrical Power Systems II (3) 2102463 Electrical Power System Protection (3) 2102464 Fundamentals of Electric Motor Drives (3) 2102465 Electrical Power Laboratory (1)	2102322 Telecommunication Transmission (3) 2102420 Principles of Antennas (3) 2102421 Principles of Microwave Engineering (3) 2102425 Data Communications (3) 2102472 Fundamental of Digital Communication (3) 2102473 Communication Engineering Laboratory (1) 2102577 Telecommunication Networks (3) 2102579 Optical Fiber Communication and Components (3)
Multidisciplinary & 21st Century (At least 6 credits)	2102466 Introduction to Active Distribution Networks (3) 2102467 Electric Vehicles, Energy Storage Systems and Grid Integration (3)	2102525 Network Management and Design (3) 2102526 Mobile Communications and Networking (3)
IT (At least 6 credits and a student must select 2102208)	2100201 Introduction to Artificial Intelligence (3) / 2100202 Introduction to Data Science and Big Data (3) / 2102208 Programming for Electrical Engineering (3)	

NAME OF THE DEGREE

: Master of Engineering
: M. Eng.

PROFESSORS :

Boonchai	Tacha-amnart,	D.Eng.(Kyoto)
Bundhit	Eua-arporn,	Ph.D. (London)
David	Banjerdpongchai,	Ph.D. (Stanford)
Songphol	Kanjanachuchai,	Ph.D.(Cambridge)

ASSOCIATE PROFESSORS :

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Jitkomut	Songsiri	Ph.D. (UCLA)
Kulyos	Audomvongseree,	D.Eng. (Tokyo)
Lunchakorn	Wuttisittikulkij,	Ph.D. (Essex)
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Nisachon	Tangsangiumvisai,	Ph.D. (London)
Sotdhipong	Phichaisawat,	Ph.D. (Brunel, UK)
Supavadee	Aramvith,	Ph.D. (Washington)
Supatana	Auethavekiat	Ph.D. (Tokyo)
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Surapong	Suwankawin,	Ph.D. (Chula)
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Thavatchai	Tayjasanant,	Ph.D. (Alberta)
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Somboon	Sangwongwanich,	D.Eng. (Nagoya)
Suchin	Arunsawatwong,	Ph.D. (Manchester)
Suree	Pumrin,	Ph.D. (Washington)
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LECTURERS :

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Pisitpol	Chirapngsananurak	Ph.D. (Texas)
Sawit	Na Songkhla,	Ph.D. (Tokyo Tech)
Teerapol	Silawan,	Ph.D. (Chula)

COURSE REQUIREMENTS

1. Required Courses

1.1) For "Plan A1" and "Plan A2" (research-based study programs): students must register (without counting credits) for the following S/U course.

2102590	Research Methodology	2(2-0-6)

1.2) For "Plan A2" (professional-based study programs): students must register (without counting credits) for the course 2102590 Research Methodology or choose from

2102790	Electrical Engineering Seminar	2(2-0-6)

2) Elective Courses in Research Cluster 6-12 credits

Students in "Plan A2", must select one of the 6 research clusters below and register for the elective courses of that cluster. Required number of credits and the elective courses of each research cluster are as follows:

- **Bioelectronics**
  - **Research-based study program 6 credits**

2102506	Finite Element Analysis for Electrical Engineers	3(3-0-9)
2102585	Biomaterial Science	3(3-0-9)
2102587	Sensor Technology and Applications	3(3-0-9)
2102611	Medical Instrumentation	3(3-0-9)
2102668	Biosensor	3(3-0-9)

- **Power and Energy**
  - **Research-based study program 6 credits**
  - **Professional-based study program 6 credits**

2102506	Finite Element Analysis for Electrical Engineers	3(3-0-9)
2102541	IoT Fundamentals	3(3-0-9)
2102543	Advanced Electric Motor Drives	3(3-0-9)
2102544	Advanced Embedded Systems	3(3-0-9)
2102548	Switched-Mode Electrical Power Processing I	3(3-0-9)
2102552	Introduction to Distributed Generation	3(3-0-9)

2102553	Fundamentals of Electromagnetic Compatibility	3(3-0-9)
2102557	Advanced High-Voltage Engineering Applications	3(3-0-9)
2102559	Energy Management Systems in Smart Grids	3(3-0-9)
2102560	High Voltage Equipment Maintenance and Testing	3(3-0-9)
2102563	Power Electronics for Smart Grids and Renewable Energy	3(3-0-9)
2102565	Economics in Energy Supply Industry	3(3-0-9)
2102566	Substation Automation Systems	3(3-0-9)
2102567	Power System Analysis	3(3-0-9)
2102568	Power Electronics for Electric Vehicles Technology	3(3-0-9)
2102569	Power Converters and Control Methods	3(3-0-9)
2102572	Power Quality in Smart Grids	3(3-0-9)
2102650	Electrical Transients in Power Systems	3(3-0-9)
2102652	Power System Dynamic and Control	3(3-0-9)
2102653	Special Topics in Power Electronics	3(3-0-9)
2102654	Software Tools for Smart Grid Analysis	3(3-0-9)
2102655	Power Grid Technologies	3(3-0-9)
2102657	Power Grid Reliability and Resilience	3(3-0-9)
2102686	Switched-Mode Electrical Power Processing II	3(3-0-9)
2102754	Electric Field Analysis in High Voltage Engineering	3(3-0-9)

- **Data Analytics**
  - **Research-based study program** **12 credits**

2102500	Linear Algebra for Electrical Engineering	1(1-0-3)
2102501	Random Processes for Electrical Engineering	2(2-0-6)
2102503	Time Series Analysis	1(1-0-3)
2102504	Introduction to Mathematical Analysis	3(3-0-9)
2102508	Optimization Concepts and Applications	1(1-0-3)
2102509	Introduction to Optimization Techniques	2(2-0-6)
2102510	Linear Programming	1(1-0-3)
2102511	Optimization Methods for Engineering and Machine Learning	2(2-0-6)
2102512	Heuristic Optimization	2(2-0-6)
2102513	Basic Image Processing	1(1-0-3)
2102514	Advanced Image Processing	2(2-0-6)
2102515	Digital Video Processing	2(2-0-6)
2102516	Adaptive Signal Processing	1(1-0-3)
2102517	Wavelet Transform	1(1-0-3)
2102518	Neural Networks and Deep Learning	1(1-0-3)
2102519	Reinforcement Learning and Applications	1(1-0-3)
2102521	System Identification	2(2-0-6)
2102523	Estimation Theory	2(2-0-6)
2102571	Multimedia Communication	3(3-0-9)
2102575	Statistical Inference and Modeling	3(3-0-9)

- **Control and Embedded Systems**
  - **Research-based study program** **9 credits**
  - **Professional-based study program** **12 credits**

2102500	Linear Algebra for Electrical Engineering	1(1-0-3)
2102501	Random Processes for Electrical Engineering	2(2-0-6)
2102504	Introduction to Mathematical Analysis	3(3-0-9)
2102508	Optimization Concepts and Applications	1(1-0-3)
2102509	Introduction to Optimization Techniques	2(2-0-6)
2102510	Linear Programming	1(1-0-3)
2102511	Optimization Methods for Engineering and Machine Learning	2(2-0-6)
2102518	Neural Networks and Deep Learning	1(1-0-3)
2102519	Reinforcement Learning and Applications	1(1-0-3)
2102521	System Identification	2(2-0-6)
2102523	Estimation Theory	2(2-0-6)
2102535	Nonlinear Control Systems	3 (3-0-9)
2102537	Glocal Control Systems	3(3-0-9)
2102541	IoT Fundamentals	3 (3-0-9)
2102542	Digital Circuit Design	2(2-0-6)
2102544	Advanced Embedded Systems	3(3-0-9)
2102545	Digital Integrated Circuits	3(3-0-9)
2102547	Analog Integrated Circuits	2(2-0-6)
2102570	Introduction to Computer Vision	2(2-0-6)
2102575	Statistical Inference and Modeling	3(3-0-9)
2102587	Sensor Technology and Applications	3(3-0-9)
2102635	Control System Theory	3(3-0-9)
2102637	Multivariable Control Systems	3(3-0-9)

- **Advanced Materials and Devices**
  - **Research-based study program** **6 credits**

2102506	Finite Element Analysis for Electrical Engineers	3(3-0-9)
2102580	Semiconductor Technology: Fabrication and Characterization	3(3-0-9)
2102582	Photonic Devices in Optical Communication Systems	3(3-0-9)
2102583	Introduction to Quantum Mechanics	3(3-0-9)
2102587	Sensor Technology and Applications	3(3-0-9)
2102589	Laser Engineering	3(3-0-9)
2102663	Solar Cell Technology	3(3-0-9)
2102682	Solid-State Physics for Electronics Engineers	3(3-0-9)

- **Telecommunication, Networking and Systems**
  - **Research-based study program** **9 credits**
  - **Professional-based study program** **12 credits**

2102506	Finite Element Analysis for Electrical Engineers	3(3-0-9)
2102520	Optical Fiber Transmissions and Networks	3(3-0-9)
2102522	Internet Technology and Applications	3(3-0-9)
2102525	Network Management and Design	3(3-0-9)
2102526	Mobile Communications and Networking	3(3-0-9)
2102527	Traffic Engineering Analysis and Simulation	3(3-0-9)
2102541	IoT Fundamentals	3(3-0-9)
2102577	Telecommunication Network	3(3-0-9)
2102579	Optical Fiber Communication and Components	3(3-0-9)
2102628	Graph Theory and Combinatorial Optimization	3(3-0-9)
2102771	Advanced Wireless Communications	3(3-0-9)

3) Elective courses in professional-based study programs: 6 credits

Students in "Plan A2" (professional-based study programs) must complete at least 6 credits from the elective courses in professional-based study programs, or choose from the electrical engineering elective courses under the supervision of a thesis advisor. Elective courses in professional-based study programs are assessed as S or U.

2102701	Industrial Experiences I	2(0-8-0)
2102702	Industrial Experiences II	2(0-8-0)
2102703	Industrial Experiences III	2(0-8-0)
2102711	Internship Aboard I	2(0-8-0)
2102712	Internship Aboard II	2(0-8-0)
2102713	Internship Aboard III	2(0-8-0)

4) Electrical Engineering Elective Courses 0-12 credits

Students in "Plan A2" choose from courses of any research clusters or choose from additional courses below in order to complete the number of credits required for the student's researcher cluster and study program.

- **Bioelectronics**
  - Research-based study program 6 credits
- **Power and Energy**
  - Research-based study program 6 credits
  - Professional-based study program 12 credits
- **Data Analysis**
  - Research-based study program 0 credits
- **Control and Embedded Systems**
  - Research-based study program 3 credits
  - Professional-based study program 6 credits
- **Advanced Material and Devices**
  - Research-based study program 6 credits
- **Telecommunication, Networking and Systems**
  - Research-based study program 3 credits
  - Professional-based study program 6 credits

2102631	Special Problems in Electrical Engineering I	1(1-0-3)
2102632	Special Problems in Electrical Engineering II	2(2-0-6)
2102633	Special Problems in Electrical Engineering III	3(3-0-9)
2102671	Future technology trends in EE industry I	1(1-0-3)
2102672	Future technology trends in EE industry II	2(2-0-6)
2102673	Future technology trends in EE industry III	3(3-0-9)

5) THESIS

2102811	THESIS	12	credits
2102814	THESIS	24	credits
2102816	THESIS	36	credits

2102811 is for "Plan A2" in professional-based study program. 2102814 is for "Plan A2" in research-based study program. 2102816 is for students in "Plan A1".

NAME OF THE DEGREE

: Doctor of Philosophy
: Ph.D.

PROFESSORS :

Boonchai	Tacha-amnart,	D.Eng.(Kyoto)
Bundhit	Eua-arporn,	Ph.D.(London)
David	Banjerdpongchai,	Ph.D.(Stanford)
Songphol	Kanjanachuchai,	Ph.D.(Cambridge)

ASSOCIATE PROFESSORS :

Chaiyachet	Saivichit,	Ph.D.(London)
Chanchana	Tangwongsan,	Ph.D.(Wisconsin)
Chaodit	Aswakul,	Ph.D.(London)
Charnchai	Pluempitiwiriyawej,	Ph.D.(Carnegie Mellon)
Cherdkul	Sopavanit,	M.Eng.(Chula)
Duang-rudee	Worasucheep,	Ph.D.(Stanford)
Jitkomut	Songsiri	Ph.D.(UCLA)
Kulyos	Audomvongseree,	D.Eng.(Tokyo)
Lunchakorn	Wuttisittikulkij,	Ph.D.(Essex)
Naebboon	Hoonchareon,	Ph.D.(Purdue)
Nisachon	Tangsangiumvisai,	Ph.D.(London)
Sotdhipong	Phichaisawat,	Ph.D.(Brunel, UK)
Supavadee	Aramvith,	Ph.D.(Washington)
Supatana	Auethavekiat	Ph.D.(Tokyo)
Surachai	Chaitusaney	Ph.D.(Tokyo)
Surapong	Suwankawin,	Ph.D.(Chula)
Suwit	Kiravittaya,	Ph.D.(Chula)
Thavatchai	Tayjasanant,	Ph.D.(Alberta)
Wanchalerm	Pora,	Ph.D.(London)
Watcharapong	Khovidhungij,	Ph.D.(UCLA)

ASSISTANT PROFESSORS :

Apiwat	Lek-Uthai	Dr.Ing.(Karlsruhe)
Arporn	Teeramongkonrasmee,	Ph.D.(Chula)
Channarong	Banmongkol,	D.Eng.(Nagoya)
Chanin	Wissawinthanon,	Ph.D.(Minnesota)
Manop	Wongsaisuwan,	D.Eng.(Tokyo Tech)
Panuwat	Janpugdee	Ph.D.(Ohio State)
Pasu	Kaewplang,	Ph.D.(Chula)
Somboon	Sangwongwanich,	D.Eng.(Nagoya)
Suchin	Arunsawatwong,	Ph.D.(Manchester)
Suree	Pumrin,	Ph.D.(Washington)
Widhyakorn	Asdornwised,	D.Eng.(Chula)

LECTURERS :

Boonchuay	Supmonchai,	M.Eng.(Chula)
Chalermchai	Himwas,	Ph.D.(Grenoble Alpes)
Hadsakoon	Boriphonmongkol,	M.Eng.(Chula)
Jakapan	Lee,	M.Eng.(Tokyo Tech)
Napong	Panitantum,	Ph.D.(Oregon State)
Pisitpol	Chirapngsananurak	Ph.D.(Texas)
Sawit	Na Songkhla,	Ph.D.(Tokyo Tech)
Teerapol	Silawan,	Ph.D.(Chula)

COURSE REQUIREMENTS

1) Required Courses

1.1) All students must register for the following S/U courses, without counting course credits.

2102721	Electrical Engineering Seminar I	1(1-0-3)
2102722	Electrical Engineering Seminar II	1(1-0-3)
2102723	Electrical Engineering Seminar III	1(1-0-3)
2102724	Electrical Engineering Seminar IV	1(1-0-3)

1.2) For Ph.D. program 1 (from Master, research only) and Ph.D. program 2 (from Master, research and coursework): students must choose to register in the following S/U courses for at least 4 credits.

For Ph.D. program 3 (from Bachelor, research and coursework): students must register for 2102590 Research Methodology (2 credits) and choose to register in other courses in the following list for at least 2 credits.

2102590	Research Methodology	2(2-0-6)
2102725	Intensive Electrical Engineering Seminar I	2(2-0-6)
2102726	Intensive Electrical Engineering Seminar II	2(2-0-6)
2102701	Industrial Experiences I	2(2-0-6)
2102702	Industrial Experiences II	2(2-0-6)
2102703	Industrial Experiences III	2(2-0-6)
2102711	Internship Aboard I	2(2-0-6)
2102712	Internship Aboard II	2(2-0-6)
2102713	Internship Aboard III	2(2-0-6)
5500532	Academic English for Graduate Studies	3(3-0-9)
5500560	Thesis Writing	3(3-0-9)

Students can count credits from courses 5500532 and 5500560 only if these course enrollments exceed the mandatory criteria as specified in the Announcement by Chulalongkorn University on the English Proficiency Test Score Criteria for Students Studying in Doctoral Degree Programs and Master's Degree Programs.

2) Elective Courses in Research Cluster 9 credits

Required for student in Ph.D. program 3 (from Bachelor, research and coursework) only

- **Bioelectronics**

2102506	Finite Element Analysis for Electrical Engineers	3(3-0-9)
2102585	Biomaterial Science	3(3-0-9)
2102587	Sensor Technology and Applications	3(3-0-9)
2102611	Medical Instrumentation	3(3-0-9)
2102668	Biosensor	3(3-0-9

- **Power and Energy**

2102506	Finite Element Analysis for Electrical Engineers	3(3-0-9)
2102541	IoT Fundamentals	3(3-0-9)
2102543	Advanced Electric Motor Drives	3(3-0-9)
2102544	Advanced Embedded Systems	3(3-0-9)
2102548	Switched-Mode Electrical Power Processing I	3(3-0-9)
2102552	Introduction to Distributed Generation	3(3-0-9)
2102553	Fundamentals of Electromagnetic Compatibility	3(3-0-9)
2102557	Advanced High-Voltage Engineering Applications	3(3-0-9)
2102559	Energy Management Systems in Smart Grids	3(3-0-9)
2102560	High Voltage Equipment Maintenance and Testing	3(3-0-9)
2102563	Power Electronics for Smart Grids and Renewable Energy	3(3-0-9)
2102565	Economics in Energy Supply Industry	3(3-0-9)
2102566	Substation Automation Systems	3(3-0-9)
2102567	Power System Analysis	3(3-0-9)
2102568	Power Electronics for Electric Vehicles Technology	3(3-0-9)
2102569	Power Converters and Control Methods	3(3-0-9)
2102572	Power Quality in Smart Grids	3(3-0-9)
2102650	Electrical Transients in Power Systems	3(3-0-9)
2102652	Power System Dynamic and Control	3(3-0-9)
2102653	Special Topics in Power Electronics	3(3-0-9)
2102654	Software Tools for Smart Grid Analysis	3(3-0-9)
2102655	Power Grid Technologies	3(3-0-9)
2102657	Power Grid Reliability and Resilience	3(3-0-9)
2102686	Switched-Mode Electrical Power Processing II	3(3-0-9)
2102754	Electric Field Analysis in High Voltage Engineering	3(3-0-9)

- **Data Analytics**

2102500	Linear Algebra for Electrical Engineering	1(1-0-3)
2102501	Random Processes for Electrical Engineering	2(2-0-6)
2102503	Time Series Analysis	1(1-0-3)
2102504	Introduction to Mathematical Analysis	3(3-0-9)
2102508	Optimization Concepts and Applications	1(1-0-3)
2102509	Introduction to Optimization Techniques	2(2-0-6)
2102510	Linear Programming	1(1-0-3)
2102511	Optimization Methods for Engineering and Machine Learning	2(2-0-6)
2102512	Heuristic Optimization	2(2-0-6)
2102513	Basic Image Processing	1(1-0-3)
2102514	Advanced Image Processing	2(2-0-6)
2102515	Digital Video Processing	2(2-0-6)
2102516	Adaptive Signal Processing	1(1-0-3)
2102517	Wavelet Transform	1(1-0-3)
2102518	Neural Networks and Deep Learning	1(1-0-3)
2102519	Reinforcement Learning and Applications	1(1-0-3)
2102521	System Identification	2(2-0-6)
2102523	Estimation Theory	2(2-0-6)
2102571	Multimedia Communication	3(3-0-9)
2102575	Statistical Inference and Modeling	3(3-0-9)

- **Control and Embedded Systems**

2102500	Linear Algebra for Electrical Engineering	1(1-0-3)
2102501	Random Processes for Electrical Engineering	2(2-0-6)
2102504	Introduction to Mathematical Analysis	3(3-0-9)
2102508	Optimization Concepts and Applications	1(1-0-3)
2102509	Introduction to Optimization Techniques	2(2-0-6)
2102510	Linear Programming	1(1-0-3)

2102511	Optimization Methods for Engineering and Machine Learning	2(2-0-6)
2102518	Neural Networks and Deep Learning	1(1-0-3)
2102519	Reinforcement Learning and Applications	1(1-0-3)
2102521	System Identification	2(2-0-6)
2102523	Estimation Theory	2(2-0-6)
2102535	Nonlinear Control Systems	3 (3-0-9)
2102537	Glocal Control Systems	3(3-0-9)
2102541	IoT Fundamentals	3 (3-0-9)
2102542	Digital Circuit Design	2(2-0-6)
2102544	Advanced Embedded Systems	3(3-0-9)
2102545	Digital Integrated Circuits	3(3-0-9)
2102547	Analog Integrated Circuits	2(2-0-6)
2102570	Introduction to Computer Vision	2(2-0-6)
2102575	Statistical Inference and Modeling	3 (3-0-9)
2102587	Sensor Technology and Applications	3 (3-0-9)
2102635	Control System Theory	3(3-0-9)
2102637	Multivariable Control Systems	3(3-0-9)

- **Advanced Materials and Devices**

2102506	Finite Element Analysis for Electrical Engineers	3(3-0-9)
2102580	Semiconductor Technology: Fabrication and Characterization	3(3-0-9)
2102582	Photonic Devices in Optical Communication Systems	3(3-0-9)
2102583	Introduction to Quantum Mechanics	3(3-0-9)
2102587	Sensor Technology and Applications	3(3-0-9)
2102589	Laser Engineering	3(3-0-9)
2102663	Solar Cell Technology	3(3-0-9)
2102682	Solid-State Physics for Electronics Engineers	3(3-0-9)

- **Telecommunication, Networking and Systems**

2102506	Finite Element Analysis for Electrical Engineers	3(3-0-9)
2102520	Optical Fiber Transmissions and Networks	3(3-0-9)
2102522	Internet Technology and Applications	3(3-0-9)
2102525	Network Management and Design	3(3-0-9)
2102526	Mobile Communications and Networking	3(3-0-9)
2102527	Traffic Engineering Analysis and Simulation	3(3-0-9)
2102541	IoT Fundamentals	3(3-0-9)
2102577	Telecommunication Network	3(3-0-9)
2102579	Optical Fiber Communication and Components	3(3-0-9)
2102628	Graph Theory and Combinatorial Optimization	3(3-0-9)
2102771	Advanced Wireless Communications	3(3-0-9)

3) Electrical Engineering Elective Courses 12 or 15 credits

(12 credits are required for Ph.D. students in Ph.D. program 2 (from Master, research and coursework), 15 credits are required for Ph.D. students in Ph.D. program 3 (from Bachelor, research and coursework).

Select from any in item 2) or the following courses

2102631	Special Problems in Electrical Engineering I	1(1-0-3)
2102632	Special Problems in Electrical Engineering II	2(2-0-6)
2102633	Special Problems in Electrical Engineering III	3(3-0-9)
2102671	Future technology trends in EE industry I	1(1-0-3)
2102672	Future technology trends in EE industry II	2(2-0-6)
2102673	Future technology trends in EE industry III	3(3-0-9)

4) Dissertation

2102828	Dissertation	48	credits
2102829	Dissertation	60	credits
2102830	Dissertation	72	credits
2102894	Doctoral Dissertation Seminar		S/U
2102897	Qualifying Examination		S/U

2102828 is for Ph.D. students in Ph.D. program 2 (from Master, research and coursework) and Ph.D. program 3 (from Bachelor, research and coursework).

2102829 is for Ph.D. students in Ph.D. program 1 (from Master, research only).

In any semester without seminar courses, students must register for 2102894 Doctoral Dissertation Seminar. And in this case students must obtain the S mark in the last semester when the students request for their graduation.

COURSES DESCRIPTIONS IN ELECTRICAL ENGINEERING (B.ENG.)

2102203 Probability and Statistics for Electrical Engineering 3(3-0-6)

Condition : Prerequisite 2301108

Elements of probability: axioms of probability, conditional probability, independent events, Bayes' theorem. random variables: discrete and continuous random variables, probability functions, function of r.v., expectation, variance, covariance, moments, moment generating functions, Markov's and Chebyshev's inequalities, the weak law of large numbers. special random variables: Bernoulli, binomial, multinomial, geometric, Poisson, hypergeometric, negative binomial, uniform, normal (Gaussian), exponential, gamma, chi-square, t, F. sampling: sample mean, sample variance, histogram, sampling distributions from a normal population. Parameter estimation: method of moments, maximum likelihood method, confidence interval, bias, mean square error. hypothesis testing: types and probability of error, tests concerning mean and variance of normal populations.

2102204 Differential Equations and Transforms 3(3-0-6)

First- order and higher- order ordinary differential equations; Fourier series; Fourier integral and transform; Laplace transform; partial fraction expansion; boundary-value problem; applications in Electrical Engineering.

2102205 Elementary Linear Algebra and Applications 3(3-0-6)

Linear equations: elementary row operations, Gaussian-Jordan elimination, homogeneous linear systems; Matrices: elementary matrix, invertibility, determinant, triangular, symmetric, orthogonal, permutation, and positive definite matrices; over- determined and under- determined linear equations; linear least-squares problem and applications; Numerical methods for solving linear equations; Matrix decompositions; Eigenvalues and eigenvectors; Diagonalizability; Applications of eigenvalues; Linear vector space: linear independence, basis, dimension, nullspace and range of a matrix, rank- nullity theorem; Linear transformation: matrix transformation, kernel, range, one-to-one, onto, isomorphism, composition, inverse; Applications of linear algebra in engineering and programming examples.

2102206 Introduction to Electrical Engineering 1(0-3-0)

Introduction to Matlab programming; present trends of electrical engineering technology; hands-on laboratories; studying trip.

2102208 Programming for Electrical Engineering 3(3-0-6)

Programming methods; complexity analysis; electrical engineering-oriented programming.

2102210 Circuit Theory I 3(3-0-6)

DC concepts; Ohm's law; Kirchhoff's laws; circuit components; passive sign convention; node and mesh analysis; superposition theorem; source transformation; Thevenin and Norton theorem; maximum power transfer; transient in first order and second order circuits; periodic function; sinusoidal steady state; phasor representations; impedances and admittances; phasor diagram; AC power analysis; polyphase circuits.

2102211 Electrical Circuit Laboratory 1(0-3-0)

A laboratory work on electrical circuits and measurements; oscilloscope, multimeter; DC circuits; first order and second order transient responses; resonance; AC circuits; three-phase circuits.

2102221 Engineering Electromagnetics 2(2-0-4)

Electrostatic fields in free space, dielectrics, and conductors; Electric potential; Electrostatic energy and forces; Steady electric currents; Magnetostatic fields; Magnetostatic energy, forces, and torques; Maxwell's equations; Time-harmonic electromagnetic fields; Plane waves.

2102241 Digital System 2(2-0-4)

Number systems and codes; Boolean algebra; minterms and maxterms; sum-of-products and product-of-sums; Karnaugh maps; two-level and multi-level gate circuits; medium-scale combinational circuits: multiplexer, encoder, and decoder; introduction to sequential circuits; latch, flip-flop; register, and counter..

2102253 Electrical Machines I and Laboratory 4(3-3-6)

Condition: Prerequisite 2102211 or 2102213

Basic principles of electromechanical energy conversion: electromagnetic forces, Faraday's law, Ampere's law, Gauss's law, magnetic materials, magnetic circuits; dc machine constructions; steady-state analysis, characteristics, and testing of dc generators and dc motors; construction and characteristics of transformers; fundamentals of ac machines; ac machine constructions; rotating magnetic fields; steady-state analysis, characteristics, and testing of synchronous generators and induction motors; hands-on activities and experimental topics related with the lecture.

2102281 Properties of Electrical And Electronic Materials 2(2-0-4)

Materials in electrical and electronic engineering; electrical properties of metals, alloys and non-metals;

dielectric properties of polymers, ceramics and glasses; non-linear dielectrics; optical properties of materials; optical emitters and detectors; magnetic properties of materials; superconductivity; novel materials in 5G, EV and IoT applications..

2102311 Electrical Measurements and Instrumentation 3(3-0-6)

Units and standard instruments; accuracy; precision; voltage current, and power measurements, impedance measurement at low and high frequencies; digital techniques in measurement; noises; shielding; signal-to-noise ratio enhancement techniques; transducers.

2102322 Telecommunication Transmission 3(3-0-6)

Wire and wireless communication; wire communication network; Z, Y, S, ABCD matrices; connection and basic circuits, network transformation, transmission quantities, signal transmission circuit techniques, wave filters, attenuator, impedance matching, transmission line theory, equation, solution for low, medium, high frequencies, primary and secondary constant; incident and reflected waves, standing wave ratio, line characteristics for open, short, terminated load, lossless and lossy lines; reflections in time domain, bounce diagrams, near-end and far-end crosstalk, differential signaling, composite line, types of cable and unshielded twisted pair, coaxial cable; current cable standards.

2102332 Linear Control Systems I 3(3-0-6)

Condition:
EE Students: Prerequisite 2102201 or 2102204
Corequisite 2102210 or 2102214
Non-EE students Prerequisite 2310312, 2102391

Open-loop and closed-loop control systems; mathematical models of physical systems; linearization; block diagrams; signal flow graphs; basic control actions and compensations; time-domain responses; Routh-Hurwitz stability test; control system design by the root locus method; Bode and Nyquist plots; Nyquist stability criterion; control system design by frequency response method. computer simulation and experiment of control system design.

2102341 Electronic Circuits 2(2-0-4)

Semiconductor devices; current-voltage and frequency characteristics; analysis and design of diode circuits; analysis and design of BJT, MOS, CMOS and BiCMOS transistor circuits, operational amplifier and its applications, power supply module; experimental topics relate to semiconductor devices, transistor amplifiers, frequency response, operational amplifier and its applications.

2102351 Fundamentals of Electrical Power Engineering and Smart Grid 2(2-0-4)

Fundamentals of electromechanical energy conversion; characteristics and applications of transformers, generators and motors; introduction to power system structure; sources of electricity and renewable energy; steady-state AC power system calculation; introduction to Smart Grid and Home Energy Management System.

2102352 Fundamentals of Power Engineering Laboratory 1(0-3-0)

Basic hands-on laboratory in topics related to electrical power engineering and smart grid.

2102360 Electrical Power Systems I 3(3-0-6)

Introduction to power system structure; load characteristics; steady-state AC power system calculation; thermal and hydro power plants; renewable energy power generation; substation and power transformer; transmission line model; simple network calculation and per unit system; distribution system and introduction to distribution automation; voltage drop and power loss; introduction to Smart Grid and energy storage application

2102372 Principles of Communications 2(2-0-4)

Introduction to communication systems; analog modulation; sampling theorem; quantization; encoding; Pulse Code Modulation (PCM); digital signaling and binary line coding; digital modulation; matched filter; signal space analysis; Gram–Schmidt process; Bit Error Rate (BER) in digital transmission; Error Vector Magnitude (EVM) in digital I-Q transmission; channel coding; information theory; entropy; channel modeling; channel capacity).

2102385 Semiconductor Devices I 3(3-0-6)

Semiconductor crystals properties and growth; energy band and charge carriers in semiconductors; carrier transport mechanisms in semiconductors; p-n junctions; metal-semiconductor junctions; bipolar junction transistors (BJT) structure, operation, and electrical properties; metal-oxide-semiconductor field-effect transistors (MOSFET) structure, operation, and electrical properties; optoelectronic devices; hands-on semiconductor device characterization.

2102399 Capstone Project 2(1-3-2)

Collaborating activity as a team to solve a practical challenge problem by following a process of identifying a problem, preparing a design, developing a prototype, testing an operation, and giving a presentation; logically applying electrical engineering knowledge on both hardware and software and properly integrating interdisciplinary skills into the operational process

2102420 Principles of Antennas 3(3-0-6)

Condition : Prerequisite 2102221 or 2102222

Basic definition and theory; isotropic point source; power and field patterns; directivity and gain; efficiency, polarization; input impedance and bandwidth; Friis transmission equation, radiation from current elements;

ground effects; radiation properties of wire and loop antennas; array antenna; Yagi-Uda antenna and log-periodic antenna; aperture antenna; microstrip antenna; modern antenna for current applications; antenna characteristics measurement.

2102421 Principles of Microwave Engineering 3(3-0-6)

Condition : Prerequisite 2102221 or 2102222

Review of Maxwell's equations, plane waves; microwave transmission lines and waveguides; microwave network analysis; impedance and equivalent voltage and current; the s-matrix; signal flow graphs, impedance matching and tuning, microwave resonators; power dividers and directional couplers; microwave filters; point-to-point microwave link; radar system; microwave propagation; basic of microwave measurement; microwave biological effects and safety.

2102423 Digital Signal Processing 3(3-0-6)

Continuous-time and discrete-time signals, spectral analysis; decimation and interpolation; sampling rate conversion; discrete-Fourier transform (DFT) and fast Fourier transform (FFT); probabilistic methods in DSP; design of FIR, IIR digital filters, multirate systems and filter banks; discrete wavelet transform; introduction to some DSP applications such as image processing, speech and audio processing, array processing..

2102425 Data Communications 3(3-0-6)

Introduction to data communications and networks; layered protocols and network architectures; basics of data transmission (characteristics of transmission media, modulation, multiplexing); data link protocols (error detection, error correction, data link control protocols); point-to-point protocols at network layer (routing, flow control, error recovery); delay models in data networks; multi-access communications (Aloha, CSMA, multi-access reservations); network security; cloud network, architecture and system.

2102432 Linear Control Systems II 3(3-0-6)

Condition: Prerequisite 2102332 or 2102333

State-space representation of dynamic systems; mathematical modeling of complex engineering systems; autonomous linear dynamical systems; stability analysis; linear dynamical systems with inputs and outputs; controllability and state transfer; observability and state estimation; state feedback and linear quadratic regulator; observer design; observer-based controller; case study emphasizing computer-aided analysis and design.

2102433 Digital Control Systems 3(3-0-6)

Condition: Prerequisite 2102332 or 2102333

Introduction to digital control; linear discrete-time system analysis; sampled-data systems; discrete equivalents to continuous transfer functions; design of digital control systems using transform techniques; design of digital control systems using state-space methods: pole placement design, estimator design; quantization effects.

2102435 Industrial Automation 3(3-0-6)

Condition : Prerequisite 2102332 or 2102332 or 2102341 or 2102386

Thermal sensors; mechanical sensors; optical sensors; signal conditioning; final control elements; programmable logic control (PLC) ; distributed control system (DCS) ; communication modules; human machine interface (HMI); alarm management systems; selected applications to factory automation and process automation.

2102436 Control and Instrumentation Laboratory 1(0-3-0)

Experimental topics related to control systems and instrumentation. System identification and control experiments on DC motor system, and thermal process.

2102444 Introduction to Embedded Systems 3(3-0-6)

Condition : Prerequisite 2102241 or 2102387 or Consent of faculty

Embedded system architecture; microprocessor/ microcontroller; memory; I/ O and peripherals; embedded C programming; interrupt; DMA; embedded system networks.

2102446 Fundamentals of Power Electronics 3(3-0-9)

Condition : Prerequisite 2102210 or 2102213

Basic principles of power electronics for electrical power processing and control; basic power converters: AC-to-DC converter, DC-to-DC converter, AC-to-AC converter, DC-to-AC converter and their operations; basic characteristics of semiconductor power devices: diodes, transistors and thyristors.

2102447 Electronics Engineering Laboratory 1(0-3-0)

Condition: Prerequisite 2102211 or 2102213

Experimental topics related to analog and digital electronic circuits.

2102456 Electrical System Design 3(3-0-6)

Basic design concepts; codes and standards; power distribution schemes; electrical wires and cables; raceways; electrical equipment and apparatus; load calculation; power factor improvement and capacitor bank circuit design; lighting and appliances circuit design; motor circuit design;

load, feeder, and main schedule; emergency power systems; short circuit calculation; grounding systems for electrical installation.

2102457 Fundamentals of Light and Lighting **3(3-0-6)**

Light, eyes, vision; definition and terminology in light and lighting; light sources, luminaries and control gears; measurement of lights; principle of lighting calculation; lighting quality and energy efficiency; basic lighting design and simulation.

2102458 High Voltage Engineering I **3(3-0-6)**

Condition: Prerequisite 2102210 or 2102213

Uses of high voltage and overvoltage in power systems; generation of high voltage for testing; high voltage measurement techniques; electric field stress and insulation techniques, breakdown of gas; liquid and solid dielectric; high voltage testing techniques; lightning and protection; insulation coordination.

2102459 High Voltage Engineering Laboratory I **1(0-3-0)**

A laboratory work on high voltage engineering: generation of dc and ac high voltages and impulse voltages; measurement of electric field dielectric losses; breakdown characteristics; partial discharges; electrical tests of insulators; RIV test of insulators; BIL test on transformers; sparkover test on lightning arresters; behavior of air gaps under dc, ac and impulse voltages; characteristics of impulse voltage dividers; protective devices; grounding resistance measurement.

2102461 Electrical Power Systems II **3(3-0-6)**

Condition : Prerequisite 2102360

Power system modeling; network equations; load flow analysis; economic operation of power systems; symmetrical faults; symmetrical components; unsymmetrical faults; protective devices and power system protection; power system stability.

2102463 Electrical Power System Protection **3(3-0-6)**

Introduction and philosophies of power system protection; instrument transformer; protective relays; non-directional and directional overcurrent and earth fault protection; differential protection; protection of transmission line, power transformers, generators, motors, buses, reactors and shunt capacitors.

2102464 Fundamentals of Electric Motor Drives **3(3-0-6)**

Condition: Prerequisite 2102253

Electric drive components; load characteristics; operating region of drives; braking methods of motors; calculation of motor ratings for various loads; control circuits and control methods of dc motors; control circuits and control methods of ac motors; servo drive systems; applications of electric drives.

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2102465 Electrical Power Laboratory **1(0-3-0)**

Experimental topics related to power systems and electrical machines.

2102466 Introduction to Active Distribution Networks **3(3-0-6)**

Distribution system structure and equipment; voltage regulation in distribution systems; distribution system protection; power quality, supervisory control and data acquisition (SCADA); distributed energy resources (DER); renewable energy integration in distribution systems; distribution management systems (DMS); microgrids; grid edge technologies.

2102467 Electric Vehicles, Energy Storage Systems and Grid Integration **3(3-0-6)**

Role of electric vehicles in the energy transition; introduction to electric vehicle and charging technologies; integration of electric vehicles in power grids; role of energy storage systems in modern power grids; energy storage technologies; applications of energy storage systems in power grids.

2102472 Fundamental of Digital Communication **3(3-0-6)**

Condition: Prerequisite 2102371 or 2102372 or Consent of Faculty

Signals and Spectra; random signals and power spectral density; review of sampling theorem; probability and random processes; baseband and bandpass transmission; baseband digital modulation and pulse shaping; bandpass digital modulation; detection theory; coherent and non-coherent receiver; performance analysis: bit and symbol error rate; channel equalization; time synchronization; multipath fading channels; spread spectrum techniques; multichannel and multicarrier systems; introduction to information theory; source coding, channel coding..

2102473 Communication Engineering Laboratory **1(0-3-0)**

Hands-on laboratory in three major areas related to communication engineering, namely, telecommunications, electromagnetic waves and digital signal processing.

2102488 Semiconductor Devices II **3(3-0-6)**

Condition : Prerequisite 2102385

Review of physics and properties of semiconductors; compound semiconductors; metal-semiconductor junctions; heterojunctions; MESFET; heterojunction transistors (HEMT

and HBT); microwave devices; introduction to quantum and nano-electronic devices.

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2102489 Principles of Analog Circuit Design 3(3-0-6)

Transistor fabrication in integrated circuits; transistor modeling in integrated circuits; passive devices in integrated circuits; one- and two-transistor amplifiers; differential amplifiers; current sources and active loads; voltage and current references; output stages; operational amplifier analysis; frequency response; feedback, stability, and compensation; basic operational amplifier design; basic communication circuits; commercial analog circuits; applications of analog circuits.

2102491 Electrical Engineering Pre-Project 1(0-2-1)

Condition : Consent of Faculty

Problem framework; guidelines for problem solving and solution of an electrical engineering project.

2102499 Electrical Engineering Project 3(0-6-3)

Condition : Prerequisite: 2102490 or 2102491 or Consent of Faculty

Practical and interesting projects or problems in various fields of electrical engineering: power, electronics, control systems and communications.

COURSE DESCRIPTIONS IN ELECTRICAL ENGINEERING (M.Eng., Ph.D.)

2102500 Linear Algebra for Electrical Engineering 1(1-0-3)

Normed linear space; vector and matrix norms; inner-product space; orthogonality; block matrix and its inverse; symmetric matrix; quadratic form of vectors; positive definite matrix; Schur complement; eigenvalue and important properties of some common matrices (orthogonal, unitary, nilpotent, permutation); matrix decomposition: LU, SVD, Cholesky; solving linear equations with different structures; derivatives of vector-valued functions; solving nonlinear equations.

2102501 Linear Algebra for Electrical Engineering 2(2-0-6)

Random vector; Gaussian vectors and properties; transform of random variables; transform methods; probabilistic measures in random processes; stationarity; power spectral density matrix; autocorrelation function; linear system with random input.

2102503 Time Series Analysis 1(1-0-3)

Data cleansing; down-sampling, up-sampling; correlation analysis; stationarity test; stationary models; maximum likelihood estimation; applications in anomaly detection and forecasting.

2102504 Introduction to Mathematical Analysis 3(3-0-9)

Mathematical proofs; basic set theory; the real number system; topology on the real line; sequence and convergence; limit and continuity of functions; vector spaces and linear operators; normed linear spaces; bounded operators; inner-product spaces; orthogonality and orthonormal bases; adjoint operators; applications to electrical engineering topics.

2102506 Finite Element Analysis for Electrical Engineers 3(3-0-9)

Condition : Consent of Faculty

Introduction of domain-dividing methods; fundamentals of discretization; elements and interpolating functions; mapped elements; weighted residual method; variational principle; electrostatic and electro-quasistatic problems; heat transfer; fluid flow problems; magnetic field problems; electromagnetic wave analysis; programming considerations; numerical quadratures; Solutions of linear equation system; finite element analysis in practice; advanced topics.

2102508 Optimization Concepts and Applications 1(1-0-3)

General setting; formulating optimization problems; overview of problem types; brief introduction to convex programs; applications in engineering; overview of available methods; essential considerations of algorithms; applying optimization softwares to solve common problem types.

2102509 Introduction to Optimization Techniques 2(2-0-6)

Condition : Corequisite 2102508

One-dimensional optimization; line search; unconstrained optimization; gradient descent; Newton method; trust-region; Levenberg-Marquardt; quasi-Newton; conjugate gradient; interior-point methods; methods for solving quadratic programming; constrained optimization; KKT conditions for nonlinear optimizations.

2102510 Linear Programming 1(1-0-3)

Condition : Corequisite 2102508

Standard form; formulating applied problems in LP form; basic feasible solutions; the simplex method; duality and sensitivity analysis; integer linear programming: relaxation, cutting-plane, branch and bound algorithm.

2102511 Optimization Methods for Engineering and Machine Learning 2(2-0-6)

Condition : Corequisite 2102508

Recent applications in engineering and machine learning; first-order methods for large-scale optimization; duality theory; convex optimization algorithms.

2102512 Heuristic Optimization 2(2-0-6)

Condition : Corequisite 2102508

Introduction to optimization; evolutionary and swarm intelligence algorithms; particle swarm optimization; ant colony optimization; genetic algorithm; decision tree; dynamic programming; applications of operations research.

2102513 Basic Image Processing 1(1-0-3)

Sampling and resolution; geometric transform; enhancement; restoration.

2102514 Advanced Image Processing 2(2-0-6)

Condition : Corequisite 2102513

Segmentation; morphology; image description and representation; transforms in image processing; filters; applications.

2102515 Digital Video Processing 2(2-0-6)

Analog and digital video; video signal analysis; frequency response of the Human Visual System (HVS); video models; two dimensional motion estimation; foundation of video coding; image and video coding standards..

2102516 Adaptive Signal Processing 1(1-0-3)

Linear optimal filter, Wiener filter; adaptive filtering, adaptive algorithms (LMS, RLS); frequency-domain adaptive filtering; applications of adaptive signal processing.

2102517 Wavelet Transform 1(1-0-3)

Short-time Fourier transform; 1D and 2D wavelet transform; filter banks; Harr, Daubechies and other wavelets; programming examples.

2102518 Neural Networks and Deep Learning 1(1-0-3)

Introduction to deep learning; neural networks basics; shallow neural networks; deep neural networks.

2102519 Reinforcement Learning and Applications 1(1-0-3)

Overview of reinforcement learning; introductory example: multi-armed bandit problem; Markov decision process; temporal-difference learning; reinforcement learning implementation with cloud technology; engineering applications.

2102520 Optical Fiber Transmissions and Networks 3(3-0-9)

Condition : Consent of Faculty

Overview of optical fiber transmission systems and networks; evolution of optical fiber transmission systems and networks from the past to the future; fabrication of optical fibers; theories of optical wave propagation in optical circular waveguides; multi-mode fiber (MMF) and single-mode fiber (SMF); fiber attenuation and dispersion; fiber nonlinear effects in and their applications: nonlinear polarization, nonlinear refraction, stimulated inelastic process; components in optical fiber transmission systems and networks; principles of optical signal transmission in SMF: analysis of dispersion, self-phase modulation (SPM), dispersion slope, four-wave mixing (FWM), cross phase Modulation (XPM); to estimate the optical signal distortion transmitted in SMF; dispersion compensation: characteristic of zero-dispersion wavelength transmission, dispersion management for WDM transmission, crosstalk in WDM systems, optical Soliton, optical phase conjugation; point-to-point (P2P) & link design: calculation of power budget, calculation of signal-to-noise ratio (SNR); coherent optical fiber transmission: coherent optical detection, digital signal processing for coherent optical detection; optical fiber networks: synchronous digital hierarchy (SDH) optical network, wavelength routed optical network, DWDM over SDH, optical transport network (OTN), IP over DWDM, reconfigurable optical add-drop multiplexer (ROADM); fiber-to-the-x (FTTx): passive optical network (PON), standards of FTTx, power budget calculation for the design of FTTx, XG-PON, evolution to the future of FTTx.

2102521 System Identification 2(2-0-6)

Dynamical models; input design; persistent excitation; constrained least-squares; prediction error method; subspace method; model selection and validation.

2102522 Internet Technology and Applications 3(3-0-9)

Condition : Consent of Faculty

Internet networking technologies; routing protocols; switching architecture; performance analysis and simulation; basic Internet services, modern Internet services and metaverse; mobile and web development; virtual reality and 3D modeling.

2102523 Estimation Theory 2(2-0-6)

Properties of estimator; asymptotic distribution of estimators; minimum mean-square estimation; maximum likelihood estimation; Fisher information matrix; Cramer-Rao bound; maximum a posteriori estimation; applications on linear additive models.

2102525 Network Management and Design 3(3-0-9)

Review of communication networking; integrated network management; network reliability and survivability; network management and control; performance evaluation, network security; network design methodology; policy and regulation.

2102526 Mobile Communications and Networking 3(3-0-9)

Condition : Consent of Faculty

Overview of mobile communication systems and networks; system and network architectures; use cases and

requirements.; Radio wave propagation and modeling for sub-6GHz and mmWave on different areas and environments; evolution from 1G, 2G, 3G, 4G, to 5G: FDMA, TDMA, and CDMA, and x-OFDM-based multi-user and multi-carrier systems and their applications for mobile communications; antennas for mobile communications; multiple-input multiple-output (MIMO) systems; beamforming technology for 5G; cellular concept and network planning; voice codec: linear predictive coding and waveform coding; techniques for combating fading: adaptive equalizer, channel coding and diversity; software defined network (SDN); cloud architecture and network virtualization concept; network function virtualization (NFV) and 5G network slicing; current 5G situation in Thailand..

2102527 Traffic Engineering Analysis and Simulation 3(3-0-9)

Condition : 2102203 or Consent of Faculty

Fundamentals of traffic engineering; revision of probability theory; traffic modelling; computer simulation; fundamentals of stochastic process; Markov chain; theory of loss system; theory of queuing system; traffic engineering application.

2102535 Nonlinear Control Systems I 3(3-0-9)

Condition : Prerequisite 2102432 or Consent of Faculty

Second-order systems; Lyapunov stability; feedback linearization; backstepping design; additional topics as needed.

2102537 Glocal Control Systems 3(3-0-9)

Hierarchical networked dynamical systems, LTI system with generalized frequency variable, homogeneous networked system, heterogeneous networked system, stability analysis: Nyquist stability, Hurwitz stability, Lyapunov stabilty, robust stability, hierarchically decentralized control design, LQR optimal control design, robust control design, applications to energy management systems, smart transportation, and electric vehicles.

2102541 IoT Fundamentals 3(3-0-9)

Condition : Consent of Faculty

Sensor network technology: communication architecture for low-powered sensors, energy-efficient communication protocols e.g. ZigBee, 6LowPan, LORA, NB-IoT; IoT cloud technology: resource sharing in cloud architecture, introduction to IoT and cloud platforms (e.g. NETPIE, IEEE1888, ECHONET Lite); IoT data analysis : feature extraction, prediction, and representation; IoT security: threats and security requirement for IoT, authentication, authorization, access control, confidentiality and key management.

2102542 Digital Circuit Design 2(2-0-6)

Introduction to digital circuit design; CAD tools and VHDL; optimized implementation of logic functions; combinational circuits; sequential circuits; digital system design.

2102543 Advanced Electric Motor Drives 3(3-0-9)

Condition : Prerequisite 2102356 or Consent of Faculty

Electric motor drive principles; modeling and dynamic equations of dc motors; control principles of dc motor drives; modeling and dynamic equations of induction and synchronous motors; control principles of synchronous and induction motors; power electronic converters for dc and ac motors; modulation techniques and current control for power converters.

2102544 Advanced Embedded Systems 3(3-0-9)

Condition : Consent of Faculty

Hardware and software platforms for embedded systems; devices and buses; embedded programming; real time operating system; hardware-software codesign in an embedded system; testing.

2102545 Digital Integrated Circuits 3(3-0-9)

Condition : Consent of Faculty

IC process techonlogy; CMOS logic circuits: static and dynamic designs; wires; arithmetic circuits; memory; performance of digital systems; testing and verification of digital integrated circuits.

2102547 Analog Integrated Circuits 2(2-0-6)

Continuous-time filters; sample and hold circuits; discrete-time signals; switched-capacitor filters; switched-capacitor amplifiers; data converter fundamentals; Nyquist-rate converters; oversampling converters.

2102548 Switched-Mode Electrical Power Processing I 3(3-0-9)

Condition : Prerequisite 2102341 or 2102386 or Consent of Faculty

Analysis of PWM converters and their derivatives; phase-controlled rectifier an PWM inverter operations and characteristics; PWM converters modeling using circuit averaging and averaged-switch modeling technique; dc and ac models of PWM converters; converters transfer functions; modeling of Pulse-Width Modulators; control of PWM converters; applications of phase-controlled rectifiers, PWM converters and inverters; analysis of resonant inverters using fundamental frequency approximation and their applications.

2102570 Introduction to Computer Vision 2(2-0-6)

Human vision; geometric camera models; object recognition; vision system design; computer vision and its applications.

2102552 Introduction to Distributed Generation 3(3-0-9)

Condition : Consent of Faculty

Introduction to Distributed Generation (DG); technologies of DG such as wind, photovoltaics, combined heat and power, small-scale hydro; DG interfaces i.e. synchronous, induction, converter; distribution systems; studies of DG impact on power systems e.g. DG impact on system voltages and power losses, DG impact on fault current and protection system, DG impact on electrical islanding, DG impact on system reliability, etc..

2102553 Fundamentals of Electromagnetic Compatibility 3(3-0-9)

Condition : Consent of Faculty

EMI/EMC understanding; source of EMI; definition and effect of EMI; EMI measurements and methods; EMC/EMI limitation and protection with suitable equipment and system grounding; ground system tests and maintenance; shielding theory, materials and performance; different types of filters and the selection and usage.

2102572 Power Quality in Smart Grids 3(3-0-9)

Power Quality (PQ) disturbances; analysis of harmonics, interharmonics, voltage sag or dip, voltage fluctuation, and voltage unbalance in smart grids; PQ standards and mitigation techniques; and PQ case studies in smart grids.

2102557* Advanced High-Voltage Engineering Applications 3(3-0-9)

Lightning overvoltage on transmission line and at substation; lightning protection for transmission line and substation; selection of lightning arrester; insulation coordination according to IEC60071; fundamental of electromechanics; electrohydrodynamics; dielectrophoresis; electrostatic application; surface charge analysis.

2102559* Energy Management Systems in Smart Grids 3(3-0-9)

Fundamentals of Energy Management Systems (EMS); centralized and decentralized EMS; load forecast; renewable energy forecast; CEMS; microgrid operation and control; BEMS and HEMS; power aggregation of distributed generation, energy storage and load; electric vehicle charging infrastructure; energy markets and ancillary services.

2102560 High Voltage Equipment Maintenance and Testing 3(3-0-9)

High-voltage equipment in transmission and distribution systems; Condition-based and preventive maintenance; high-voltage equipment testing for condition assessment.

2102563 Power Electronics for Smart Grids and Renewable Energy 3(3-0-9)

Condition : Consent of Faculty

Power electronics circuits and electrical generators for conversion of renewable energy generation; power electronics circuits for battery energy storage system, active and reactive power control of power converters; control of power converters for grid-connected and intentional islanding operations; impacts of renewable energy on electrical grids, grid-connection codes for renewable energy integration.

2102565 Economics in Energy Supply Industry 3(3-0-9)

Classical Economic Dispatch Problem; Renewable Energy Generation Model; Renewable Energy Project Feasibility Study; Feed-in Tariff; Power Development Planning; Microeconomic theory; Structure of Energy Supply Industry.

2102566 Substation Automation Systems 3(3-0-9)

Primary equipment in substations and protective relays; functions and benefits of substation automation, structure and architectures; system standard IEC 61850; data communication in substation automation.

2102567 Power System Analysis 3(3-0-9)

Condition : Consent of Faculty

Basic power system modeling, review of load flow calculation, sensitivity of loss and load flow, principle of power dispatch, review of fault calculation, distribution system reliability, dynamic simulation for power system analysis, basic power system controls.

2102568 Power Electronics for Electric Vehicle Technology 3(3-0-9)

Basic structure and theories of the electric propulsion system of electric vehicles; electric propulsion system for battery EV; electric propulsion system for hybrid EV; DC motors, synchronous motors, and Induction motors for EV; efficiency map of motors; field-weakening operation; battery technology for EV.

2102569 Power Converters and Control Methods 3(3-0-9)

Dc-dc converters; dc-ac converter; ac-dc converters; ac-ac converters; multilevel converters; pulse-width-modulation theory; conduction losses and switching losses; switching signals generation with digital signal processors.

2102571 Multimedia Communication 3(3-0-9)

Condition : Consent of Faculty

Multimedia communication system; multimedia compression technology and standards (image, video, audio); multimedia communication protocols; telecommunication Infrastructure and mobile network ecosystem; multimedia communication applications

(Internet of Things (IoTs); intelligent transport system (ITS) and autonomous vehicles; smart health, smart surveillance in smart cities; multimedia data analytics.

2102575 Statistical Inference and Modeling 3(3-0-9)
Condition : Consent of Faculty

Procedures in statistical modeling; supervised learning; unsupervised learning; ensemble learning; regression models; classification; clustering; model selection; model validation; engineering applications.

2102577 Telecommunication Networks 3(3-0-9)
Condition : Consent of Faculty

Review of OSI model and principle of communication; multimedia service; microwave communication system; wide area network; network simulator; telecommunication technology and trends; telecommunication markets; telecommunication economics; telecommunication project management.

2102579* Optical Fiber Communication and Components 3(3-0-9)

Components in optical fiber communication; types of optical fibers and transceiver; insertion loss and Fresnel's reflection; mode theory; signal distortion due to attenuation and dispersion; optical transmitter and receiver; lasers & diodes; optical modulators; temperature control circuit; photodetectors; digital transmission system; budget analysis of optical power and rise-time; bit error rate; optical amplifiers; WDM system; passive optical network.

2102580 Semiconductor Technology: Fabrication and Characterization 3(3-0-9)

Material and device requirements of electronic and MEMS industries; wafer fabrication process overview; MEMS process overview; lithography; etching; metallization; thermal oxidation; diffusion; ion implantation; passivation; contacts; electron and force microscopies (SEM, TEM, AFM); electronic and optical spectroscopies (4PP, VdP, IV, CV, PL, Raman); semiconductor nanomaterials.

2102582 Photonic Devices in Optical Communication Systems 3(3-0-9)

Wave nature of light; dielectric waveguides and optical fibers; semiconductor science; operating principles, structure and properties of LEDs, laser diodes, photodetectors, optical modulators, and optical amplifiers.

2102583* Introduction to Quantum Mechanics 3(3-0-9)

Wave and particles; Schroedinger equation; tunneling; periodic potentials; harmonic oscillators; operators and bases; perturbation theory; motion in centrally symmetric potentials; spin angular momentum; introduction to quantum computing.

2102585 Biomaterial Science 3(3-0-9)
Condition : Consent of Faculty

Biological interactions with materials or any invasion: protein adsorption, blood coagulation, inflammation, immunology, hypersensitivity and infection; various types of biomaterials that have been used in biomedical applications: metals, synthetic polymers, hydrogel, ceramics, composites, and natural materials.

2102587* Sensor Technology and Applications 3(3-0-9)

Sensor characteristics: static and dynamic characteristics, sensor fabrication technology; Microelectromechanical systems (MEMs); sensor operations; Interface circuits.

2102589 Laser Engineering 3(3-0-9)
Condition : Prerequisite 2102385 or Consent of Faculty

Fundamental theory: energy states in atoms, electron population inversion, spontaneous emissions; stimulated emissions principles of lasers; coherent light; gas lasers; solid-state lasers, semiconductor lasers; applications of lasers in medical sciences, precision measurement, telecommunication materiel processing, spectroscopy, display hologram and nonlinear optics.

2102590* Research Methodology 2(2-0-6)

Introduction to research methodologies and importance of research works; necessary skills for new researchers: literature searching, academic reading, academic writing and academic presentation; ethics of good researchers: plagiarism, intellectual property and academic honesty; academic seminar in small-group workshops.

2102611 Medical Instrumentation 3(3-0-9)
Condition : Consent of Faculty

Electrical signals in human body; action potential in cells; electrodes; amplifiers; transducers; medical devices such as ECG, EEG, EMG, blood pressure monitor and pulse oximeter; electrical hazards and prevention; medical instrumentation.

2102628 Graph Theory and Combinatorial Optimization 3(3-0-9)
Condition : Consent of Faculty

Introduction to graph theory; graph structure; concept of path, cycles and trees; various types of graphs; connectivity; graph planarity; matchings; matroids; graph colouring; transshipment problem; introduction to combinatorial optimization; shortest path problem; maximum flows problem; minimum cost flows problem; network optimization; recap on linear programming; integer programming and solving methods; applications in engineering.

2102631 Special Problems in Electrical Engineering I **1 (1-0-3)**

Condition : Consent of Faculty

Special problems assigned by the instructor with consent of the head of the Department.

2102632 Special Problems in Electrical Engineering II **2 (2-0-6)**

Condition : Consent of Faculty

Special problems assigned by the instructor with consent of the head of the Department

2102633 Special Problems in Electrical Engineering III **3(3-0-9)**

Condition : Consent of Faculty

Special problems assigned by the instructor with consent of the head of the Department

2102635 Control System Theory **3(3-0-9)**

Condition : Consent of Faculty

Mathematical descriptions of dynamic systems; linearization method; solutions of linear dynamic equations; stability, controllability, observability; internal stability of interconnected systems; state feedback; linear quadratic regulation; observers and observer-based compensation; introduction to nonlinear systems; Lyapunov theory.

2102637 Multivariable Control Systems **3(3-0-9)**

Condition : Consent of Faculty

Internal stability; Q parameterization; performance and stability issues in MIMO (sensitivity function); uncertainties and robustness; multivariable control design; frequency domain methods; LQG and loop transfer recovery (LTR) methods; parameter optimization methods; H2 and Hinf; model reduction.

2102650 Electrical Transient in Power Systems **3(3-0-9)**

Condition : PRER 2102458 or Consent of Faculty

Introduction to eletromagnetic transients in power systems, switching and lightning overvoltages, travelling waves, models of power apparatus and simulation for transient analysis, counter measures and mitigation techniques against impacts of voltage transients.

2102652 Power System Dynamic and Control **3(3-0-9)**

Basics and descriptions of power system stability problems; dynamical models and controls of a synchronous machine; active power and frequency control; transient stability; small-signal stability; voltage stability; introduction to WAMS and WAPC.

2102653 Special Topics in Power Electronics **3(3-0-9)**

Selected topics of advanced technology or applications related to power electronics engineering.

2102654 Software Tools for Smart Grid Analysis **3(3-0-9)**

Applications of software tools for power flow analysis, quasi static analysis, stability analysis, transient analysis, fault analysis, voltage sag analysis and harmonic analysis in smart grids.

2102655 Power Grid Technologies **3(3-0-9)**

Traditional and modern power grid structures; applications of smart grids and microgrids; basic power grid analytics; characteristics of fundamental components in power grids; advanced technologies in modern power grids; fundamentals of power grid controls and protections.

2102657 Power Grid Reliability and Resilience **3(3-0-9)**

Power grid reliability and resilience perception; uncertainties in power grids; essential reliability services in power grids; applications of deterministic and probabilistic methods in reliability evaluation of power grids; reliability evaluation of generation systems including variable renewable energies; reliability evaluation of composite generation and transmission systems; reliability evaluation of distribution systems; reliability cost/reliability worth evaluation; power grid resilience enhancement using distributed energy resources and microgrids

2102663 Solar Cell Technology **3(3-0-9)**

Condition : Consent of Faculty

Band theory of semiconductors; optical properties of semiconductor; structure of solar cells; characteristics of solar cells; equivalent circuit of solar cells; p-n junction silicon solar cells; polycrystalline silicon solar cells; amorphous silicon sola; gallium arsenide solar cells; photovoltaic system design; concentrated sunlight system; photovoltaic system applications.

2102668 Biosensors **3(3-0-9)**

Necessary concepts relevant to the principle of measuring chemical and biological phenomena with emphasis on integrating these concepts and be able to develop, to apply, and to construct novel instruments for observing, examining, and controlling manipulating various phenomena in the field of biotechnology, medical engineering for both fundamental research and process development in industrial production.

2102671 Future technology trends in EE industry I **1 (1-0-3)**

Condition : Consent of Faculty

Technologies under current interest or future technologies related to applications to electrical engineering industry. Topcis is assigned by the instructor with consent of the head of the Department.

2102672 Future technology trends in EE industry I **2 (2-0-6)**

Condition : Consent of Faculty

Technologies under current interest or future technologies related to applications to electrical engineering industry. Topcis assigned by the instructor with consent of the head of the Department.

2102673 Future technology trends in EE industry II **3(3-0-9)**

Condition : Consent of Faculty

Technologies under current interest or future technologies related to applications to electrical engineering industry. Topcis assigned by the instructor with consent of the head of the Department.

2102682 Solid-State Physics for Electronics Engineers **3(3-0-9)**

Condition : Consent of Faculty

Crystal structures and lattices; lattice vibration and thermal properties of crystals; crystalline defects; modern theory of solids; quantum theory of metals; quantum theory of electrons in periodic lattices; semiconductors and their electrical and optical properties; dielectric materials and insulation; optical properties of materials; magnetism and magnetic resonances; superconductivity; introduction to nanostructures.

2102686 Switched-Mode Electrical Power Processing II **3(3-0-9)**

Condition : Consent of Faculty

Modeling of PWM converters using state-space averaging technique; state-space averaging of non-ideal converters; Analysis of PWM converters operating in discontinuous conduction mode; modeling of DCM PWM converters; current-mode control of PWM converters; current-programmed control; current-programmed converter model and transfer functions; current-programmed controller model; switched-mode rectifiers; switching loss reduction technique; snubbers for PWM switches; ZVS ZCS single resonant switches; analysis of basic converters using single resonant switches; analysis of resonant inverters and resonant converters.

2102701 Industrial Experiences I **2 (0-8-0)**

Experience at related industrial, research, or government sectors under supervision of a mentor engineer and thesis advisor.

2102702 Industrial Experiences II **2 (0-8-0)**

Experience at related industrial, research, or government sectors under supervision of a mentor engineer and thesis advisor.

2102703 Industrial Experiences III **2 (0-8-0)**

Experience at related industrial, research, or government sectors under supervision of a mentor engineer and thesis advisor.

2102711 Internship Aboard I **2 (0-8-0)**

Experience at a related university or research institute in foreign country under collaborated supervision of thesis advisor and a faculty staff/researcher at the host university or institute.

2102712 Internship Aboard II **2 (0-8-0)**

Experience at a related university or research institute in foreign country under collaborated supervision of thesis advisor and a faculty staff/researcher at the host university or institute.

2102713 Internship Aboard III **2 (0-8-0)**

Experience at a related university or research institute in foreign country under collaborated supervision of thesis advisor and a faculty staff/researcher at the host university or institute

2102721 Electrical Engineering Seminar I **1 (1-0-3)**

Preliminary lectures by instructors; seminar on current and new topics in electrical engineering, in which each student is required to present an oral and written report.

2102722 Electrical Engineering Seminar II **1 (1-0-3)**

Preliminary lectures by instructors; seminar on current and new topics in electrical engineering, in which each student is required to present an oral and written report.

2102723 Electrical Engineering Seminar III **1 (1-0-3)**

Preliminary lectures by instructors; seminar on current and new topics in electrical engineering, in which each student is required to present an oral and written report.

2102724 Electrical Engineering Seminar IV **1 (1-0-3)**

Preliminary lectures by instructors; seminar on current and new topics in electrical engineering, in which each student is required to present an oral and written report.

2102725 Intensive Electrical Engineering Seminar I **2 (2-0-6)**

Preliminary lectures by instructors; seminar on current and new topics in electrical engineering, in which each student is required to present an oral and written report.

2102726 Intensive Electrical Engineering Seminar II **2(2-0-6)**

Preliminary lectures by instructors; seminar on current and new topics in electrical engineering, in which each student is required to present an oral and written report.

2102754 Electric Field Analysis in High Voltage Engineering **3(3-0-9)**

Condition : Consent of Faculty

Basics of electric field analysis; practical problems in the field analysis of high-voltage systems; introduction to numerical methods in field analysis; charge simulation method; surface charge method; boundary element method; examples of field analysis; comparison of methods; advanced topics.

2102771 Advanced Wireless Communications **3(3-0-9)**

Condition : Consent of Faculty

Wireless channel characterization, narrowband and wideband; techniques for combating fading: adaptive equalizer, channel coding and diversity; spread spectrum, multiuser systems, mutlicarrier modulation and multiple access: OFDM and NOMA; multiple input/output systems (MIMO), spacetime coding.

2102790 Electrical Engineering Seminar **2(2-0-6)**

Condition : Consent of Faculty

Preliminary lectures by instructors; seminar on current and new topics in electrical engineering, in which each student is required to present an oral and written report.

2102811 Thesis **12 credits**

2102814 Thesis **24 credits**

2102816 Thesis **36 credits**

2102828 Dissertation **48 credits**

2102829 Dissertation **60 credits**

2102830 Dissertation **72 credits**

2102894 Doctoral Dissertation Seminar **0(0-0-0)**

2102897 Qualifying Examination **0(0-0-0)**

5500532 Academic English for Graduate Studies **3(3-0-9)**

Practice in reading academic texts in order to find main ideas and make notes; practice in reading academic and research articles in order to analyse the organisation of an article and to identify important components of the article; practice in writing abstracts of articles and research papers, research proposals, summaries, reports and academic articles.

5500560 Thesis Writing **3(3-0-9)**

Practice paraphrasing, summary writing, and writing different components of theses and dissertations using academic resources.

DEPARTMENT OF MECHANICAL ENGINEERING

Mechanical Engineering is a very broad field of science, engineering, and technology. It encompasses virtually all aspects of everyday life. To get some perspective, it can be broadly identified according to the foundation, role, and purpose of mechanical engineering as:

The science, engineering, and technology that are foundation to research and development, design and manufacturing, and installation and maintenance, of devices, machines or systems that transform, transmit, or utilize energy for the benefit of humankind. These devices, machines, or systems generally involve the transform of energy into motion and motion into energy;

People who study and practice mechanical engineering can therefore

- function in many different roles such as researchers, inventors, designers, practicing engineers, etc.;
- work in many different areas such as power generation, distribution and utilization; engine, vehicle and transportation; material, design and manufacturing; dynamics, control and robotics; machinery and maintenance; refrigeration, air conditioning and building technology; energy resource, management, utilization and conservation; environment technology; MEMS and nanotechnology, etc.;
- work in many different places, both public and private sectors, such as in industry, factory, hospital, large building and structure, consulting company, governmental office, university, etc.

MISSION

The mission of the Department of Mechanical Engineering is to provide firm-foundationed and creative-minded mechanical engineers for the advancement of mechanical engineering and for the advancement of mechanical engineering discipline and profession and for the development of the country.

The offered programs emphasize

- fundamental knowledge of advanced mathematics, sciences, engineering, and mechanical engineering;
- general knowledge in social sciences and humanity;
- mathematical, scientific, and engineering methodologies;
- design and conduct of experiments, analysis of data, and meaningful physical interpretation of data;
- identification, formulation, and solving engineering problems;
  - conceptualization of objectives and constraints,
  - identification of governing physical principles,
  - applications of fundamental analytical tools as well as modern engineering tools, with sound appreciation of its capabilities and limitations and with sound understanding of the underlying physics and physical insights.
- open-ended problems, design projects, and research;
- effective written and verbal communication skills;
- independent study experiences as well as teamwork efforts;
- appreciation of engagement in life-long learning; and
- appreciation of the roles and responsibilities of mechanical engineers in society.

DEGREES OFFERED

The Department of Mechanical Engineering offers two degreed programs (Bachelor of Engineering, B.Eng.) in Mechanical Engineering and Automotive Engineering, at the undergraduate level. At the graduate level, the department offers a Master of Engineering (M.Eng.) in Mechanical Engineering, and in Cyber-physical System, and a Doctor of Philosophy (Ph.D.), in Mechanical Engineering. Details for each program are given in the following sections.

HEAD:

Angkee	Sripakagorn	Ph.D. (Washington)

PROFESSORS:

Pairod	Singhatanadgid	Ph.D. (Washington)

ASSOCIATE PROFESSORS:

Alongkorn	Pimpin	D.Eng. (Tokyo)
Angkee	Sripakagorn	Ph.D. (Washington)
Asi	Bunyajitradulya	Ph.D. (UC, Irvine)
Boonchai	Lertnuwat	Ph.D. (Tokyo)
Chanat	Ratanasumawong	D.Eng. (Tokyo Tech.)
Chanyaphan	Virulsri	D.Eng. (Tokyo)
Chittin	Tangthieng	Ph.D. (Penn State)
Gridsada	Phanomchoeng	Ph.D. (Minnesota)
Kuntinee	Maneeratana	Ph.D. (London)
Niphon	Wansophark	D.Eng. (Chula)
Nopdanai	Ajavakom	Ph.D. (Berkeley)
Pairat	Tangpornprasert	D.Eng. (Tokyo)
Phongsaen	Pitakwatchara	Ph.D. (Tokyo)
Ratchatin	Chanchareon	D.Eng. (Chula)
Sompong	Putivisutisak	Ph.D. (London)
Thitima	Jintanawan	Ph.D. (Washington)
Thanyarat	Singhanart	Ph.D. (Tokyo)
Witaya	Wannasuphoprasit	Ph.D. (Northwestern)

ASSISTANT PROFESSORS:

Nattapol	Damrongplasit	Ph.D. (UC, Berkeley)
Nuksit	Noomwongs	Ph.D. (TUAT)
Saran	Salakij	Ph.D. (Oregon State)

Sunhapos	Chantranuwathana	Ph.D. (Michigan)
Tawan	Paphapote	M.S. (Illinois)
Surat	Kwanmuang	Ph.D. (Michigan)
Werayut	Srituravanich	Ph.D. (UCLA)

LECTURERS:

Atsawin	Salee	D.Eng. (Tokyo)
Naphatsorn	Vongsoasup	Ph.D. (Tokyo)
Parineak	Romtrairat	Ph.D. (Chula)
Rina	Tse	Ph.D. (Cornell)
Roytor	Charoensin-O-larn	Ph.D. (Washington)
Sarita	Morakul	Ph.D. (Nagaoka)

MECHANICAL ENGINEERING UNDERGRADUATE PROGRAMS

The general aim of the Department of Mechanical Engineering is to provide the students with an understanding of theoretical principles and, through experimental and design work, to provide him/her with confidence in solving practical problems. The department offers two undergraduate programs: Mechanical Engineering, and Automotive Engineering. Students who plan to further their study for higher degrees, as well as those who wish to specialize in any of the fields offered, are strongly urged to consult their advisors to select and prepare the required elective programs.

NAME OF THE DEGREE

: Bachelor of Engineering
: B.Eng.

COURSE REQUIREMENTS

Mechanical Engineering Program

Total credits for graduation 138 credits

1.	General Education	30	credits
2.	Basic Science	27	credits
3.	Basic Engineering	27	credits
4.	Program Core Courses	45	credits
5.	Elective Courses	3	credits
6.	Free Electives	6	credits

Automotive Engineering Program

Total credits for graduation 138 credits

1.	General Education	30	credits
2.	Basic Science	27	credits
3.	Basic Engineering Science	31	credits
4.	Program Core Courses	41	credits
5.	Elective Courses	3	credits
6.	Free Electives	6	credits

STUDY PROGRAM: MECHANICAL ENGINEERING
FIRST YEAR CURRICULUM

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER			**SIXTH SEMESTER**	
2103201	INTRO MECH DESIGN	3	2103307	MFR PRODUCT REAL	3
2103211	STATICS	3	2103308	ME PROJ MGT	3
2103242	THERMODYNAMICS	4	2103361	EN THERM DESIGN I	3
2301215	MULTIVARIABLE	3	2103409	INTRO MECHATRONICS	3
	CALCULUS		2103433	INTRO MECH VIBRAT	3
2104201	ENG STAT I	3	5500208	COM PRES SKIL	3
XXXXXXX	GENERAL EDUCATION	3			**18**
		19			
	FOURTH SEMESTER			**SUMMER SEMESTER**	
2103212	DYNAMICS	3	2103399	MECH ENG PRACTICE	2
2103232	MECH OF MAT	3			
2103260	ME EXP LAB I	2		**SEVENTH SEMESTER**	
2103351	FLUID MECHANICS I	3	2103423	ME CAPSTONE PROJECT	3
2301216	LINEAR ALGEBRA AND		2103493	ME PORTFOLIO	1
	DIFFERENTIAL EQUATIONS	3	XXXXXXX	ELECTIVE COURSES	3
XXXXXXX	GENERAL EDUCATION	3	XXXXXXX	GENERAL EDUCATION	3
		17	XXXXXXX	FREE ELECTIVES	3
					13
	FIFTH SEMESTER				
2102391	ELEC ENG I	3		**EIGHTH SEMESTER**	
2102392	ELEC ENG LAB I	1	2103499	MECH ENG PROJECT	3
2103304	AUTO CONTROL I	3	5500308	TECH WRIT ENG	3
2103306	COM-AIDED ME DES	3	XXXXXXX	GENERAL EDUCATION	3
2103320	DES MECH ELEM	3	XXXXXXX	FREE ELECTIVES	3
2103322	MECH MACHINERY	3			**12**
2103360	ME EXP LAB II	2			
2103463	HEAT TRANSFER	3			
		21			

TOTAL CREDITS FOR GRADUATION = 138

STUDY PROGRAM: AUTOMOTIVE ENGINEERING
FIRST YEAR CURRICULUM

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER			**SIXTH SEMESTER**	
2103201	INTRO MECH DESIGN	3	2103307	MFR PRODUCT REAL	3
2103211	STATICS	3	2103308	ME PROJ MGT	3
2103242	THERMODYNAMICS	4	2103409	INTRO MECHATRONICS	3
2301215	MULTIVARIABLE	3	2103433	INTRO MECH VIBRAT	3
	CALCULUS		5500208	COM PRES SKIL	3
2104253	ENG STAT I	3	2103355	AUTO ENG LAB	1
XXXXXXX	GENERAL EDUCATION	3	2103356	MODERN AUTO	3
		19		POWERTRAIN	
					19
	FOURTH SEMESTER				
2103212	DYNAMICS	3		**SUMMER SEMESTER**	
2103232	MECH OF MAT	3	2103399	MECH ENG PRACTICE	2
2103351	FLUID MECHANICS I	3			
2103481	AUTOMOTIVE ENG	3		**SEVENTH SEMESTER**	
2301216	LINEAR ALGEBRA AND	3	2103483	AUTOMOTIVE SYS DES	3
	DIFFERENTIAL EQUATIONS		2103493	ME PORTFOLIO	1
XXXXXXX	GENERAL EDUCATION	3	XXXXXXX	GENERAL EDUCATION	3
		18	XXXXXXX	FREE ELECTIVES	3
			XXXXXXX	FREE ELECTIVES	3
	FIFTH SEMESTER				**13**
2103354	MECHANICS OF VEHICLES	3			
2103408	AUTOMOTIVE CONTROL	3		**EIGHTH SEMESTER**	
2103306	COMP AIDED ME DES	3	2103499	MECH ENG PROJECT	3
2103320	DES MECH ELEM	3	5500308	TECH WRIT ENG	3
2103463	HEAT TRANSFER	3	XXXXXXX	ELECTIVES COURSES	3
2102391	ELEC ENG I	3	XXXXXXX	GENERAL EDUCATION	3
2102392	ELEC ENG LAB I	1			**12**
		19			

TOTAL CREDITS FOR GRADUATION = 138

APPROVED ELECTIVES FOR UNDERGRADUATE PROGRAMS FOR 2024

Mechanical Engineering				**Automotive Engineering**
2100310 2102505 2147336	2103302 2103381 2103382 2103354	2103402 2103404 2103405 2103406 2103407 2103421 2103432 2103443 2103454 2103460 2103462 2103465 2103467 2103471 2103472 2103475 2103477 2103478 2103479 2103481 2103491 2103495 2103496	2103510 2103530 2103532 2103533 2103535 2103540 2103541 2103552 2103555 2103560 2103566 2103567 2103570 2103571 2103580 2103581 2103582 2103595 2103596	2103302 2103303 2103381 2103402 2103421 2103465 2103467 2103472 2103479 2103491 2103495 2103496 2103510 2103532 2103540 2103541 2103556 2103558 2103580 2103581 2103582 2103595 2103596

Remarks: Electives are subject to change and will be announced by the department. Do not double count subjects, for example, if you count a course as approved elective already, it cannot be counted again as free elective. Also, required courses cannot be counted again as approved or free electives.

MECHANICAL ENGINEERING GRADUATE PROGRAMS

The mechanical engineering department offers a graduate program leading to the degrees of Master of Engineering and Doctor of Philosophy in Mechanical Engineering. The program is housed in the Mechanical Engineering Department which offers three different majors: Solid Mechanics, Heat transfer/ Thermodynamics/ Fluids, and Control/ Dynamics/ Manufacturing. Approximately one hundred and thirty graduate students are full-time students in the department. Students who have demonstrated record of high academic achievement normally receive a kind of financial support which may be in a form of educational grant from different supporting organizations, or as teaching or research assistants, as well as the eligibility for waiving the tuition fee.

Recently, the new program in Cyber-Physical System was successfully launched. The program aims to allow students to gain new knowledge and skills required for life in the 21st century, as well as to advance modern industries to enable Thai society to smoothly transition into the 'Industry 4.0' era. The students are provided with the ability to design, assemble, create, control, administer, and maintain modern cyber-physical systems effectively and securely.

Presently, there are approximately 30 faculty members who are associated with the graduate program in the mechanical engineering department. The department is involved in research activities in a number of different fields. Several faculty members are associate technical editors for journals. A large number of technical papers resulted from faculty research and student theses have been published annually.

MASTER DEGREE PROGRAM IN MECHANICAL ENGINEERING

NAME OF THE DEGREE

: Master of Engineering
: M.Eng.

ADMISSION

The applicant must hold a Bachelor's Degree in Mechanical Engineering or related fields and meet the Graduate School requirements based on the regulations governing the study in Chulalongkorn University's Graduate School, 2018.

DEGREE REQUIREMENTS

There are two programs in the degree of Master of Engineering in Mechanical Engineering.

Program A1

This program is for students who have demonstrated high academic achievement and are approved from the graduate program committee. Students do not need to study course work. 36 credits for thesis and one credit for engineering seminar (S/U) are required in the program A1.

Program A2

Each of the following area of study consists of 18 credits for course work, one credit for engineering seminar (S/U), and 18 credits for thesis. One of the three programs below must be chosen:

- Solid Mechanics area of study
- Heat Transfer/ Thermodynamics/ Fluids area of study
- Control/ Dynamics/ Manufacturing area of study

the applicant must fulfill the requirements of the graduate school by passing the English proficiency requirement and publishing technical paper based on the regulations governing the study in Chulalongkorn University's Graduate School, 2018.

COURSE REQUIREMENTS

(For Program A2)

COURSE REQUIREMENTS

1) Required Courses for all area of study

2103790	Seminar in Mechanical Engineering	1(0-3-1)

2) Additional Required Courses for each area of study

2.1) Solid Mechanics:

2103601	Advanced Engineering Mathematics	3(3-0-9)

3 credits are to be chosen from the following list

2103612	Elasticity	3(3-0-9)
2103614	Continuum Mechanics	3(3-0-9)

2.2) Heat Transfer/Thermodynamics/Fluid:

2103601	Advanced Engineering Mathematics	3(3-0-9)

6 credits are to be chosen from the

2103602	Measurement and Instrumentation	3(2-3-7)
2103650	Advanced Engineering Thermodynamics	3(3-0-9)
2103651	Advanced Fluid Mechanics	3(3-0-9)
2103652	Combustion Theory	3(3-0-9)
2103655	Convection Heat Transfer	3(3-0-9)

2.3) Control/Dynamics/Manufacturing:

2103603	Mathematic for Control Engineers	3(3-0-9)
2103631	Control of Dynamic Systems	3(3-0-9)

3) Approved Elective Courses for each area of study

3.1) Solid Mechanics:

9 credits are to be chosen from the

2103510	Mechanics of Composite Materials	3(3-0-9)
2103511	Introduction to Continuum Mechanics	3(3-0-9)
2103540	Failure Analysis and Non-destructive Testing	3(2-3-7)
2103541	Vibration Monitoring and Analysis	3(2-3-7)
2103570	Micro Fabrication Technology	3(3-0-9)
2103571	Micro and Nano Electromechanical Systems (MEMS-NEMS)	3(3-0-9)
2103602	Measurement and Instrumentation	3(2-3-7)
2103612	Elasticity	3(3-0-9)
2103614	Continuum Mechanics	3(3-0-9)
2103615	Mechanical Vibrations for Graduated Study	3(3-0-9)
2103616	Optimum Design of Complex Mechanical Elements	3(3-0-9)
2103621	Energy Principles in Solid Mechanics	3(3-0-9)
2103622	Analysis of Composite Structure	3(3-0-9)
2103623	Fatigue of Metals	3(3-0-9)
2103625	Advanced Finite Element Method	3(3-0-9)
2103626	Thermal Stress Analysis	3(3-0-9)
2103701	Selected Topics in Mechanical Engineering	3(3-0-9)
2103721	Fracture Mechanics	3(3-0-9)

3.2) Heat Transfer/Thermodynamics/Fluid:

9 credits are to be chosen from the following list

2103552	An Introduction to Computational Fluid Mechanics	3(3-0-9)
2103555	Engine Emissions and Control	3(3-0-9)
2103556	Fundamental of Engine Fuel Control Systems	3(3-0-9)
2103558	Intake Manifold and Induction System Design	3(3-0-9)
2103560	Gas Turbine Performance	3(3-0-9)
2103566	Compressible Fluid Dynamics	3(3-0-9)
2103567	Turbulent Shear Flows	3(3-0-9)
2103602	Measurement and Instrumentation	3(2-3-7)
2103604	Advanced Numerical Methods	3(3-0-9)
2103625	Advanced Finite Element Method	3(3-0-9)
2103650	Advanced Engineering Thermodynamics	3(3-0-9)
2103651	Advanced Fluid Mechanics	3(3-0-9)
2103652	Combustion Theory	3(3-0-9)
2103653	Fluid Dynamics Aspects of Wind Turbines	3(3-0-9)
2103654	Conduction Heat Transfer	3(3-0-9)
2103655	Convection Heat Transfer	3(3-0-9)
2103656	Radiation Heat Transfer	3(3-0-9)
2103658	Advanced Internal Combustion Engine	3(3-0-9)
2103659	Utilization of Alternative Fuels	3(3-0-9)
2103663	Advanced Refrigeration and Air Conditioning	3(3-0-9)
2103664	Design of Thermal Systems	3(3-0-9)
2103665	Advanced Computational Fluid Dynamics	3(3-0-9)
2103666	Finite Element Method for Computational Fluid Dynamics	3(3-0-9)

3.3) Control/Dynamics/Manufacturing:

9 credits are to be chosen from the following list

2103510	Mechanics of Composite Materials	3(3-0-9)
2103530	Industrial Robots I	3(3-0-9)
2103532	Computer-Aided Design and Computer-Aided Manufacturing	3(2-3-7)
2103533	Modern Computer Based Manufacturing System	3(2-3-7)
2103535	Mechatronics	3(3-0-9)
2103602	Measurement and Instrumentation	3(2-3-7)
2103604	Advanced Numerical Methods	3(3-0-9)
2103615	Mechanical Vibrations for Graduated Study	3(3-0-9)
2103616	Optimum Design of Complex Mechanical Elements	3(3-0-9)
2103617	Advanced Dynamics	3(3-0-9)
2103625	Advanced Finite Element Method	3(3-0-9)
2103630	Industrial Robots II	3(3-0-9)
2103632	Applied Nonlinear Control	3(3-0-9)
2103633	Applied Optimal Control	3(3-0-9)
2103634	Dynamics System Modeling and Simulation	3(3-0-9)

4) Elective Courses

4.1) Solid Mechanics: **3 credits**

4.2) Heat Transfer/Thermodynamics/Fluid: **none**

4.3) Control/Dynamics/Manufacturing: **3 credits**

Elective courses are to be chosen from the following list

2103510	Mechanics of Composite Materials	3(3-0-9)
2103511	Introduction to Continuum Mechanics	3(3-0-9)
2103530	Industrial Robots I	3(3-0-9)
2103532	Computer-Aided Design and Computer-Aided Manufacturing	3(2-3-7)
2103533	Modern Computer Based Manufacturing System	3(2-3-7)
2103535	Mechatronics	3(3-0-9)
2103540	Failure Analysis and Non-destructive Testing	3(2-3-7)
2103541	Vibration Monitoring and Analysis	3(2-3-7)
2103552	An Introduction to Computational Fluid Mechanics	3(3-0-9)
2103555	Engine Emissions and Control	3(3-0-9)
2103556	Fundamental of Engine Fuel Control Systems	3(3-0-9)

2103558	Intake Manifold and Induction System Design	3(3-0-9)
2103560	Gas Turbine Performance	3(3-0-9)
2103566	Compressible Fluid Dynamics	3(3-0-9)
2103567	Turbulent Shear Flows	3(3-0-9)
2103570	Micro Fabrication Technology	3(3-0-9)
2103571	Micro and Nano Electromechanical Systems (MEMS-NEMS)	3(3-0-9)
2103580	Introduction to Intelligent Systems	3(3-0-9)
2103581	Robot Operating System and Applications	3(3-0-9)
2103582	Advance Robot Operating System and Applications	3(3-0-9)
2103583	Mechanic of Biomaterials	3(3-0-9)
2103602	Measurement and Instrumentation	3(2-3-7)
2103604	Advanced Numerical Methods	3(3-0-9)
2103612	Elasticity	3(3-0-9)
2103614	Continuum Mechanics	3(3-0-9)
2103615	Mechanical Vibrations for Graduated Study	3(3-0-9)
2103616	Optimum Design of Complex Mechanical Elements	3(3-0-9)
2103617	Advanced Dynamics	3(3-0-9)
2103621	Energy Principles in Solid Mechanics	3(3-0-9)
2103622	Analysis of Composite Structure	3(3-0-9)
2103623	Fatigue of Metals	3(3-0-9)
2103625	Advanced Finite Element Method	3(3-0-9)
2103626	Thermal Stress Analysis	3(3-0-9)
2103630	Industrial Robots II	3(3-0-9)
2103631	Control of Dynamic Systems	3(3-0-9)
2103632	Applied Nonlinear Control	3(3-0-9)
2103633	Applied Optimal Control	3(3-0-9)
2103634	Dynamics System Modeling and Simulation	3(3-0-9)
2103650	Advanced Engineering Thermodynamics	3(3-0-9)
2103651	Advanced Fluid Mechanics	3(3-0-9)
2103652	Combustion Theory	3(3-0-9)
2103653	Fluid Dynamics Aspects of Wind Turbines	3(3-0-9)
2103654	Conduction Heat Transfer	3(3-0-9)
2103655	Convection Heat Transfer	3(3-0-9)
2103656	Radiation Heat Transfer	3(3-0-9)
2103658	Advanced Internal Combustion Engine	3(3-0-9)
2103659	Utilization of Alternative Fuels	3(3-0-9)
2103663	Advanced Refrigeration and Air Conditioning	3(3-0-9)
2103664	Design of Thermal Systems	3(3-0-9)
2103665	Advanced Computational Fluid Dynamics	3(3-0-9)
2103666	Finite Element Method for Computational Fluid Dynamics	3(3-0-9)
2103701	Selected Topics in Mechanical Engineering	3(3-0-9)
2103721	Fracture Mechanics	3(3-0-9)
2103863	Flexible Learning III	3(0-0-12)

5) Thesis

2103813	Thesis	18	credits
2103816	Thesis	36	credits

MASTER DEGREE PROGRAM IN CYBER-PHYSICAL SYSTEM

The Master of Engineering Program in Cyber-Physical Systems aims to provide graduate students with the ability to design, assemble, create, control, administer, and maintain modern cyber-physical systems effectively and securely. The program also aims to allow students to gain new knowledge and skills required for life in the 21st century, as well as to advance modern industries to enable Thai society to smoothly transition into the 'Industry 4.0' era.

To achieve the aforementioned goals, the curriculum was designed under the concept of being part of an ecosystem of cyber-physical space development, putting students at the center of learning, developing, and producing research theses. Undertaking a thesis, including assessment of it, can be divided into two parts: the first part provides students with opportunities to learn about technologies through a wide variety of channels that are appropriate for individual learning.

Specifically, the program stresses educational quality by cooperating with various areas and sectors within the ecosystem and monitoring learning closely so as to foster the originality of theses. The curriculum opens up opportunities for students to learn and compose their thesis using: courseware developed by a flagship technology company; MOOC certified by the program committee; and technology camps or other activities organized to familiarize students with modern technology. Moreover, the program provides opportunities for students to carry out industrial projects with companies that participate in a collaborative framework with the program in order that thesis questions address real needs of the industrial sector. Another channel of learning in the curriculum is studying at an international university. In this channel, students can choose to study at an international university collaborating with the program. This aims to allow students to learn about new technologies from leading universities around the world, resulting in their theses meeting international standards.

NAME OF THE DEGREE

: Master of Engineering
: M.Eng.

ADMISSION

The applicant must hold a Bachelor's Degree in Mechanical Engineering, Electrical Engineering, Computer Engineering or related fields and meet the Graduate School requirements based on the regulations governing the study in Chulalongkorn University's Graduate School, 2018.

DEGREE REQUIREMENTS

The students must complete the required courseworks of the program. In addition, they must fulfill the requirements of the graduate school by passing the English proficiency requirement and publishing technical paper based on the regulations governing the study in Chulalongkorn University's Graduate School, 2018.

COURSE REQUIREMENTS

This study plan concentrates on lectures to expand fundamental knowledge for Master's graduate students and requires conducting a thesis.

1) Required Courses

2103610	Introduction to Cyber Physical System	3(3-0-9)
2103611	Instrumentation and Precision Engineering	3(3-0-9)
2103790	Seminar in Mechanical Engineering	1(0-3-1)

2) Approved Elective Courses, Group I (Selected 6 credits from the following courses)

2102525	Internet and Network Security	3(3-0-9)
2102544	Advanced Embedded Systems	3(3-0-9)
2102577	Telecommunication Network	3(3-0-9)
2102581	Digital Circuit Design	3(3-0-9)
2102588	Biomedical Electronics	3(3-0-9)
2102676	Digital Image Processing	3(3-0-9)
2103530	Industrial Robots I	3(3-0-9)
2103532	Computer Aided Design and Computer Aided Manufacturing	3(2-3-7)
2103535	Mechatronics	3(3-0-9)
2103570	Micro Fabrication Technology	3(3-0-9)
2103571	Micro and Nano Electromechanical Systems	3(3-0-9)
2103580	Introduction to Intelligent Systems	3(3-0-9)
2103581	Robot Operating System and Applications	3(3-0-9)
2103582	Advance Robot Operating System and Applications	3(3-0-9)
2103583	Mechanic of Biomaterials	3(3-0-9)
2103602	Measurement and Instrumentation	3(2-3-7)
2103631	Control of Dynamic Systems	3(3-0-9)
2103664	Design of Thermal System	3(3-0-9)
2110651	Digital Image Processing	3(3-0-9)
2110654	Artificial Intelligence	3(3-0-9)
2110681	Computer Algorithm	3(3-0-9)
2110682	Embedded and Real-Time Systems	3(3-0-9)
2110744	Machine Vision	3(3-0-9)

3) Approved Elective Courses, Group II (Selected 12credits from the following courses)

2103861	Flexible Learning I	1(0-0-4)
2103862	Flexible Learning II	2(0-0-8)
2103863	Flexible Learning III	3(0-0-12)
2103864	Flexible Learning IV	6(0-0-24)
2103871	Research Abroad I	1(0-0-4)
2103872	Research Abroad II	2(0-0-8)
2103873	Research Abroad III	3(0-0-12)
2103874	Research Abroad IV	6(0-0-24)
2103881	Industrial Project I	1(0-0-4)
2103882	Industrial Project II	2(0-0-8)
2103883	Industrial Project III	3(0-0-12)
2103884	Industrial Project IV	6(0-0-24)

4) Thesis

2103811	Thesis	12	credits

Ph.D. DEGREE PROGRAM

NAME OF THE DEGREE

: Doctor of Philosophy
: Ph.D.

ADMISSION

1. The applicant must have bachelor's degree in mechanical engineering/related fields or master degree in mechanical engineering/related fields. The applicant with bachelor's degree must receive at least second class honor degree. Both the bachelor's and master's degree applicants must possess other qualifications which the Doctor of Philosophy Program Committee considers sufficient to enter the program.

2. The applicant must present three letters of recommendation written by persons who are engaging in teaching graduate study and/or his or her academic advisors.

3. The applicant must possess other qualifications which fulfill the regulations governing the study in Chulalongkorn University's Graduate School and the standard of study for the Doctor of Engineering Degree, 2018.

DEGREE REQUIREMENTS

There are three programs in the Doctor of Philosophy in Mechanical Engineering. For the Program 2.2, the applicant with bachelor's degree must take 24 credits of the listed elective courses and 48 credits of dissertation. For the Program 2.1, the applicant with master's degree must take 12 credits of the listed elective courses and 48 credits of dissertation. For Program 1.1, the applicant with master's degree must take 60 credits of dissertation without any elective courses. In addition, the applicant must fulfill the requirements of the graduate school by passing the English proficiency requirement and publishing technical paper based on the regulations governing the study in Chulalongkorn University's Graduate School, 2018.

COURSE REQUIREMENTS

1) Elective Courses

2103601	Advanced Engineering Mathematics	3(3-0-9)
2103602	Measurement and Instrumentation	3(2-3-7)
2103603	Mathematics for Control Engineers	3(3-0-9)
2103604	Advanced Numerical Methods	3(3-0-9)
2103612	Elasticity	3(3-0-9)
2103614	Continuum Mechanics	3(3-0-9)
2103615	Mechanical Vibrations for Graduated Study	3(3-0-9)
2103616	Optimum Design of Complex Mechanical Elements	3(3-0-9)
2103617	Advanced Dynamics	3(3-0-9)
2103621	Energy Principles in Solid Mechanics	3(3-0-9)
2103622	Analysis of Composite Structures	3(3-0-9)
2103623	Fatigue of Metals	3(3-0-9)
2103625	Advanced Finite Element Method	3(3-0-9)
2103626	Thermal Stress Analysis	3(3-0-9)
2103630	Industrial Robots II	3(3-0-9)
2103631	Control of Dynamic Systems	3(3-0-9)
2103632	Applied Nonlinear Control	3(3-0-9)
2103633	Applied Optimal Control	3(3-0-9)
2103634	Dynamic System Modeling and Simulation	3(3-0-9)
2103650	Advanced Engineering Thermodynamics	3(3-0-9)
2103651	Advanced Fluid Mechanics	3(3-0-9)
2103652	Combustion Theory	3(3-0-9)
2103653	Fluid Dynamic Aspects of Wind Turbines	3(3-0-9)
2103654	Conduction Heat Transfer	3(3-0-9)
2103655	Convection Heat Transfer	3(3-0-9)
2103656	Radiation Heat Transfer	3(3-0-9)
2103658	Advanced Internal Combustion Engine	3(3-0-9)
2103659	Utilization of Alternative Fuels	3(3-0-9)
2103663	Advanced Refrigeration and Air Conditioning	3(3-0-9)
2103664	Design of Thermal Systems	3(3-0-9)
2103665	Advanced Computational Fluid Dynamics	3(3-0-9)
2103666	Finite Element Method for Computational Fluid Dynamics	3(3-0-9)
2103701	Selected Topics in Mechanical Engineering	3(3-0-9)

2103721	Fracture Mechanics	3(3-0-9)
2103863	Flexible Learning III	3(0-0-12)

2) Dissertation

2103828	Dissertation	48 credits
2103829	Dissertation	60 credits
2103894	Doctoral Dissertation Seminar	0(0-0-0)
2103897	Qualifying Examination	0(0-0-0)

COURSES DESCRIPTIONS IN MECHANICAL ENGINEERING (UNDERGRADUATE LEVEL)

2103106 Engineering Drawing 3(1-4-4)

Introduction; orthographic projection principle; orthographic writing; pictorial sketching; orthographic reading; dimensioning; Mechanical part's drawing such as threaded fastener; assembly drawing; Introduction to 3D modeling.

2103201 Introduction to Mechanical Design 3(2-2-5)

Principles of Design Thinking method; Design process: defining design problems from the real complicated problem, empathy, concept generation and evaluation, brainstorming, evaluation, conceptual design, configuration design; simple mechanisms and mechanical devices; simple mechanical standard parts; design project.

2103211 Statics 3(3-0-6)

Force-couple system; resultants; equilibrium; factor of safety; frames and machines; truss; distributed forces; fluid statics; flexible cable; friction, friction in machines; principle of virtual work; stability; numerical tools.

2103212 Dynamics 3(3-0-6)

Condition: Corequisite 2103211 or 2103213

Kinematics & kinetics of particles and planar rigid body; Newton's second law; equations of motion; work and energy; impulse and momentum of particles and planar rigid body; state equations of dynamical systems.

2103232 Mechanics of Materials 3(3-0-6)

Condition: Corequisite 2103211 or 2103213

Mechanical properties of material; engineering stress-strain diagrams; Concept of stress, strain and deformation; stress and strain transformation; Mohr's circle of plane stress; axially loaded member; circular shaft subjected to torsional load; flexural loaded member; thin- walled pressure vessel; buckling of column; combined stress; stress concentration; theories of failure; factor of safety.

2103242 Thermodynamics 4(4-0-8)

Introduction, concepts and definitions, properties of pure substances, work and heat, the first law and the second law of thermodynamics, a power system such as power plants and internal combustion engines, a refrigeration system, ideal gas mixture, psychrometry and air conditioning, combustion.

2103260 Mechanical Engineering Experimentation and Laboratory I 2(1-3-2)

Conceptual thinking about problem solving by experimental method, Basic statistics for data analysis; Operational principles and interpreting the technical specifications of basic measuring instruments; Introduction to uncertainty analysis; Various experiments on measurement of basic physical quantities such as viscosity, fluid flow rate, strain, modulus of elasticity, hardness, impact properties, temperature, coefficient of restitution; modern technology such as artificial Intelligence.

2103302 Engineering Measurements 3(2-2-5)

Condition: Consent of Faculty

This course introduces students to the basic concept of measurement and instrumentations that engineers often encounter in real-world scenarios. The course structure consists of both lectures and lab modules. Foundation knowledge in dynamic characteristics, principles of mechanical sensors such as strain gauge, motion and temperature sensors, circuit analysis, frequency response, signal conditioning, data acquisition methods, and uncertainty analysis are covered. Hands-on laboratory modules allow students to apply theoretical knowledge on real experiments. Students will learn how to operate benchtop equipment such as oscilloscope, digital multimeter, power supply, function generator, network analyzer, and data acquisition (DAQ). Students will have the opportunity to experiment with different sensors used for measuring physical signals such as strain gauge, inertial measurement sensor, RGB-D camera, and IoT (Internet of Things) devices. Students will also learn the art of data visualization, how to pre/post-process signals using computer software, and how to apply statistics and machine learning on acquired data. The course will culminate in a project that allows students to explore a topic of interest and apply the knowledge they have learned throughout the class in answering those questions.

2103303 Numerical Methods For Mechanical Engineering 3(3-0-6)

Digital computers principles and computer languages; root of algebraic and transcendental equations; solution of simultaneous algebraic equations; curve fitting; numerical integration and differentiation; numerical integration of ordinary differential equations: initial-value problems, ordinary differential equations: boundary-value problems.

2103304 Automatic Control I 3(3-0-6)

Introduction to control system; mathematical models of systems; state- space description; dynamics simulation; feedback control system characteristics; the performance of feedback control systems; the stability of linear feedback systems; essential principles of feedback, the root- locus method; frequency response methods; stability of the frequency domain, time-domain analysis of control systems; the design and compensation of feedback control systems. Introduction to usage of Artificial Intelligence.

2103306 Computer-Aided Mechanical Engineering Design **3(3-0-6)**

Numerical methods for analysis, modeling and design of mechanical engineering problems. Physical modeling and simulations of mechanical engineering problems and related applications. Use of computer-aided engineering for design and analysis of mechanical engineering problems.

2103307 Manufacturing for Product Prototype Realization **3(2-2-5)**

Working drawing; manufacturing process: casting, plastic processing, metal forming, sheet metalworking, turning, milling, welding, digital manufacturing, laser cut, 3D printing; dimensions, precision, tolerances, surfaces and their measurement; manufacturing process selection; design for manufacturing; assembly & installation process; product evaluation and cost estimation

2103308 Mechanical Engineering Project Management **3(3-0-6)**

Management models; project proposal; break even analysis; time value of money; feasibility study; project planning; contracts and tendering; schedules and control of project operation; resource and cost management; risk management; service and maintenance planning; project delivery; information system for project management; case studies.

2103320 Design of Mechanical Elements **3(3-0-6)**

Condition: Prerequisite 2103231 or 2103232

Properties of materials, theory of failure; fatigue analysis for mechanical design, design of various interesting mechanical elements.

2103322 Mechanics of Machinery **3(3-0-6)**

Condition: Prerequisite 2103212

Basic Mechanisms; Position, velocity and acceleration of Linkages, graphical linkage synthesis; linkage synthesis; static and dynamic force analysis; static and dynamic balancing of a simple rotating and reciprocating machine.

2103335 Vehicle Structural Analysis 1 **3(3-0-6)**

Condition: Prerequisite 2103232

Types and functions of vehicle body and chassis, layout of driving system, and chassis's load; factors affecting the structural design: safety; analysis of stress and deformation in beam and frame under axial load, bending moment, torque, transverse load and thermal load, respectively. The analysis involves both analytical method and finite element method, use of software in solving structural problems.

2103342 Thermodynamics II **3(3-0-6)**

Condition: Prerequisite 2103241 or 2103242

Gaseous mixture; thermodynamic relations; fuel and chemical reactions; irreversibility, availability or exergy and second law efficiency; compressible flow.

2103351 Fluid Mechanics I **3(3-0-6)**

Condition: Prerequisite 2103242 or 2103295

Introduction and fundamental concepts: fluid as a continuum, velocity field, forces in fluid; Reynolds' transport theorem; governing equations for fluid motion in integral form: conservation of mass, linear momentum, angular momentum, and energy; fluid machinery; introduction to kinematics of fluid motion: Eulerian and Lagrangian description of fluid motion, substantial derivative, translation, rotation, deformation; introduction to governing equations for fluid motion in differential form: conservation of mass, stress in fluid motion, resultant force due to stress, the Navier-Stokes equation; introduction to inviscid flow: Euler's equation, Bernoulli's equation; dimensional analysis and similarity; introduction to internal viscous flow: fully- developed laminar flow, flow in pipes and ducts; introduction to external viscous flow: boundary layer flow, flow about immersed bodies.

2103354 Mechanics of Vehicles **3(3-0-6)**

Condition: Prerequisite 2103211

Dynamics of wheels; vehicle's resistance forces and power requirement; performance and fuel consumption; road loads; dynamics of breaking; power spectrum of road surfaces; quarter car and half car model; ride comfort evaluation; tire force model; Single track model for steady-state cornering; understeer/ oversteer; types of suspensions

2103355 Automotive Engineering Laboratory **1(1-3-0)**

Experiments are designed to familiarize students with experimental techniques and instrumentations in the field of mechanical and automotive engineering; modern technology such as artificial Intelligence.

2103356 Modern Automotive Powertrain **3(3-0-6)**

Fundamentals of automotive propulsion systems; Internal combustion engine; Modern enhancement of ICE for performance and emission requirements; Electric propulsion systems; EV, HEV, PHEV systems; Electric motors; Energy sources; Performance and testing.

2103360 Mechanical Engineering Experimentation and Laboratory II **2(1-3-2)**

Condition: Prerequisite 2103260

Systematic experimentation for the formulation and solving of engineering problems. Problem formulation, and objective of an experiment as objective functional form. The application of physical principle as

experimental principle and in experimental set up. Systematic data collection and data analysis. Graphical representation of experimental results. Extraction and analysis of experimental results. Logically draw conclusions from evidences and experimental results, with the consideration of experimental uncertainties. Application of the principle in, and hands-on experience on, systematic experimentation of various mechanical engineering systems. Focus will be on moderately complex experiment such as those in finding the performance of an equipment or a system over a range of operating conditions, at design and off-design points. Technical communication, and the description of the problem-solving methodology via short experimental report.

2103361 Energy and Thermal-Fluid System Design I 3(3-0-6)
Condition: Corequisite 2103463
Engineering design concept; Fluid transport system; Fluid driving devices and piping system such as water piping, fire water piping; Introduction to optimization, Heat exchangers; Energy and energy transfer devices.

2103381 System-Level Analysis of Electric Vehicles 3(3-0-6)
Knowledge in present day energy conversion and energy storage devices; characteristics of battery, fuel cell, and supercapacitor; principles of different kinds of electric vehicles, including hybrid vehicle, plug-in hybrid vehicle and fuel cell vehicle; common misconceptions about the electric vehicle technology in terms of users' behavior and a new form of business that is related to changes in global market; ability to deal with those misconceptions through the use of knowledge in the electric vehicle technology.

2103399 Mechanical Engineering Practice 2(0-12-0)
Engineering practice is a tool for student to have a chance to practice and apply the knowledge in classroom. To be familiar with work in engineering field, as well as develop interpersonal and networking skill before actual working after graduation. Engineering practice is in related areas under
supervision of experience experienced engineers in private sectors or government agencies.

2103402 Refrigeration and Air Conditioning 3(3-0-6)
Condition: Consent of Faculty
Vapor-compression refrigeration system; refrigerants; refrigeration components; vapor-compression refrigeration system analysis; heating, ventilation and air conditioning (HVAC) systems; thermal comfort; psychrometry and air conditioning process; indoor air quality and ventilation; cooling load calculation.

2103404 Dynamic Systems Simulation 3(3-0-6)
Condition: Prerequisite 2103304
Introduction; multiport systems and bond graphs; basic component models; system models; state-space equations; analysis of linear systems; multiport fields and junction structures; transducers, amplifiers, and instruments.

2103405 Automatic Control II 3(3-0-6)
Condition: Prerequisite 2103304
Describing-function analysis of non-linear control systems, phase-plane analysis, state-space analysis of control system; linear dynamical equations and impulse-response matrices; controllability and observability of linear dynamical equations, irreducible realizations: strict system, equivalence and identification.

2103406 Digital Control 3(3-0-6)
Condition: Prerequisite 2103304
Introduction to discrete systems by time-domain representations of linear discrete systems; the analysis of discrete-time systems, z-transformation of linear discrete systems; state variable representation; analysis of linear discrete-time system: z-domain approach; the analytical design of discrete systems; engineering characteristics of computer control systems.

2103407 Industrial Control 3(3-0-6)
Pasic control system; industrial control components: pneumatic electric, electronic and fluid devices; analysis and design of the complete control systems; special control applications; boiler control air condition control flight control; introduction to direct digital control and supervisory control.

2103408 Automotive Control 3(3-0-6)
Basic electronics; principle of feedback control system; digital control system; control device in automotive; sensors, controller, actuator; various control systems in automobile; system failure analysis.

2103409 Introduction to Mechatronics 3(3-0-6)
Introduction to Mechatronic Systems; Digital circuits; OP-AMP and analog circuits; Sensors and Measurement Systems; Actuators; Microprocessor; Programming, Project in Mechatronics.

2103421 Introduction to Finite Element Method for Mechanical Engineering 3(3-0-6)
Condition: Prerequisite 2103303
Mathematical preliminaries and matrices, general procedure of the finite element method, derivation of finite equations using; direct approach, variational approach and method of weighted residuals, finite element types in one, two and three dimensions, and their interpolation functions, applications to structural, heart transfer, and fluid flow problems.

2103423 Mechanical Engineering Capstone Project **3(1-4-4)**

Condition: Corequisite 2103320, 2103322 and 2103361

Conducting a complicated mechanical engineering design project in full cycle from problem consideration, analyses, design, implement, test, and reflection. Teamwork and communication.

2103424 External Mechanical Engineering Project **3(0-6-3)**

Condition: Corequisite 2103320, 2103322 and 2103361

Conducting a mechanical engineering- related project in external organization in full cycle from problem consideration, analyses, design, implement, test, reflection. Teamwork and communication.

2103432 Mechanics of Materials II **3(3-0-6)**

Condition: Prerequisite 2103231 or 2103232

Analysis of stresses at a point; analysis of stresses at adjacent points; analysis of strain at a point; analysis of strain at adjacent points; introduction to theory of elasticity; applications to thick cylinders; compound cylinders: rotating disks: criteria of yielding: energy method.

2103433 Introduction to Mechanical Vibration **3(3-0-6)**

Condition: Prerequisite 2103212, 2301312

Oscillatory motion; Equations of motion of discrete mechanical systems; Free responses of one- degree-of-freedom mechanical systems: natural frequency and modal damping; Forced responses of one- degree- of- freedom mechanical systems: frequency response function, impulse response, and transient response; Vibration of multi-degree- of- freedom mechanical systems: natural frequencies, modal damping, mode shapes, and modal analysis; Engineering applications of vibration: rotating machine unbalance, base excitation, vibration suppression, tuned mass damper (TMD), and vibration instruments; Computational methods in vibration; Vibration testing.

2103443 Refrigeration **3(3-0-6)**

Condition: Prerequisite 2103241 or 2103242 and 2103351

Various types of refrigerating system; refrigeration cycle: single stage, booster, multi-stage and cascade system; basic principles of cryogenic technique; properties of refrigerants; blast freezer and anteroom construction: refrigeration load estimation; cold storage construction; freezing preservation of foods; low temperature refrigeration system; introduction to cryogenic technique; control system and instrumentations.

2103454 Ventilation and Air Conditioning **3(3-0-6)**

Condition: Prerequisite 2103342, 2103351

Psychrometric properties and process of air, criteria for thermal comfort; general ventilation; industrial ventilation; fume and dust removal; air conditioning load calculation; various types of air conditioning system and equipment; air distribution and duct system design; air conditioning piping design; noise and vibration control: air.

2103460 Mechanical Engineering Experimentation and Laboratory III **2(1-3-2)**

Concepts in experimentation and design of an experiment (DoE); problem formulation: motivation and problem statement for an experiment and for the design of an experiment; setting up the objectives and the objective functional forms $y = f(x ; p ; c)$ of an experiment; setting up the specifications of the design of an experiment (DoE specifications); the two fundamental DoE specifications; systematic design of an experiment according to the DoE specifications and optimization using concepts, knowledges, and tools such as design concept, physical principles, data reduction diagram (DRD), instruments and data acquisition systems, measurement and uncertainty analysis, and design evaluation and design optimization based on DoE specifications; practice design of an experiment via problem-based projects.

2103461 Automotive Engineering Experimentation and Laboratory **2(1-3-2)**

Basic concepts and framework of experimentation; uncertainty analysis; analysis of data; interpretation of experimental results; analysis of characteristics and physical behavior of the system from experimental results via the use of physical observation and knowledge of basic physical principles; practices in applying principles and theories in automotive systems.

2103462 Fluid Mechanics II **3(3-0-6)**

Condition: Prerequisite 2103241 or 2103242 and 2103351

Fundamental concepts in fluid mechanics: methods of description of fluid motion, kinematics of fluid motion, stress at a point, the Navier-Stokes equation; inviscid irrotational flows: vorticity and circulation, velocity potential, stream function, Euler's equation of motion, Bernoulli's equation, elementary plane flows, superposition of elementary plane flows, lift and circulation; laminar viscous flows: Poiseuille flow, Couette flow, flow between rotating concentric cylinders; laminar boundary layers: displacement and momentum thicknesses, thin shear layer assumption and laminar boundary layer equation, flat plate boundary layer, momentum integral equation; introduction to turbulent flows: mean flow and turbulence, the Reynolds-Average Navier-Stokes equation, turbulent flows in channel and pipe, turbulent boundary layers; lift and drag of immersed bodies; introduction to compressible flows: local isentropic reference states, steady one-dimensional compressible flows with area change, with friction, and with heat transfer, normal shock.

2103463 Heat Transfer 3(3-0-6)

Condition: Prerequisite 2103242 and 2103351

Modes of heat transfer; heat conduction equation; steady, one-dimensional heat conduction; steady, two-dimensional heat conduction; unsteady, one- dimensional heat conduction; Introduction to convection heat transfer; velocity and thermal boundary layer; forced convection along external surfaces; forced convection inside tubes; free convection; boiling and condensation; introduction to thermal radiation; blackbody radiation; real surface emission; surface absorption, reflection and transmission; view factor; radiation exchanger between blackbody; radiation exchanger between real surface.

2103465 Fluid Power System 3(3-0-6)

Condition: Prerequisite 2103351, 2301312

Fundamentals of fluid power system, basic components and circuits, standard symbols, definitions using steady-state characteristics, transmission system, logic components and circuits, electrical components and wiring diagrams definition using transient characteristic, dynamic of fluid power system.

2103467 Combustion Technology 3(3-0-6)

Condition: Prerequisite 2103342, 2103351

Combustion phenomena; chemical kinetics, total collision frequency, equation of Arrhenius, activation energy, rates of reaction, ignition, quenching distance, flammability limits, fuel technology, stoichiometric combustion calculation, thermochemical analysis, theoretical flame temperature, performance of steam boilers, boiler's efficiency, boiler's heat balance sheet, boiler draught and fan power calculation, classification of industrial furnaces, heat source and heating method, operating method and material transfer equipment, furnace's radiative heat transfer, combustion apparatus, fuel-to-steam efficiency.

2103471 Internal Combustion Engines 3(3-0-6)

Condition: Prerequisite 2103241 or 2103242

Internal combustion engines fundamentals, SI engines, CI engines, fuels and combustion, fuel metering systems, ignition systems, supercharging and scavenging lubrication, alternative fuels and performances.

2103472 Power Plant Engineering 3(3-0-6)

Condition: Prerequisite 2103241 or 2103242

Power plant and energy conversion systems: load calculation; power plant economics; fuel and combustion; steam turbines; steam and nuclear generators; condensers and auxiliary equipment; steam, internal combustion engine, gas turbine and hydroelectric plans.

2103475 Energy Management in Building 3(3-0-6)

Condition: Senior project

Energy audit program for building and facilities, initiating energy management program, guidelines for methods of reducing energy usage in each area in buildings, conservation of the energy in the planning, design, installation, utilization, maintenance and modernization of the mechanical systems in existing and new buildings, utilization of microcomputer in energy management and in automatic control of air conditioning and ventilation systems in buildings.

2103477 Design of Industrial Piping 3(3-0-6)

Condition: Prerequisite 2103351

Boiler, principle of steam piping system, steam trapping, condensate recovery, flash steam, steam system design; principle of industrial compressed air piping system, air compressor and equipment, compressed air system design; air compressor and equipment, compressed air system design; principle of low pressure gas piping, pressure reducing station, calculation and sizing of gas pipes.

2103478 Energy Management in Industry 3(3-0-6)

Condition: Prerequisite 2103351

Energy balance studies for various equipment in industrial plants and options for improved efficiency, waste heat recovery techniques, cogeneration concepts in industry and management for efficient use of energy.

2103479 Engine Cooling Systems 3(3-0-6)

Function of engine cooling system; fundamental of engine heat transfer; engine cooling system components; engine temperature; engine cooling circuits; vehicle coolant circuits; heat rejection; failure mode of cooling system; system characteristics; design process and test methods.

2103481 Automotive Engineering 4(3-3-6)

Basic principles; suspension system; body and chassis, brake systems; steering system; front wheel geometry; transmission system; automotive equipment; performance factors; Manufacturing process; modern manufacturing such as robotics; related considerations such as occupation health and safety, fire safety system, impact on the environments

2103482 Mechanics of Vehicles II 3 (3-0-6)

Condition: Prerequisite 2103211 and 2103212

PART I: Introduction, degree of freedom, mechanical replacement system, uneven road surface, one-mass system, impulse due to the unevenness of the road, spectral density, spectral density of uneven road surfaces, evaluation criteria of vibration and its calculation, evaluating the effect of the vibration on person, tire, seat, vibration of motor vehicles and single point excitation, magnification factor (amplitude ratio), assessment criteria.

PART II: Single-track model, equation of motion, center of curvature and instantaneous center, tire characteristics, aerodynamic characteristic values, linear differential equation of the single-track model, steady-state circular test at a constant speed, characteristic variable and its subjective assessment, effect of vehicle data, dynamic

behavior, drive with large slip angles (in non-linearized range), effect of the height of center of mass.

2103483 Automotive System Design 3(1-4-4)
Condition: Prerequisite 2103320, 2103306 and 2103354

A practical interesting automotive system design project assigned by the instructor; the project must be completed within one semester; a complete written design report is required.

2103491 Rolling Stock Engineering 3(3-0-6)

Fundamentals of railway rolling stock engineering railway stock components; introduction to railway vehicle dynamics; stability analysis; bogie, suspension, propulsion and brake system; fundamentals of bogie forms and design concept; principle of railway rolling stock maintenance.

2103493 Mechanical Engineering Portfolio 1(0-0-3)

Collection of activities and reflection of that show the evidence of achievement in the mechanical engineering graduate attributes in English, communication, multi-disciplinary collaboration and teamwork, lifelong learning, critical thinking, responsibility to society, and other related topics

2103495 Advanced Topics in Mechanical Engineering I 3(3-0-6)
Condition: Consent of Faculty

Topics of current interest and new developments in various fields of mechanical engineering.

2103496 Advanced Topics in Mechanical Engineering II 3(3-0-6)
Condition: Consent of Faculty

Topics of current interest and new developments in various fields of mechanical engineering.

2103498 Mechanical Engineering Pre-Project 1(0-2-1)
Condition: Senior Standing or Consent of Faculty

Conduct and complete design processes for a mechanical engineering project in a team as well as documenting and presenting the processes in a professional manner.

2103499 Mechanical Engineering Project 3(0-6-3)
Condition: Consent of Faculty

Conduct and complete a mechanical engineering project in a team such that the processes comply with prescribed design processes as well as documenting and presenting the project in a professional manner.

2104201 Engineering Statistics I 3(3-0-6)

The scopes and uses of statistics in engineering; concepts of variables and data; distribution functions; sampling distribution; estimation; hypothesis testing for one and two populations; goodness-of-fit test.

2301215 Multivariable Calculus 3(3-0-6)
Condition: Prerequisite 2301108

vectors; curves, planes and surfaces; derivatives of vector-valued functions; partial, total and directional derivatives; implicit differentiation; maxima-minima; gradient, divergence, curl; scalar and 2vector fields; line integral; surface integral and volume integral; integral theorems of vector analysis

2301216 Linear Algebra and Differential Equations 3(3-0-6)
Condition: Prerequisite 2301108

systems of linear algebraic equations; linear spaces; inner products; eigenvalues and eigenvectors; principal axis theorem; higher-order linear differential equations; method of variation of parameters; systems of first- order linear differential equations; qualitative analysis and dynamical system.

COURSES DESCRIPTIONS IN MECHANICAL ENGINEERING (GRADUATE LEVEL)

2103510 Mechanics of Composite Materials 3(3-0-9)

Basic concepts of fiber reinforced composite materials and their application, stress and strain analysis of continuous fiber composite materials; Hooke' law and hygrothermal behavior of orthotropic lamina; classical lamination theory, failure criterion, and design concepts, as applied to composite structures; analysis of composite beams and plates; introduction to material fabrication and testing.

2103511 Introduction to Continuum Mechanics 3(3-0-9)
Condition : Consent of Faculty

Introduction to continuum mechanics; essential mathematics: notations, tensor and operations, transformation, equation and symbol presentation; Kinematics of motion and small deformation; engineering stress; governing equations; constitutive equations; applications: setting and interpretation of heat conduction, solid mechanics and fluid mechanics.

2103530 Industrial Robots I 3(3-0-9)

Introduction Industrial Robots; robot reference frames; manipulator kinematics; inverse manipulator kinematics; Jacobian; manipulator dynamics; introduction to robot controls; trajectory generation; mechanism design; introduction to hybrid force/position control; summary.

2103532 Computer Aided Design and Computer Aided Manufacturing 3(2-3-7)

Introduction to CAD/CAM; basic concept of CAD/CAM/CAE; product design and strategy; 3D modeling

concept; techniques for geometry modeling; surface design; computer aided manufacturing concept; the design and manufacturing interface; NC programming & verification; link to manufacture; CAD/CAM standard and data exchange; rapid-prototyping concept; total approach to product development.

2103533 Modern Computer Based Manufacturing System **3(2-3-7)**

Production with modern computer-based machines; Structure, components and operations of modern computer based machines; Theory of metal cutting; Selection of cutting tools and conditions of machining operations; Programming of NC code, G code and M code; Software for NC programming and NC code generation; Advanced Research in Modern Computer Based Manufacturing System

2103535 Mechatronics **3(3-0-9)**

Introduction to mechanical system interfacing; combinational digital logic; industrial electronic components; industrial sensors; simple computer structure; low level programming techniques; embedded control computers; microcontroller; stepping motors; DC motors; analog/digital conversion; position and velocity measurement; amplifiers; projects related to mechatronics.

2103540 Failure Analysis and Non-destructive Testing **3(2-3-7)**

Condition: Consent of Faculty

Stress at crack tip and concerning parameters; failure phenomena: crack propagation, creep, corrosion, failure surface; life assessment; case studies; nondestructive testing; practice on NDT techniques.

2103541 Vibration Monitoring and Analysis **3(2-3-7)**

Condition : Consent of Faculty

Predictive maintenance; mechanical vibration; Fourier series and Fast Fourier Transform; measurement and instrumentation; symptoms of vibration signals; diagnosis; setup of alarm band; case studies; and projects.

2103552 An Introduction to Computational Fluid Mechanics **3(3-0-9)**

Dynamics of body moving through a fluid medium; numerical solution of ordinary differential equations. Inviscid fluid flows. Numerical method for solving elliptic partial differential equations. Viscous fluid flows: explicit and implicit methods for solving parabolic partial differential equations. Artificial viscosity. Mathematical behavior of partial differential equations. Boundary condition and Grid transformation.

2103555 Engine Emissions and Control **3(3-0-9)**

Air pollution system, effects of pollutants; engine fundamentals, engine emissions; emission control techniques; instrumentation and techniques for measuring emissions.

2103556 Fundamental of Engine Fuel Control System **3(3-0-9)**

Fuel properties; fuel tank; carburetor; fuel injection system; injector; injection timing and control strategies; injector quality evaluation and testing; throttle body analysis and design; idle air control; fuel rail; fuel pumps and pressure regulator; fuel control systems for alternative fuels.

2103558 Intake Manifold and Induction System Design **3(3-0-9)**

Engine intake manifold design; primary design parameters and tuning, analysis methods; multicylinder wave dynamics; flow losses in induction systems; testing method for performance evaluation; noise in induction system, silencers.

2103560 Gas Turbine Performance **3(3-0-9)**

Condition : Prerequisite 2103342 and 2103351 or Consent of Faculty

Introduction, thermodynamics of gas turbine cycle: efficiency and output of hypothetical cycle of intercooling, reheat and regenerative separately and in combination: the aeroturbo-propeller engine; the turbojet engine, the bypass jet engine, the supersonic turbojet engine; component matching problem.

2103566 Compressible Fluid Dynamics **3(3-0-9)**

Condition : Consent of Faculty

Thermodynamics of motion; physical acoustics; wave equation; speed of sound; quasi-one-dimensional flow with friction and heat addition; shock waves and related discontinuities; one-dimensional unsteady flow; two-dimensional steady flow; method of characteristics; nozzle design; linearized flow; flow visualization using optical techniques.

2103567 Turbulent Shear Flows **3(3-0-9)**

Characteristics of turbulent flows; Reynolds equations; dynamics of turbulence; free turbulent shear flows; jets, wakes, mixing layers, channel and pipe flows; turbulent transport of scalar quantities.

2103570 Micro Fabrication Technology **3(3-0-9)**

Photo-lithography, etching, deposition, thermal oxidation, diffusion, ion implantation, bulk and surface micromachining, metrology, packaging, advanced lithography and the applications of micro and nanofabrication.

2103571 Micro and Nano Electromechanical Systems (MEMS-NEMS) **3(3-0-9)**

Overview of MEMS, review of engineering mechanics and thermo-fluid engineering, electromechanics and light phenomena, micro system design of micromechanical devices, MEMS materials, review of micro fabrication, applications of MEMS, micro sensor, micro actuator, micro fluidic systems, display technologies, future trends.

2103580 Introduction to Intelligent Systems 3(3-0-9)

The mathematical fundamentals of algorithms commonly used in intelligent systems. Topics include data representation and feature extraction, supervised and unsupervised learning problems, artificial neural network, deep learning, K-means algorithm, probabilistic graphical models such as Bayesian network and Markov random field.

2103581 Robot Operating System and Applications 3(3-0-9)

Robot Operating System, ROS commands, ROS Packages and File system, Communication between Nodes, Topics, Services, ROS Simulator and ROS application on real robots.

2103582 Advance Robot Operating System and Applications 3(3-0-9)

Advanced Robot Operating System, ROS commands, ROS Packages and File system, Communication between Nodes, Topics, Services, ROS Simulator and ROS application on real robots

2103583 Mechanic of Biomaterials 3 (3-0-9)

Materials; biocompatibility and materials selection for implant design, metal for medical implants, ceramics and polymers. Mechanics; fracture mechanics, fatigue, and friction and wear. Case study; orthopedics. Mechanical testing of orthopedic implants; joint kinematics, kinetics and joint loads, mechanical testing and modeling for joint implant.

2103601 Advanced Engineering Mathematics 3(3-0-9)

Ordinary differential equations, series solution of differential equations, Laplace transform, vector calculus, boundary values and characteristic-function representations, curvilinear coordinates transformation, partial differential equations, solutions of partial differential equations of mathematical physics.

2103602 Measurement and Instrumentation 3(2-3-7)

Generalized performance characteristic of instruments; static and dynamic characteristics, study of measurement method for temperature, pressure, mass flow, stress-strain and vibration; experimental design and data analysis.

2103603 Mathematics for Control Engineers 3(3-0-9)

System representation; linear system analysis; state-space solutions and realizations; stability; controllability and observability; minimal realization; nonlinear systems analysis; phase plane analysis; Lyapunov theory for autonomous system; introduction to Lyapunov theory for non-autonomous systems; differential geometry; Lie derivative and Lie bracket; the Frobenius theorem; describing function analysis; Fourier series; Fourier integral; discrete-time mathematic; digital signal processing and fast Fourier transform (FFT).

2103604 Advanced Numerical Methods 3(3-0-9)

Condition : Consent of Faculty

Solution of equation; numerical Instabilities and their cure; simultaneous linear algebraic equations; numerical differentiation and integration; least squares approximations; ordinary differential equations; boundary value problems; partial differential equations.

2103610 Introduction to Cyber Physical System 3(3-0-9)

Introduction; Synchronous Model; Synchronous Designs; Safety Requirements; Symbolic Search; Asynchronous Model; Liveness Requirements; Controllers; Timed Automata; Real-Time Scheduling

2103611 Instrumentation and Precision Engineering 3(3-0-9)

Introduction; Background principles; Kinematic design; Alignment; Force loops; Material selection; Introduction to metrology; Uncertainty analysis; Manufacturing; Micro fabrication; Rapid prototyping; Environmental isolation; Control systems for precision motion.

2103612 Elasticity 3(3-0-9)

Two and three dimensional stress and strain analysis, theory of elasticity, Hooke's law for two and three dimensional problems, equilibrium conditions, compatibility conditions; stress function: two and three dimensional problems in Cartesian, polar and curvilinear coordinate systems; introduction to three dimensional elasticity.

2103614 Continuum Mechanics 3(3-0-9)

Condition : Consent of Faculty

Introduction to continuum mechanics; Essential mathematics: notations, tensor and operations, transformation, integral theorems of Gauss and Stokes; Kinematics of deformation and motion; Stress principles; Governing equations; Constitutive equations; Applications (heat conduction, solid mechanics, fluid mechanics); Introduction to computational modelling.

2103615 Mechanical Vibration for Graduated Study 3(3-0-9)

Review of discrete-system vibration, including modeling, formation of mass, stiffness and damping matrices, free and forced vibration of 1-DOF systems, vibration of multi-degree-of-freedom discrete systems; Design for vibration suppression and vibration applications; Vibration of one-dimensional continuous (distributed-parameter) systems; Introduction to non-linear: Qualitative analysis (equilibrium states, phase planes and stability of

states) and Quantitative analysis of free and forced vibration (perturbation techniques and averaging techniques).

2103616 Optimum Design of Complex Mechanical Elements **3(3-0-9)**

Techniques for optimum design with application to simple mechanical elements in problem with practical constraints.

2103617 Applied 3D-Dynamics using Matlab **3(3-0-9)**

Translating and Rotating coordinate systems; Principles of dynamics and equations of motion of dynamical systems ranging from one-dimensional motion of a single particle to three-dimensional motions of rigid bodies and systems of rigid bodies; Applications in engineering problems such as rotor-dynamics, gyroscopic systems, multibody robotic systems, electromechanical systems; Introduction to energy methods: Lagrangian mechanics; Stability; Simulation and analysis of dynamical systems, focusing on the use of Matlab-Simscape Multibodies.

2103620 Theory of Elastic Stability I **3(3-0-9)**

Condition: Prerequisite 2103432 or Consent of Faculty

Stability of mechanical models and elastic beams by classical, kinetic, and energy approaches; snapthrough and bifurcation buckling; buckling of beams on elastic foundation; approximate methods for critical loads, buckling of rings and arches.

2103621 Energy Principles in Solid Mechanics **3(3-0-9)**

Variational calculus; energy principles of structural mechanics; Hamilton's principle and Lagrange's equations; formulation and solution of engineering problems by direct variational methods.

2103622 Analysis of Composite Structures **3(3-0-9)**

Concept and analysis structural response of laminated composite components; bending, vibration and stability of laminated composite structures; interlaminar stresses; effect of shear deformation on structural response; numerical modeling of laminated plates.

2103623 Fatigue of Metals **3(3-0-9)**

Fatigue damage process; analysis and design against fatigue failure through stress-based, strain-based and fracture mechanics-based approaches; problems of high temperature fatigue.

2103625 Advanced Finite Element Method **3(3-0-9)**

Procedures of the finite element method for structural, thermal and fluid differential equations; nonlinear structural static and dynamic problems with discrete and continuum structures; transient nonlinear heat transfer problems with conduction, convection and radiation; steady and unsteady nonlinear incompressible and compressible fluid flow problems.

2103626 Thermal Stress Analysis **3(3-0-9)**

Derivation of different classes for thermal stress differential equations and analytical solutions to thermal stress problems. Numerical methods for solving thermal stress problems with arbitrary continuum bodies and built-up structures.

2103630 Industrial Robots II **3(3-0-9)**

Condition: Prerequisite 2103530 or Consent of Faculty

Arm kinematics, homogenous transformation, Denavit-Hartenberg representation, kinematic equations for manipulators, inverse kinematics solutions, differential relationships of arm kinematics, arm dynamics, Lagrange-Euler equations of motion of robot manipulator arms, Newton-Euler formulation, computer simulation of arm dynamics, control of multiple-joint manipulator arms.

2103631 Control of Dynamic Systems **3(3-0-9)**

Classical control; linear system theory; response of linear, lumped-parameter stationary systems; stability of linear lumped-parameter stationary systems; scalar input-output systems and feedback control; frequency response; introduction to multi-variable control systems; linear digital control.

2103632 Applied Nonlinear Control **3(3-0-9)**

Introduction; phase plane analysis; describing function analysis; feedback linearization; sliding control; adaptive control.

2103633 Applied Optimal Control **3(3-0-9)**

Introduction; parameter optimization problems, optimization problems for dynamic systems, optimization problems for dynamic systems with path constraints, optimal feedback control, linear system with quadratic criteria.

2103634 Dynamic System Modeling and Simulation **3(3-0-9)**

Mechanical background; mathematical modeling and numerical solution of engineering problems; modeling of mechanical systems; model representation and response; modeling of electrical, hydraulic and thermal system; modeling of mixed systems; time response analysis of linear dynamic systems; introduction to optimization and numerical solution; solution techniques for non-linear systems; signal processing.

2103650 Advanced Engineering Thermodynamics **3(3-0-9)**

Review of principles and essential concepts; thermodynamic properties relations of mixtures and solutions, chemical reactions, introduction to phase and chemical equilibrium; thermodynamics of high speed flow.

2103651 Advanced Fluid Mechanics 3(3-0-9)

Review of principles and concepts; Cartesian tensor; transport eq., special model for steady laminar flow; shear flows, boundary layer equations, the concept of similarity; turbulent flow.

2103652 Combustion Theory 3(3-0-9)

Review of combustion processes, review of chemical thermodynamics, stoichiometric combustion analysis, equation of Arrhenius, activation energy, reaction orders, chain reactions, premixed laminar flames, thermal theories, comprehensive theory, Spalding's theory, ignition, minimum ignition energy, quenching distance, application in combustion engineering.

2103653 Fluid Dynamic Aspects of Wind Turbines 3(3-0-9)

Basic fluid dynamics, aerodynamic theory, boundary layers, aerofoils; basic wind turbines; characteristics and mathematical modelling. principles of testing.

2103654 Conduction Heat Transfer 3(3-0-9)

Introduction; definition of concept and statement of general laws; formulation of heat conduction equations; lumped integral and differential formulation of general laws; initial and boundary conditions. solutions for steady and unsteady problems, one; two and three dimensional problems; method of solution, separation of variables, Laplace transform, partial solution, etc.

2103655 Convection Heat Transfer 3(3-0-9)

Governing equations for heat and mass transfer, basic solutions for heat transfer in ducts and over external surfaces; heat and momentum transfer analogy, free convection; boiling and condensation.

2103656 Radiation Heat Transfer 3(3-0-9)

Physics of radiation, radiation properties, radiation shapes factor; radiative exchange between surfaces; radiation through absorbing and transmitting media, radiation properties of gases; solar radiation.

2103658 Advanced Internal Combustion Engine 3(3-0-9)

Standard air engine cycle, theory of combustion, fuel and combustion, reaction kinetics, reaction rates of air and fuel, engine combustion, gas exchange processes, heat transfer, principle of flow and combustion process modelling, engine's performance prediction.

2103659 Utilization of Alternative Fuels 3(3-0-9)

Special requirements for the use of alternative fuels in furnaces, the use of alternative fuels in transport, engine-fuels matching and optimisation, alternative engines, durability, vehicle fuel storage options, engine-vehicle matching.

2103663 Advanced Refrigeration and Air Conditioning 3(3-0-9)

Condition: Prerequisite 2103443, 2103454 or Consent of Faculty

Low temperature refrigeration, refrigeration system study, industrial applications of refrigeration, air conditioning system and building thermal environmental influences on air conditioning design, ventilation, direct contact, transfer processes between moist air and water, flow in ducts and a unconfined spaces, automatic control, testing, adjusting and balancing, economic factors in air conditioning, noise, and vibration control.

2103664 Design of Thermal System 3(3-0-9)

Engineering design, design of a workable system, economics, equation fitting and mathematical modelling, system simulation, optimization, Lagrange multipliers, search methods, dynamic programming, linear programming.

2103665 Advanced Computational Fluid Dynamics 3(3-0-9)

Mathematical and Numerical aspects of heat transfer and Fluid mechanics, finite difference and finite volume methods for solving basic governing equations of fluid flow and heat transfer: continuity, momentum and energy, discretisation methods for two and their dimensional problems, boundary conditions, numerical schemes and solvers, consistency, stability and convergence, advanced numerical techniques for CFD, applications of the method for some engineering problems.

2103666 Finite Element Method for Computational Fluid Dynamics 3(3-0-9)

Finite element method for solving fluid dynamics problems with complex geometries under different boundary conditions; solutions the problem of potential flows, inviscid and viscous flows, incompressible and compressible flows; finite element equations and corresponding computer programs in each case.

2103701 Selected Topics in Mechanical Engineering 3(3-0-9)

Topics are drawn from various fields of current interest in mechanical engineering.

2103721 Fracture Mechanics 3(3-0-9)

Condition: Prerequisite 2103612 or Consent of Faculty

Rheology, model and law of material evolution in time, model of elastic material; model of non-elastic material; linear model of Newton, Maxwell and Voight Kehin; application of Zener's solid; elementary crystal model linear solid generalization; dynamic equation. Fracture mechanics, Griffith criteria; stress intensity, influence of plastic zone at notch root; crack opening displacement.

2103790 Seminar in Mechanical Engineering **1(0-3-1)**

Discussion of special topics in the advent of mechanical engineering; written report is required.

2103813	**Thesis**	**18 credits**
2103816	**Thesis**	**36 credits**
2103821	**Thesis**	**12 credits**
2103828	**Dissertation**	**48 credits**
2103829	**Dissertation**	**60 credits**

2103861	**Flexible Learning I**	**1(0-0-4)**
2103862	**Flexible Learning II**	**2(0-0-8)**
2103863	**Flexible Learning III**	**3(0-0-12)**
2103864	**Flexible Learning IV**	**6(0-0-24)**

Customized learning, i.e. content, mode, time and place, for an individual student; choices of learning delivery, synthesis of knowledge and self managment

2103871	**Research Abraod I**	**1(0-0-4)**
2103872	**Research Abraod II**	**2(0-0-8)**
2103873	**Research Abraod III**	**3(0-0-12)**
2103874	**Research Abraod IV**	**6(0-0-24)**

Collaborative research with partners abroad; searching for and sharing of knowledges for conducting research, self preparation, communication, collaboration and adaptability in multicultural environment

2103881	**Industrial Project I**	**1(0-0-4)**
2103882	**Industrial Project II**	**2(0-0-8)**
2103883	**Industrial Project III**	**3(0-0-12)**
2103884	**Industrial Project IV**	**6(0-0-24)**

Interesting engineering problems in industry; current knowledge that helps solve the problems, searching for and sharing of knowledge that helps solve the problems, communication, collaboration and adaptability

2103894	**Doctoral Dissertation Seminar**	**0(0-0-0)**
2103897	**Qualifying Examination**	**0(0-0-0)**

DEPARTMENT OF INDUSTRIAL ENGINEERING

The courses in Industrial Engineering are designed to produce engineers specializing in problem solving and decision-making functions. To this end production, planning and control, work study, quality assurance and control, systems and procedures analysis of emphasized in general, practical applications of production-oriented operations research techniques, data processing, and computer programming fundamentals are also stressed. As well as the aforementioned techniques, the department is also making an effort in developing studies on human aspects industry as exemplified by the topics of human relationship in industry, ergonomics (Small group activities) and industrial law.

The Department of Industrial Engineering provides the Bachelor of Engineering degree, the Master of Engineering degree, and the Doctor of Philosophy (Ph.D.).

HEAD:

Angsumalin	Senjuntichai,	D.Eng (AIT)

PROFESSORS:

Parames	Chutima,	Ph.D. (Nottingham)
Somkiat	Tangjitsitcharoen,	D.Eng. (Kobe)

ASSOCIATE PROFESSORS:

Angsumalin	Senjuntichai,	D.Eng. (AIT)
Arisara	Jiamsanguanwong,	D.Eng. (Tokyo Tech)
Haruetai	Lohasiriwat,	M.S. (Virginia Tech)
Jittra	Rukijkanpanich,	D.Eng. (AIT)
Jirapat	Ngaoprasertwong,	M.Sc. (Iowa)
Naragain	Phumchusri,	Ph.D. (Georgia Tech)
Natcha	Thawesaengskulthai,	Ph.D. (Nottingham)
Natt	Leelawat,	D.Eng. (Tokyo Tech)
Paveena	Chaovalitwongse,	Ph.D. (Florida)
Pisit	Jarumaneeroj,	Ph.D. (Georgia Tech)
Wipawee	Tharmmaphornphilas,	Ph.D. (Pittsburgh)
Oran	Kittithreerapronchai,	Ph.D. (Georgia Tech)
Daricha	Sutivong,	Ph.D. (Stanford)
Pramual	Suteecharuwat,	Ph.D. (TITECH)

ASSISTANT PROFESSORS:

Manida	Swangnetr Neubert,	Ph.D. (North Caroline State)
Napassavong	Osotssilp,	Ph.D. (Wisconsin)
Phairoat	Ladavichitkul,	Ph.D. (Texas Tech)
Poom	Luangjarmekorn,	M.Eng. (Nagoya)
Prasert	Akkharaprathomphong,	M.Eng. (Keio)
Amonsiri	Vilasdaechanont,	Ph.D. (Wisconsin)
Nantachai	Kantanantha,	Ph.D. (Georgia Tech)

LECTURERS:

Worachok	Chaiwong,	M.Eng. (Chula)
Puwadol	Dusadeerungsikul,	Ph.D. (Purdue)

INDUSTRIAL ENGINEERING UNDERGRAD PROGRAMS

The department provides two undergraduate tracks of study: a general track and a co-operative education track. Similar to other Chulalongkorn University's engineering curriculums, the general track requires 2 credits of engineering practice during the third year's summer semester. The co-operative education track offers one more semester (seventh semester) for students to practice their skills in real workplaces.

INDUSTRIAL ENGINEERING CURRICULUM OF BACHELOR'S DEGREE
FIRST YEAR CURRICULUM

GENERAL STUDY PROGRAM

COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER	
2103213	ENGINEERING MECHANICS I	3
2104201	ENGINEERING STATISTICS I	3
2104206	AUTOMATION	3
2104207	INDUSTRIAL ENGINEERING LAB I	1
2104208	WORK DESIGN	2
5500208	COMMUNICATION AND PRESENTATION SKILLS	3
xxxxxxx	FREE ELECTIVES	3
		18
	FOURTH SEMESTER	
2103261	FUNDAMENTALS OF THERMO-FLUID ENGINEERING	3
2104202	ENGINEERING STATISTICS II	3
2104205	MANUFACTURING ENGINEERING	3
2104258	MANUFACTURING PROCESSES LABORATORY	1
2104209	COMPUTER AND INFORMATION TECHNOLOGY FOR IE	3
2104210	ENGINEERING ECONOMY	3
2104259	OPERATIONS RESEARCH	3
		19
	FIFTH SEMESTER	
2102391	ELECTRICAL ENGINEERING I	3
2102392	ELECTRICAL ENGINEERING LABORATORY I	1
2104302	OPERATIONS MANAGEMENT	3
2104303	SIMULATION PROGRAMMING	3
2104306	BUSINESS ANALYTICS FOR IE	3
2104354	INDUSTRIAL COST ANALYSIS AND BUDGETING	3
xxxxxxx	FREE ELECTIVES	3
		19

COURSE NO.	SUBJECT	CREDITS
	SIXTH SEMESTER	
2103393	ME LAB FOR NON ME	1
2104301	QUALITY ENGINEERING AND MANAGEMENT	3
2104304	FACILITY DESIGN	2
2104305	INTRO MACHINE LEARNING FOR IE	3
2104307	INDUSTRIAL ENGINEERING LAB II	1
2104358	SAFETY ENGINEERING	3
5500308	TECHNICAL WRITING FOR ENGINEERING	3
xxxxxxx	GENERAL EDUCATION	3
		19
	SUMMER SEMESTER	
2100301	ENGINEERING PRACTICE (S/U)	2
		2
	SEVENTH SEMESTER	
2104491	INDUSTRIAL ENGINEERING PRE-PROJECT	1
xxxxxxx	APPROVED ELECTIVES	6
xxxxxxx	GENERAL EDUCATION	9
		16
	EIGHTH SEMESTER	
2104409	INDUSTRIAL BUSINESS MANAGEMENT	3
2104499	INDUSTRIAL ENGINEERING PROJECT	3
OR		
2100499	SENIOR PROJECT	
xxxxxxx	APPROVED ELECTIVES	3
		9

TOTAL CREDITS FOR GRADUATION = 138

INDUSTRIAL ENGINEERING CURRICULUM OF BACHELOR'S DEGREE
FIRST YEAR CURRICULUM

CO-OPERATIVE EDICATION PROGRAM

COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER	
2103213	ENGINEERING MECHANICS I	3
2104201	ENGINEERING STATISTICS I	3
2104206	AUTOMATION	3
2104207	INDUSTRIAL ENGINEERING LAB I	1
2104208	WORK DESIGN	2
5500208	COMMUNICATION AND PRESENTATION SKILLS	3
xxxxxxx	FREE ELECTIVES	3
		18
	FOURTH SEMESTER	
2103261	FUNDAMENTALS OF THERMO-FLUID ENGINEERING	3
2104202	ENGINEERING STATISTICS II	3
2104205	MANUFACTURING ENGINEERING	3
2104258	MANUFACTURING PROCESSES LABORATORY	1
2104209	COMPUTER AND INFORMATION TECHNOLOGY FOR IE	3
2104210	ENGINEERING ECONOMY	3
2104259	OPERATIONS RESEARCH	3
		19
	FIFTH SEMESTER	
2102391	ELECTRICAL ENGINEERING I	3
2102392	ELECTRICAL ENGINEERING LABORATORY I	1
2104302	OPERATIONS MANAGEMENT	3
2104303	SIMULATION PROGRAMMING	3
2104306	BUSINESS ANALYTICS FOR IE	3
2104354	INDUSTRIAL COST ANALYSIS AND BUDGETING	3
xxxxxxx	FREE ELECTIVES	3
		19

COURSE NO.	SUBJECT	CREDITS
	SIXTH SEMESTER	
2103393	ME LAB FOR NON ME	1
2104301	QUALITY ENGINEERING AND MANAGEMENT	3
2104304	FACILITY DESIGN	2
2104305	INTRO MACHINE LEARNING FOR IE	3
2104307	INDUSTRIAL ENGINEERING LAB II	1
2104358	SAFETY ENGINEERING	3
5500308	TECHNICAL WRITING FOR ENGINEERING	3
xxxxxxx	GENERAL EDUCATION	3
		19
	SUMMER SEMESTER	
2100301	ENGINEERING PRACTICE (S/U)	2
		2
	SEVENTH SEMESTER	
2104401	CO-OPERATIVE EDUCATION (S/U)	6
2104491	INDUSTRIAL ENGINEERING PRE-PROJECT	1
2104499	INDUSTRIAL ENGINEERING PROJECT	3
OR		
2100499	SENIOR PROJECT	
		10
	EIGHTH SEMESTER	
2104409	INDUSTRIAL BUSINESS MANAGEMENT	3
Xxxxxxx	APPROVED ELECTIVES	3
Xxxxxxx	GENERAL EDUCATION	9
		15

TOTAL CREDITS FOR GRADUATION = 138

NAME OF THE DEGREE

: Master of Engineering
: M. Eng.

The department offers two plans of study: plan A1 and plan A2. Plan A1 is non-coursework plan (36 credits for thesis only). Plan A2 requires 24 coursework credits (6 required course credits and 18 approved elective credits) and 12 thesis credits.

Plan A1
COURSE REQUIREMENTS

1) Required Courses		***36 credits***
2104816	Thesis	36(0-144-0)

Plan A2
COURSE REQUIREMENTS

1) Required Courses		***18 credits***
2104696	System Improvement	3(3-0-9)
2104697	System Modeling and Analysis	3(3-0-9)
2104811	Thesis	12(0-48-0)
2) Approved Elective		***18 credits***
2104501	Engineering Economic Profitability Analysis	3(3-0-9)
2104505	Machinery and Instrument Appraisal	3(3-0-9)
2104506	Engineering Project Management	3(3-0-9)
2104507	Logistics and Supply Chain Management	3(3-0-9)
2104509	Warehouse and Warehousing Management	3(3-0-9)
2104511	Introduction to Virtual Environments	3(3-0-9)
2104512	Production and Operations Management Information Systems	3(3-0-9)
2104513	Industrial Engineering Integration	3(3-0-9)
2104515	Responsible Care	3(3-0-9)
2104516	Quality Improvement	3(3-0-9)
2104518	Quality System	3(3-0-9)
2104520	Visual Factory	3(3-0-9)
2104521	Computer Programming for Industrial Engineering	3(3-0-9)
2104523	Introduction to Stochastic Models	3(3-0-9)
2104524	Operations & Service Management	3(3-0-9)
2104525	Work Process Design and Improvement	3(3-0-9)
2104528	Applied Work Analysis	3(2-2-8)
2104529	Computational Methods for Industrial Engineering	3(3-0-9)
2104548	Strategic Planning for Engineers	3(3-0-9)
2104555	System Safety	3(3-0-9)
2104559	Risk Management for Industry	3(3-0-9)
2104581	Logistics Engineering I	3(3-0-9)
2104582	Logistics Engineering II	3(3-0-9)
2104583	Introduction to Financial Engineering	3(3-0-9)
2104585	Industrial Forecasting	3(3-0-9)
2104588	Disaster Management and Technology	3(3-0-9)
2104590	Introduction to Quantitative Data Analysis	3(3-0-9)
2104602	Analysis of Business System	3(3-0-9)
2104604	Advanced Quality Management	3(3-0-9)
2104606	Advanced Industrial Organization and Management	3(3-0-9)
2104609	Reliability Theory in Engineering	3(3-0-9)
2104611	Inventory Analysis	3(3-0-9)
2104612	Computer Simulation Techniques	3(3-0-9)
2104613	Principle of Optimization	3(3-0-9)
2104615	Engineering Experimental Design	3(3-0-9)
2104616	Activity Scheduling	3(3-0-9)
2104617	Industrial Scheduling	3(3-0-9
2104618	Machine Learning for Industrial Engineering	3(3-0-9)
2104619	Supply Chain Analytics	3(3-0-9)
2104624	Factory and Production Management	3(3-0-9)
2104625	Computerized Statistical Data Analysis	3(3-0-9)
2104626	Materials and Processing	3(3-0-9)
2104627	Product and Production Design	3(3-0-9)
2104640	Decision Analysis in Engineering	3(3-0-9)
2104642	Decision Support Systems	3(3-0-9)
2104644	Advanced Maintenance Management	3(3-0-9)
2104645	Applied Biomechanics	3(2-3-7)
2104646	Work Physiology	3(2-3-7)
2104647	Hazardous Material and Fire Protection Engineering	3(3-0-9)
2104648	Strategic Planning for Engineers	3(3-0-9)
2104649	Cognitive Ergonomics	3(3-0-9)
2104650	Project Management Concepts	3(3-0-9)
2104671	Advanced Work Design	3(2-3-7)
2104677	Seminar in Safety Engineering	3(2-3-7)
2104684	Technology and Innovation Management	3(3-0-9)
2104688	Research Methodology in Industrial Engineering and Operations Management	3(3-0-9)
2104690	Quantitative Data Analysis for Industrial Engineering	3(3-0-9)
2104691	Research Problems in Industrial Engineering I (OR techniques)	3(3-0-9)
2104692	Research Problems in Industrial II	3(3-0-9)
2104711	Advanced Manufacturing Engineering	3(3-0-9)
2104713	Advanced Optimization Techniques	3(3-0-9)

2104741	Comparative Engineering Management	3(3-0-9)
2104811	Thesis	12(0-48-0)
2104816	Thesis	36(0-144-0)

Remark: **The student can select other courses offered by the Industrial Engineering, which will be announced by Industrial Engineering Department**.

INDUSTRIAL ENGINEERING CURRICULUM OF MASTER'S DEGREE

Plan A1

COURSE NO.	**SUBJECT**	**CREDITS**	**COURSE NO.**	**SUBJECT**	**CREDITS**
	FIRST SEMESTER			**THIRD SEMESTER**	
2104816	THESIS	9	2104816	THESIS	9
		9			***9***
	SECOND SEMESTER			**FOURTH SEMESTER**	
2104816	THESIS	9	2104816	THESIS	9
		9			***9***

TOTAL CREDITS FOR GRADUATION = 36

Plan A2

COURSE NO.	**SUBJECT**	**CREDITS**	**COURSE NO.**	**SUBJECT**	**CREDITS**
	FIRST SEMESTER			**THIRD SEMESTER**	
2104696	SYSTEM IMPROVEMENT	3	xxxxxxx	APPROVED ELECTIVES	6
2104697	SYSTEM MODELING AND ANALYSIS	3	2104811	THESIS	3
					9
xxxxxxx	APPROVED ELECTIVES	3			
		9			
	SECOND SEMESTER			**FOURTH SEMESTER**	
xxxxxxx	APPROVED ELECTIVES	6	xxxxxxx	APPROVED ELECTIVED	3
2104811	THESIS	3	2104811	THESIS	6
		9			***9***

TOTAL CREDITS FOR GRADUATION = 36

NAME OF THE DEGREE

: Doctor of Philosophy
: Ph.D..

The doctoral degree requires 12 credits of course works (9 required course credits and 3 approved elective credits) and 36 dissertation credits. Doctoral seminar and qualifying exam are also required, but the credits will not be assessed toward the degree.

INDUSTRIAL ENGINEERING CURRICULUM OF DOCTORAL DEGREE

COURSE NO.	SUBJECT	CREDITS
	FIRST SEMESTER	
2104xxx	REQUIRED COURSE	6
2104894	DOCTORAL SEMINAR IN INDUSTRIAL ENGINEERING	(0)*
2104826	DISSERTATION	3
		9
	SECOND SEMESTER	
2104xxx	REQUIRED COURSE	3
2104xxx	APPROVED ELECTIVE	3
2104894	DOCTORAL SEMINAR IN INDUSTRIAL ENGINEERING	(0)*
2104826	DISSERTATION	3
		9
	THIRD SEMESTER	
2104897	QUALIFYING EXAMINATION	(0)*
2104894	DOCTORAL SEMINAR IN INDUSTRIAL ENGINEERING	(0)*
2104826	DISSERTATION	9
		9

COURSE NO.	SUBJECT	CREDITS
	FORTH SEMESTER	
2104894	DOCTORAL SEMINAR IN INDUSTRIAL ENGINEERING	(0)*
2104826	DISSERTATION	9
		9
	FIFTH SEMESTER	
2104894	DOCTORAL SEMINAR IN INDUSTRIAL ENGINEERING	(0)*
2104826	DISSERTATION	6
		6
	SIXTH SEMESTER	
2104894	DOCTORAL SEMINAR IN INDUSTRIAL ENGINEERING	(0)*
2104826	DISSERTATION	6
		6

TOTAL CREDITS FOR GRADUATION = 48

Remarks: * **Credits for this course are not assessed towards the degree program**.

COURSE DESCRIPTIONS IN INDUSTRIAL ENGINEERING
(B.ENG.)

2104201 Engineering Statistics I 3(3-0-6)

The scopes and uses of statistics in engineering; concepts of variables and data; distribution functions; sampling distribution; estimation; hypothesis testing for one and two populations; goodness-of-fit test.

2104202 Engineering Statistics II 3(3-0-6)

Analysis of Variance, Design and Analysis of Single Factor Experiments, Design of Experiments with Several Factors, Simple and Multiple Linear Regression, Response Surface Designs and Methods.

2104205 Manufacturing Engineering 3(3-0-6)

Introduction to Manufacturing Processes towards Intelligent Manufacturing System, Machine tool and Intelligent Machine, Conventional Manu Processes, Non-Conventional Manufacturing Processes, DFA & DFD, Role of sensor in assembly process, Automation in Manufacturing, Inspection and Measurement, CAD, CAE, CAM, Reverse Engineering, Rapid Prototyping, CNC Technology, Virtual Manufacturing, Condition based Maintenance.

2104206 Automation 3(2-3-4)

Basic concepts of automation systems in manufacturing industry; equipment in automation systems pneumatics, hydraulics, sensor, logical control; industrial robot technology; control theory.

2104207 Industrial Engineering Lab I 1(0-3-0)

Laboratory work related to design, assign, control, and evaluation of work considering productivity and quality aspects.

2104208 Work Design 2(2-0-4)

Principles of work study and design, method study and work measurement, operation analysis and problem-solving using exploratory tools, work and method improvement, motion study and principles of motion economy, intro to ergonomics, workstation and material work design, human-work system interaction, time study, performance rating, allowances, learning curve, work sampling, predetermined time systems, work standards follow-up and uses.

2104209 Computer and Information Technology for IE 3(2-3-4)

Computer system & Information Technology; Network Architectures; Database System; System Study & Design; Data Flow; System Usability Evaluation.

2104210 Engineering Economy 3(3-0-6)

Interest formulation; time value of money; equivalent value and rate of return; project analysis and evaluation; breakeven point; sensitivity analysis; risk and uncertainty analysis; asset replacement decision; depreciation and tax.

2104258 Manufacturing Processes Lab 1(0-3-0)

Condition: Prerequisite **2104205** *or Inclusive Compulsory or Consent of Faculty*

Practice in manufacturing processes: machining and hand tools, heat treatment, welding and casting.

2104259 Operations Research 3(3-0-6)

Deterministic operations research in industrial engineering problem solving with emphasis on the use of mathematical models; linear programming; transportation model; and game theory.

2104301 Quality Engineering and Management 3(3-0-6)

Condition: Prerequisite **2104202**

Quality concepts; cost of quality; quality management; quality planning; quality design and innovation; quality control; quality improvement; quality systems; quality assurance; risk management.

2104302 Operations Management 3(3-0-6)

Condition: Prerequisite **2104201** *or* **2104202** *or Consent of Faculty*

Operations Management, Demand Forecasting, Aggregate Production Planning, Master Production Schedule, Material Requirement Planning, Inventory Management, Capacity Planning, Operations Control, Operations Scheduling, Project Management.

2104303 Simulation Programming 3(3-0-6)

Probabilistic operations research in industrial engineering problem solving, emphasis is made on the use of simulation; queuing theory; and inventory model.

2104304 Facility Design 2(2-0-4)

Condition: Prerequisite **2104208** *or Consent of Faculty*

Introduction to facility design; importance and process of facility design; preliminary analysis of facility design: layout and related factors: products, processes, material handling, machine, man, selection of facility location.

2104305 Introduction to Machine Learning for Industrial Engineering 3(3-0-6)

Condition: Prerequisite **2110101** *or Consent of Faculty*

Artificial intelligence; machine learning principles; supervised learning techniques; unsupervised learning techniques; linear regression; logistics regression; neural networks; support vector machine; clustering; dimensionality reduction; model selection; error analysis.

2104306 Business Analytics for Industrial Engineer 3(3-0-6)

Condition: Prerequisite **2104202** *or Consent of Faculty*

To develop business operation and effective business model by the implementation of engineering background, quantitative analysis, statistical analysis, predictive analysis, descriptive analysis, data mining, data warehouse, and big data to construct a strategy that the most optimum for a specific business.

2104307 Industrial Engineering Lab II 1(0-3-0)

Laboratory work related to design, assign, control, and evaluation of work considering productivity quality safety and cost aspects.

2104354 Industrial Cost Analysis and Budgeting 3(3-0-6)

Condition: Prerequisite **2104210** *or Consent of Faculty*

Fundamentals of financial reports; cost analysis for planning process; capital expenditure; cost control and opportunity loss management; capital rationing; profitability analysis and decision making for investment in challenging projects under uncertainty and risk.

2104358 Introduction to Safety Engineering 3(3-0-6)

Safety principles and safety standards; basic human anatomy; study of the following hazards: noise, chemicals, electricity, fire, radiation, machine tools and pressure vessels, work in hot environment; hazard prevention method; accident investigation techniques; safety law; principle of safety management; introduction to industrial psychology; laboratory and field trips.

2104401 Co-operative Education 6(0-36-0)

Full-time job training in a real-life industrial environment; working as an organization's employee in the discipline associated with each student's curriculum and career goals.

2104409 Industrial Business Management 3(3-0-6)

Basic knowledge about Organization - Business - Industry - Supply Chain; changed directions of the world and industry and adaptation; strategic Management; innovation management; operations management; ,management and utilization of data / information / knowledge / information technology; project development and project management; leadership; change management; human resource management; good governance and risk management; virtue; ethics; code of conduct; social responsibility; business management according to the philosophy of Sufficiency Economy.

2104414 CNC Turning Technology 3(3-0-6)

Introduction to CNC Turning, CNC Lathe Cutting Fundamentals, CNC Lathe Control and Operation, CNC Lathe Technical Data, CNC Lathe Rapid and Feed Moves, CNC Lathe Circular interpolation, Tool Nose Radius Compensation and Command of CNC lathe by CNC Lathe Fixed Cycles G70-G94 and others.

2104415 CNC Machining Technology 3(3-0-6)

Introduction to CNC turning centres, CNC turning fundamentals, CNC turning centre cutting fundamentals, CNC turning centre control and operation, CNC turning centre technical data, CNC turning centre rapid and feed moves, CNC turning centre circular interpolation, CNC cutter diameter compensation, CNC canned cycles and CNC canned cycles G84, G86, and G76.

2104424 Applied Ergonomics 3(2-3-4)

Science of motion; biomechanics; 2-D analysis; problems of neck, shoulder, wrist, elbow, lower back, using a goniometer and EMG; psychophysics principles; fatigue and motivation; factory survey; work design; doing term projects, and presentation.

2104425 Maintenance Engineering 3(3-0-6)

Maintenance concepts; terotechnology; preventive maintenance; corrective maintenance; maintenance organization planning and control of maintenance activities; materials and spare part management; reliability and failure statistics; application of waiting line theory to maintenance problem, critical part scheduling, measurement and evaluation maintenance performance; depreciation causes; machine and equipment inspection.

2104429 Applications of OR 3(3-0-6)

Condition: Prerequisite **2104303** *and* **2104259** *or Consent of Faculty*

Applications of Operations Research techniques: Linear Programming, Integer Programming, Stochastic Programming, and Simulation to solve real-world problems of industrial organizations.

2104432 Introduction to Cognitive Ergonomics 3(3-0-6)

Specialty the inter-discipline of design and system development that are involved with humans to make the systems more effective and more robust, focusing on amplifying human capability in performing cognitive work by integrating technical functions with human cognitive processes to create efficient and reliable systems.

2104456 Ergonomics 3(2-3-4)

Introduction to Ergonomics; human body as a working system (i.e. bones, joints, muscles, metabolism); anthropometry; work demand evaluation and factory inspection using biomechanics and physiology method; displays and controls; introduction to human information processing.

2104459 Value Engineering 3(3-0-6)

Introduction to value engineering methodology; application for value engineering technique to product

design; procurement and manufacturing in order to reduce cost without loss of quality.

2104463 Project Feasibility Study 3(3-0-6)
Condition: Prerequisite **2104210** *or Consent of Faculty*
Study key factors crucial to decision making in industrial investment.

2104491 Industrial Engineering Pre-Project 1(0-2-1)
Problem framework; guidelines for problem solving and solutions to the problems in an industrial engineering project.

2104493 Special Problems in IE III 3(2-3-4)
Study or investigation of special problems assigned by the instructor with the consent of the head of the department.

2104494 Advanced Topics in IE III 3(3-0-6)
Study of current interesting topics and new developments in industrial engineering.

2104495 Advanced Topics in IE I 3(3-0-6)
Condition: Senior Students or Consent of Faculty
Study of current interesting, topics and new development in Industrial Engineering.

2104496 Advanced Topics in IE II 3(3-0-6)
Condition: Senior Students or Consent of Faculty
Study of current interesting topics and new development in Industrial Engineering.

2104499 Industrial Engineering Project 3(0-9-0)
Condition: Senior Students or Consent of Faculty
Practical interesting project or problems in various fields of Industrial Engineering assigned by the instructor.

COURSE DESCRIPTIONS IN INDUSTRIAL ENGINEERING
(M.ENG., PH.D.)

2104501 Engineering Economic Profitability Analysis 3(3-0-9)

Theoretical foundations and advanced topics in engineering economic and profitability analysis; investment project evaluation in industrial and engineering works under conditions of uncertainty and risk; analysis of capital budgeting decision.

2104505 Machinery and Instrument Appraisal 3(3-0-9)

Importance of appraisal for machines; equipment and instruments; life cycle of machinery; conditions and efficiency of machinery; factor effects to appraisal; step of appraisal; engineering economy; reporting case studies.

2104506 Engineering Project Management 3(3-0-9)

Project management models; project initiation; project planning, organization, scheduling and control; resource and cost management; risk management; project termination; project management information system; case study.

2104507 Logistics and Supply Chain Management 3(3-0-9)

Definition of logistics and supply chain management; distribution network design; distribution strategies production-inventory models; transportation design; coordination and information technology; international issues.

2104509 Warehouse and Warehousing Management 3(3-0-9)

Condition: Prerequisite 2104252 and 2104524 or Consent of Faculty

The role of the warehouse; warehousing decisions; warehousing operations; materials handling and packaging.

2104511 Introduction to Virtual Environments 3(3-0-9)

Theory, development, and applications of virtual reality (VR) technology for the generation of the virtual environments (VE); human-computer interaction based on the 5 basic senses of human perception; use of 3D software and some scripting language to generate models in the CAVE system; application of VR technology in product and production design and others.

2104512 Production and Operations Management Information Systems 3(3-0-9)

Information strategy, business information systems, ERP, system analysis and design, database for production and operations management, information systems for production and operations management and control; systems implementation; systems operation and support, case studies.

2104513 IE Integration 3(3-0-9)

Condition: Prerequisite 2104252 or 2104524 or Consent of Faculty

Work in the manufacturing systems, servicing system and business system; Components of the management and control systems, core processes and supporting systems; design of organization structure, products, facilities, transformation process, supporting system and detail operation; operation and monitoring, evaluation, reviews and improvement.

2104515 Responsible Care 3(3-0-9)

Importance of Responsible Care (RC), A history of RC principles, laws, rules and standards, cooperation among organizations: producers, distributors, users, transporters, disposers, RC organizational structure, necessary internal activities for RC, emergency response, data managing and reporting concerning environment, health and safety.

2104516 Quality Improvement 3(3-0-9)

Condition: Prerequisite 2104254 or 2104690 or Consent of Faculty

Quality improvement based on Six Sigma approach; improvement project selection; steps for quality improvement; tools for quality improvement; appraisal of return on quality investment in quality improvement project.

2104518 Quality System 3(3-0-9)

Concept of quality system; several types of quality system, design and application of quality system in manufacturing or service industry; evaluation; analysis and improvement of quality system.

2104520 Visual Factory 3(3-0-9)

Meaning and principles of visual factory; need for communication in a factory; traditional methods for communication in a factory; key elements of a visual factory: workplace organization and standardization; visual displays; visual controls; good visual communication; visual production control; visual quality control; process indications; and implementing visual communication.

2104521 Computer Programming for IE 3(3-0-9)

Practical Computer programming including database implementation, graphic user interface (GUI), network programming.

2104523 Introduction to Stochastic Models **3(3-0-9)**

Condition: Prerequisite 2104253 or 2104690 or Consent of Faculty

Unconditional and conditional probability; discrete models; evaluation of complexity of problems; partitioning problems; use of statistics in decision making; systematic approach for problem solving.

2104524 Production and Service Management **3(3-0-9)**

Work study; production time improvement; flow process chart; Therblig symbol; work measurement; time study; skill and effort rating; standard time; man machine Chart; motion and time study; Gang process chart; human factor integration and cognitive science; reengineering.

2104525 Work Process Design and Improvement **3(3-0-9)**

Condition: Consent of Faculty

Design Layout and Routing, Material Handling Method Study; Analysis & Improvement Standard Method Work & Motion, Motion Economy Work Measurement; Standard Time in Work Element Level and Motion Level Safety and Environment of Work Human Factor; Manual Work, Cognitive Work, Hand Tools Design, Workstation Design, Psychophysics, Job Analysis and Job Evaluation, Incentive and Work Payment, Shift Management and Cost; Unit Cost & ABC Analysis.

2104528 Applied Work Analysis **3(2-2-8)**

Workshop for practice work-analysis skills in various processes mainly using labors via video media, staring from flow process chart creating, task separating and data is collecting in difficult types to fit the objective of analysis in the view of work safety, efficiency and performance to concluding the advantages and disadvantages or limitations of occurrences.

2104529 Computational Methods for IE **3(3-0-9)**

Problem solving using computational methods for Industrial Engineering; data mining and visualizing; algorithms for inventory models, production planning, production analysis, and optimization.

2104548 Strategic Planning for Engineers **3(3-0-9)**

Strategic planning process; analytical techniques used in formulating plans; concepts of manufacturing strategy.

2104555 System Safety **3(3-0-9)**

Human Error; System Safety Design Requirements; Hazard Identification; Analysis and Resolution; Hazard Resolution Matrix; Preliminary Hazard Analysis (PHA); Failure Modes and Effects Analysis (FMEA); Event Trees; Fault Trees; Fault Classification; Fault-Tree Construction; Direct Evaluation of Fault Tree; Fault Trees Evaluation by Cut Sets.

2104559 Risk Management for Industry **3(3-0-9)**

Introduction to Risk Management; types and classification of Risk from both internal factor and external factor with cover production industry and service industry; tools and techniques for Systems/Process Analysis and Internal Control System Setting in order to reduce and prevent failure of the designed System supported by ICT as a monitoring tool.

2104581 Logistics Engineering I **3(3-0-9)**

Condition: PRER 2104259

Investigation on the fundamental logistics systems, transportation planning, design of transportation systems, design of mathematical programming models and heuristics for solving the underlying transportation problems

2104582 Logistics Engineering II **3(3-0-9)**

Condition: PRER 2104259 and 2104581

Mathematical programming models for advanced logistics problems in industries, metaheuristics and advanced heuristics for complex logistics systems, decision support systems for industrial logistics.

2104583 Introduction to Financial Engineering **3(3-0-9)**

This course aims to explore the methodology of financial modelling, including their objectives and varieties of model development. Application of financial models include asset valuation portfolio management and risk management by implementation of financial innovation and tools to the financial concepts and process development. The financial tools will cover the investment in capital markets with scenario analysis, model evaluation, model analysis, model validation, and simulation of outcome by computer package. More particularly, a critical analysis of gaining investment, raising capital, and risk minimization will be assessed.

2104585 Industrial Forecasting **3(3-0-9)**

Exploratory data analysis and model construction for industrial forecasting; moving average; exponential smoothing; application of methos of least-square; regression analysis; components of time series; time series analysis; judgmental forecasting.

2104588 Disaster Management and Technology **3(3-0-9)**

Fundamental process of each type of disaster through the use of knowledge in engineering, management, and technologies; type of basic theories, principles, policies, and practiced related to disaster management including preparedness, response, recovery, and mitigation phases; case studies of the community and organizational levels in Thailand and overseas.

2104590 Introduction to Quantitative Data Analysis **3(3-0-9)**

Probability theory and statistical inference used in engineering applications; random variables and distributions, probability models, parameter estimation and sampling distribution, confidence intervals, hypothesis testing, simple and multiple linear regression models, analysis of variance for design of experiments.

2104602 Analysis of Business System **3(3-0-9)**

Condition: Consent of Faculty

Business enterprises; business area; business components; product/services; business plan; concepts of business system strategies: marketing, production, and financial strategies; strategic management; performance measurement by Key Performance Indicator (KPI) and the Balanced Scorecard approach; improvement tools; improvement methods and process; quality systems and quality award.

2104604 Advanced Quality Management **3(3-0-9)**

Theory, principles, concepts of quality system development including Quality Control, Quality Inspection, Quality Assurance, Quality Improvement, Quality Management, Quality Enhancement and Innovation; analysis and design of quality problem solving approach.

2104606 Advanced Industrial Organization and Management **3(3-0-9)**

Management science; information systems for executive; strategic management; job and organization design; managerial decision making process; leadership in organization and organization communication; financial analysis; case analysis; production control.

2104608 User Experience and System Usability **3(3-0-9)**

Concept of user experience; customer journey map, service blueprint; human-computer interaction (HCI); iterative design process; qualitative and quantitative usability evaluation; return on investment; fundamental user interface design principles.

2104609 Reliability Theory in Engineering **3(3-0-9)**

Condition: Prerequisite 2104690 or Consent of Faculty

Reliability analysis with emphasis on the exponential, weibull, gamma, lognormal and extreme value distributions; reliability of systems; redundancy; maintainability and availability.

2104611 Inventory Analysis **3(3-0-9)**

Condition: Prerequisite 2104690 or Consent of Faculty

Key elements of determining inventory replenishment policy; development of mathematics models for deterministic and stochastic inventory systems; derivation of optimal decision rules for the timing and size of replenishment orders; simulation models for designing the appropriate inventory replenishment policy.

2104612 Computer Simulation Techniques **3(3-0-9)**

Condition: Prerequisite 2104690 or Consent of Faculty

Application of simulation techniques to optimization of large scale operations; construction of simulation models; validation of simulation models; limitations of simulation techniques; programming with simulation languages.

2104613 Principle of Optimization **3(3-0-9)**

Linear programming; the simplex method: big M and two-phase method; sensitivity and duality; integer linear programming and branch and bound method; goal programming; nonlinear programming: convex and concave functions, one variable, unconstrained with several variables, steepest ascent, Lagrange multipliers, Khun -Tucker conditions; intro to heuristic search.

2104615 Engineering Experimental Design **3(3-0-9)**

Applications of experimental design to engineering Problems. Emphasis on the methods of experimental set up, data collection, and data analysis.

2104616 Activity Scheduling **3(3-0-9)**

Principle of activity scheduling selection and application of appropriate models to deal with scheduling problems.

2104617 Industrial Scheduling **3(3-0-9)**

Condition: Prerequisite 2104616 or Consent of Faculty

Concepts of industrial scheduling; single machine scheduling with both types of performance measures: tardiness based and utilization based measures; flow shop scheduling; parallel machine scheduling and batch sequencing; network based scheduling; job shop scheduling and open shop scheduling.

2104618 Machine Learning for Industrial Engineering **3(3-0-9)**

Machine learning concepts, supervised learning techniques, unsupervised learning techniques, python basics, linear regression, logistics regression, neural networks, support vector machine, clustering, dimensionality reduction, model selection, error analysis.

2104619 Supply Chain Analytics **3(3-0-9)**

Definition of supply chain analytics; inventory analysis and risk pooling in supply chain; demand forecasting methods; warehouse analysis; supply contracts; suppliers selection; big data in supply chain; the value of

Information in supply chain analytics; distribution strategies; supply chain integration.

2104624 Factory and Production Management **3(3-0-9)**

Emphasis on small industrial management; project management; plant site, layout and tool selection; types of production processes and their control; use of budgets for decision making and integrating the roles of various units.

2104625 Computerized Statistical Data Analysis **3(3-0-9)**

Condition: Prerequisite 2104690 or Consent of Faculty

Use of computer for research design, data collection planning, data preparation, data analysis.

2104626 Materials and Processing **3(3-0-9)**

Types and characteristics of materials; manufacturing processes; mechanical, physical, and chemical analyses of materials.

2104627 Product and Production Design **3(3-0-9)**

Condition: Prerequisite 2104626 or Consent of Faculty

The design of product for optimal production cost under specified tolerance; analysis of factors of production and processes.

2104640 Decision Analysis in Engineering **3(3-0-9)**

Analysis of decisions in engineering and industry under uncertainty; decision tree analysis, expected monetary value and expected utility; expected value of perfect information and sampling information; basis for expected utility theory; rating and ranking of alternatives using multiple criteria; case studies.

2104642 Decision Support Systems **3(3-0-9)**

Taxonomy of decision support systems (DSSs); a framework of the development of DSSs; multi-criteria decision methodology; components of an architecture for DSS; an approach for an integrated DSS for strategic planning; executive information and support systems; group decision support system; intelligent DSS; using DSSs in various situations.

2104644 Advanced Maintenance Management **3(3-0-9)**

Framework of maintenance management (MM); maintenance philosophies; interaction between production management and maintenance philosophies; maintenance management decision making; balancing between preventive and corrective maintenance; performance evaluation; computerized maintenance management system; ISO9000 and ISO14000 compliance.

2104645 Applied Biomechanics **3(2-3-7)**

Applying biomechanics in order to design and develop work tasks, work places and tools based on ergonomics, which considers human strength as the first priority.

2104646 Work Physiology **3(2-3-7)**

Applying physiology in order to design and develop work tasks, workplaces, tools and working environments or exhaustion based on ergonomics which considers human endurance as the first priority.

2104647 Hazardous Material and Fire Protection Engineering **3(3-0-9)**

Evaluation, design, development of a workplace under a risk of fire and hazardous material based on engineering rules, which covers a protection and stop the hazardous events with consideration of safety management and safety engineering usage.

2104648 Strategic Planning for Engineers **3(3-0-9)**

Strategic planning process; analytical techniques used in formulating plans; concepts of manufacturing strategy.

2104649 Cognitive Ergonomics **3(2-3-7)**

Specialty inter-discipline of design and system development that are involved with containing humans to make the systems more effective and more robust, focusing on amplifying human capability in performing cognitive work by integrating technical functions with human cognitive processes to create efficient and reliable systems.

2104650 Project Management Concepts **3(3-0-9)**

Introduction to engineering project management including overview and concepts of project management, planning successful projects, implementing, executing and closeout.

2104671 Advanced Work Design **3(2-3-7)**

An advanced study of work design and methods of improving human work; factors affecting work such as fatigue, learning and physical capacity.

2104677 Seminar in Safety Engineering **3(2-3-7)**

Intensive study of safety programs in industrial organization; critical discussion and review of existing working conditions in industry; case studies and factory tours used as means to recognize safety problems; analysis and discussion of solutions to the problems required as well as reports.

2104684 Technology and Innovation Management **3(3-0-9)**

Key issues and core concept of technology and innovation management, develop a framework for innovation strategy, in search of innovation, technology and innovation selection, techniques and tools for effective implementation of innovation, the management

of operations, execution of innovation, manufacturing and commercializing science and technology based ideas.

2104688 Research Methodology in IE and Operations Management 3(3-0-9)

Research philosophy; epistemology; ontology; qualitative and quantitative research methodology in Industrial Engineering and operations management; research proposal; literature review; research topic; research design; bibliography; research presentation.

2104690 Quantitative Data Analysis for IE 3(3-0-9)

Probability theory and statistical inference used in engineering applications; random variables and distributions, probability models, jointly distributed random variables, parameter estimation and sampling distribution, confidence intervals, hypothesis testing, simple and multiple linear regression models, analysis of variance for design of experiments, non-parametric statistics.

2104691 Research problems in IE I (OR) 3(3-0-9)

Interesting problems in industry (OR techniques); current knowledge that helps solve the problems, searching for and sharing of knowledge that helps solve the problems.

2104692 Research problems in IE II 3(3-0-9)

Application of new Theories and technologies to investigating industrial engineering research problems.

2104696 System Improvement 3(3-0-9)

Principles, guidelines, and processes for system development or improvement in manufacturing and service industries to respond to stakeholders' requirements in terms of productivity, quality, safety, and worthiness by integrating resources such as personnel, machines, materials, methods, and budget.

2104697 System Modeling and Analysis 3(3-0-9)

Condition: Prerequisite

Consent of Faculty

Principles of system modeling and controls, System dynamics, System analysis; decisions and issues in Operating system.

2104711 Advanced Manufacturing Engineering 3(3-0-9)

Recent advances in engineering materials and processing; cost and value engineering as related to material and processing system selection and specification; computer controls of machines and processes in manufacturing systems; industrial robotics and flexible assembly; laboratory assignments.

2104713 Advanced Optimization Techniques 3(3-0-9)

Optimization Theory, P/NP Problems, search space for discrete problem, search space for continuous problem, heuristics optimization techniques including local search, simulated annealing, tabu search, genetic algorithm, ant colony optimization, particle swarm optimization, hybrid heuristics methods.

2104741 Comparative Engineering Management 3(3-0-9)

Analysis and comparison of western and eastern practices in engineering management in the areas of manufacturing, marketing and technology strategy; effects of differences in national and organizational cultures; case studies.

2104811 Thesis 12 credits

Research and report of research results in Industrial Engineering.

2104816 Thesis 36 credits

Research and report of research results in Industrial Engineering.

2104826 Dissertation 36 credits

2104XXX Required Course 6 credits

2104XXX Approved Elective 6 credits

2104894 Doctoral Dissertation Seminar 0(0-0-0)

2104897 Qualifying Examination 0(0-0-0)

DEPARTMENT OF CHEMICAL ENGINEERING

The Department of Chemical Engineering offers the Bachelor of Engineering Degree, the Master of Engineering Degree, and the Doctor of Engineering Degree in Chemical Engineering. The department currently accepts a sophomore class of about 80 students for two Bachelor's degree programs (40 for Thai program and 40 for international program), 100 students for the Master's degree program and 10 students for the Doctoral program.

The Department of Chemical Engineering offers two Bachelor of Engineering programs, i.e., Thai program (Chemical Engineering program) and International program (Chemical and Process Engineering program). The Thai program offers a complete set of basic courses in chemical engineering, emphasizing design of various chemical engineering pieces of equipment and plants. The curriculum also offers elective courses in various chemical engineering fields. This special feature broadens the students' knowledge to meet their interest and the demands of the industries. The senior project introduces the students to the integration of knowledge and gives them hands-on experiences in solving engineering and technological problems.

The International program covers all chemical engineering aspects via fundamental approaches. The curriculum offers two distinct study fields, i.e., Bioprocess Engineering, and Sustainable Energy, each of which covers novel trends in chemical engineering industries via series of elective courses. The curriculum additionally stresses the training of the students to think and present oneself logically and independently.

The Department of Chemical Engineering offers two graduate programs leading to the Master of Engineering Degree and the Doctor of Engineering Degree. Students entering graduate study in the department normally hold bachelor's degrees in chemical engineering. The department also admits exceptional students who majored in other branches of engineering or science at the undergraduate level. An applicant for the Doctoral Degree must hold either a bachelor's degree in chemical engineering with second-class honors or equivalent, or a master's degree in chemical engineering.

Research activities are grouped into 8 areas, namely, biochemical engineering, catalysis and catalytic reaction engineering, control and system engineering, oleochemical, particle technology and material processing, polymer science and polymer engineering, process systems engineering, and separation technology. Students can choose their research topics in any of these research areas. The graduate program is strengthened by collaboration with top universities in several countries such as Japan, Canada, UK, Australia and China.

The above curricula and research activities together with strong interaction between faculties and students in all levels have produced graduates who meet the demands and needs of the chemical, petrochemical, and related industries as well as various governmental organizations. Additionally, these have paved the way for the Department of Chemical Engineering to establish itself as an active partner in the advancement of the chemical engineering discipline in Thailand.

HEAD:

Soorathep Kheawhom, Ph.D. (Tokyo)

PROFESSORS:

Anongnat Somwangthanaroj, Ph.D. (Michigan)
Artiwan Shotipruk, Ph.D. (Michigan)
Bunjerd Jongsomjit, Ph.D. (Pittsburgh)
Joongjai Panpranot, Ph.D. (Clemson)
Muenduen Phisalaphong, Ph.D. (Colorado State)
Paisan Kittisupakorn, Ph.D. (London)
Sarawut Rimdusit, Ph.D. (CWRU)
Siriporn Damrongsukkul, Ph.D. (London)
Suttichai Assabumrungrat, Ph.D. (London)
Tawatchai Charinpanitkul, D.Eng. (Tokyo)
Varong Pavarajarn, Ph.D. (Oregon State)

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Kasidit Nootong, Ph.D. (Pennsylvania)
Pattaraporn Kim, Ph.D. (London)
Soorathep Kheawhom, Ph.D. (Tokyo)
Sorada Kanokpanont, Ph.D. (Drexel)
Supareak Praserthdam, Ph.D. (Texas A&M)
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Paravee Vas-Umnuay, Ph.D. (Oregon State)

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Nattaporn Tonanon, D.Eng. (Kyoto)
Palang Bumroongsakulsawat, Ph.D. (Imperial)
Pimporn Ponpesh, Ph.D. (California)
Pongtorn Charoensuppanimit, Ph.D. (Oklahoma State)
Rungthiwa Methaapanon, Ph.D. (Stanford)
Phuet Prasertcharoensuk Ph.D. (Newcastle)

LECTURERS:

Kritchart Wongwailikhit, Ph.D. (INSA-Toulouse)
Merika Chanthanumataporn, D.Eng. (Tokyo Tech)
Chonlatep Usaku Ph.D. (Imperial)
Chanon Pornrungroj Ph.D. (Cambridge)
Sirikanya Singcuna, M.S. (Waterloo)

CHEMICAL ENGINEERING CURRICULUM (THAI PROGRAM)
FIRST YEAR CURRICULUM

COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER	
2105261	CHEM PROD IND	3
2105210	CHEM CHE	3
2105211	CHEM CHE LAB	1
2105212	PHYS CHEM CHE	3
2105216	MASS ENER BALANCE	3
5500208	COM PRES SKIL	3
XXXXXXX	GENERAL EDUCATION	3
		19
	FOURTH SEMESTER	
2105213	THERMO CHE	3
2105214	MATH CHE	3
2105215	STAT CHE	3
2105217	KIN REACTOR DSGN	3
2105218	FLUID TRANSPORT	3
XXXXXXX	GENERAL EDUCATION	3
		18
	FIFTH SEMESTER	
2105310	HEAT MASS TRANSFER	3
2105312	MATH MODEL CHE	3
2105313	INS ELEC PLANT	3
2105318	FLUID LAB	1
2105320	SEM CHE I	1
5500308	TECH WRIT ENG	3
XXXXXXX	GENERAL EDUCATION	3
		17
	SIXTH SEMESTER	
2105311	STAGEWISE SEP	3
2105314	COM CAL CHE	3
2105315	DATA ANALYTICS CHE	3
2105316	DYN CON CHEM PROC	3
2105317	SAFETY CHEM PROC	3
2105319	HEAT MASS LAB	1
		16
	SUMMER SEMESTER	
2100301	ENG PRACTICE	2
	SEVENTH SEMESTER	
2105413	CHEM PROC OPER	3
2105414	ECON AMT CHEM PROC	3
2105415	CHEM PROC DSGN I	4
2105417	PROJ CHE I	1
2105419	SEM CHE II	1
2105XXX	APPROVED ELECTIVE	3
XXXXXXX	FREE ELECTIVE	3
		18
	EIGHTH SEMESTER	
2105416	CHEM PROC DSGN II	4
2105418	PROJ CHE II	3
2105XXX	APPROVED ELECTIVE	3
XXXXXXX	GENERAL EDUCATION	3
XXXXXXX	FREE ELECTIVE	3
		16

TOTAL CREDITS FOR GRADUATION = 142

CHEMICAL AND PROCESS ENGINEERING CURRICULUM
(INTERNATIONAL PROGRAM)

COURSE NO.	SUBJECT	CREDITS
	FIRST SEMESTER	
2185101	INTRO CHE	3
2301107	CALCULUS I	3
2302105	CHEM ENGS	3
2302103	GEN CHEM LAB	1
2304153	PHYSICS ENGS	3
2304193	PHYSICS LAB ENGS	1
5501112	COMM ENG I	3
		17
	SECOND SEMESTER	
2183101	ENG GRAPHICS	3
2185105	ENG MAT	3
2185120	CHE PRIN CAL	3
2301108	CALCULUS II	3
2304154	PHYS ELEC ENGS	3
2304194	PHYS ELEC LAB ENGS	1
5500112	COMM ENG I	3
		19
	THIRD SEMESTER	
2183212	STATICS	3
2185211	CHE MATH	3
2185223	CHE THERMO I	3
2302106	BSC ORG CHEM	3
XXXXXXX	GENERAL EDUCATION	3
XXXXXXX	GENERAL EDUCATION	3
		18
	FOURTH SEMESTER	
2185212	APPL CHE STAT	3
2185224	CHE THERMO II	3
2185241	FLUID MECH CHE	3
21853XX	Study-field core course	3
5501214	COM PRES SKIL	3
XXXXXXX	GENERAL EDUCATION	6
		18
	FIFTH SEMESTER	
2185310	COM PROG CHE	3
2185343	HEAT/MASS TRANS OP	3
2185345	CHE KIN REACT DSGN	3
2185351	INSTRU CHEM PROC	3
21853XX	Study-field core course	3
5501225	TECH WRIT	3
		18
	SIXTH SEMESTER	
2185312	CHE ECON	3
2185346	UNIT OPER LAB	1
2185347	CHEM PROC DYN CONTROL	3
2185353	CHEM PROC SIMU	3
2185355	SAFETY CHEM OP	3
21853XX	Study-field core course	3
XXXXXXX	GENERAL EDUCATION	3
		19
	SUMMER SEMESTER	
2185301	INDUS TRAINING	2
	SEVENTH SEMESTER	
21854XX	APPROVED ELECTIVE	3
21854XX	APPROVED ELECTIVE	3
21854XX	APPROVED ELECTIVE	3
21854XX	APPROVED ELECTIVE	3
XXXXXXX	GENERAL EDUCATION	3
XXXXXXX	FREE ELECTIVE	3
		18
	EIGHTH SEMESTER	
2184410	FUND OM	3
2185451	CHE PROC DSGN ANALYSIS	3
21854XX	APPROVED ELECTIVE	3
2185499	CHE PROC ENG PROJ	3
2100499	ENG PROJ	3
XXXXXXX	FREE ELECTIVE	3
		15

TOTAL CREDITS FOR GRADUATION = 144

Core courses for each field of study:

COURSE NO.	SUBJECT	CREDITS
<u>Bio-process Engineering</u>		
2185370	FUND BIOCHEM ENG	3
2185371	RECOV PUR BIO PROD	3
2185372	BIOCHEM ENG PROC	3
<u>Sustainable Energy</u>		
2185380	INTRO SUST ENERGY	3
2185381	ALT FUEL THER CONV	3
2185382	CHE SOL CIRC ECON	3

NAME OF THE DEGREE

: Master of Engineering
: M.Eng.

PROFESSORS:

Anongnat	Somwangthanaroj,	Ph.D. (Michigan)
Artiwan	Shotipruk,	Ph.D. (Michigan)
Bunjerd	Jongsomjit,	Ph.D. (Pittsburgh)
Joongjai	Panpranot,	Ph.D. (Clemson)
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Paisan	Kittisupakorn,	Ph.D. (London)
Sarawut	Rimdusit,	Ph.D. (CWRU)
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Pongtorn	Charoensuppanimit,	Ph.D. (Oklahoma State)
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Merika	Chanthanumataporn,	D.Eng. (Tokyo Tech)
Phuet	Prasertcharoensuk,	Ph.D. (Newcastle)
Sirikanya	Singcuna,	M.S. (Waterloo)

ADMISSION

An applicant must hold a bachelor's degree in chemical engineering or equivalent and also meets the requirements of the Graduate School.

DEGREE REQUIREMENTS
(for holders of bachelor's degrees in chemical engineering)

Holders of bachelor's degrees in chemical engineering are required to complete 24 course credits and 12 thesis credits. Students are required to select their fields of study from the following: Research & Innovation, Engineering Practice, and Biorefinery. The program structure depends on the field of study. Chemical Engineering Seminar I and II are (S/U) courses and their credits are not counted towards graduation.

COURSE REQUIREMENTS

Field of study: Research & Innovation

1) Required Courses

2105605	Chemical Engineering Seminar I	1(1-0-3)
2105606	Chemical Engineering Seminar II	1(1-0-3)

2) Fundamental Courses 9 credits

Students must choose one course from each of the following groups.

- **Group I**

2105602	Advanced Transport Phenomena	3(3-0-9)
2105685	Selected Topics in Transport Phenomena	3(3-0-9)

- **Group II**

2105603	Advanced Chemical Engineering Thermodynamics	3(3-0-9)
2105686	Selected Topics in Chemical Engineering Thermodynamics	3(3-0-9)

- **Group III**

2105604	Advanced Chemical Engineering Kinetics and Chemical Reactor Design	3(3-0-9)
2105687	Advanced Chemical Kinetics and Catalysis	3(3-0-9)
2105688	Selected Topics in Chemical Engineering Kinetics	3(3-0-9)

3) Core Course 3 credits

2105621	Deep Tech Entrepreneurship	3(3-0-9)

4) Approved Elective Courses 6 credits

Students must choose 2 courses from the following list.

2105601	Advanced Engineering Mathematics for Chemical Engineers	3(3-0-9)
2105607	Chemical Engineering Process Scale-up	3(3-0-9)
2105612	Chemical Engineering Process and Product Development	3(3-0-9)
2105617	Research Methodology and Statistical Analysis	3(3-0-9)
2105618	Characterization and Instrumental Analysis	3(3-0-9)
2105623	Optimization of Chemical Processes	3(3-0-9)
2105629	Computational Tools in Chemical Engineering	3(3-0-9)
2105671	Process Dynamics	3(3-0-9)
2105676	Instrumentation in Chemical Process	3(3-0-9)
2105689	Safe Process Operation and Design	3(3-0-9)
2105699	Multifunctional Reactor	3(3-0-9)

5) Elective Courses 6 credits

Students must choose 2 courses from the following list.

2105522	Dynamic Process Simulation	3(3-0-9)
2105526	Total Productive Management for Chemical Process Industry	3(3-0-9)
2105527	Polymer Characterization and Fracture	3(3-0-9)
2105572	Encapsulation Process	3(3-0-9)
2105578	Nanotechnology for Sustainable Society	3(3-0-9)
2105599	Batch Chemical Processes	3(3-0-9)
2105609	Advanced Particulate Technology	3(3-0-9)
2105610	Membrane Technology	3(3-0-9)
2105611	Separation Technology via Liquid Membrane and Application	3(3-0-9)
2105613	Mass Transfer Operation	3(3-0-9)
2105619	Advanced Automatic Process Control	3(3-0-9)
2105620	Research Communication for Chemical Engineers	3(3-0-9)
2105626	Advanced Heat Transfer	3(3-0-9)
2105630	Heterogeneous Catalytic Reactor Modeling	3(3-0-9)
2105631	Advanced Catalysts for Polymers	3(3-0-9)
2105632	Petrochemical Technology	3(3-0-9)
2105633	Catalyst Stability	3(3-0-9)
2105634	Catalysis	3(3-0-9)
2105636	Heterogeneous Catalysis	3(3-0-9)
2105637	Design of Industrial Catalysis	3(3-0-9)
2105638	Advanced Polymer Engineering	3(3-0-9)
2105639	Computational Heterogeneous Catalysis Engineering	3(3-0-9)
2105641	Biodegradable Material Engineering	3(3-0-9)
2105643	Polymer Processing	3(3-0-9)
2105649	Polymer Blends and Composites	3(3-0-9)
2105650	Biochemical Engineering	3(3-0-9)
2105652	Bioreactor Analysis and Control Design	3(3-0-9)
2105654	Biosensors	3(3-0-9)
2105655	Bioprocess Plant Design	3(3-0-9)
2105659	Biochemical Separation Technology	3(3-0-9)
2105663	Heat Transfer Operation	3(3-0-9)
2105666	Source Control of Particulate Emission	3(3-0-9)
2105667	Loss Prevention in Chemical Operations	3(3-0-9)
2105672	Simulation of Particulate and Material Processing	3(3-0-9)
2105675	Polymer Chemistry for Engineers	3(3-0-9)
2105676	Instrumentation in Chemical Process	3(3-0-9)
2105678	Introduction to Nanotechnology	3(3-0-9)
2105679	Bioactive Compounds	3(3-0-9)
2105681	Catalyst Deactivation	3(3-0-9)
2105682	Surface Technology	3(3-0-9)
2105684	Chemical Analysis for Chemical Process Control I	3(3-0-9)
2105690	Independent Study I	3(3-0-9)
2105691	Independent Study II	3(3-0-9)
2105692	Independent Study III	3(3-0-9)
2105693	Special Problems in Process Control Engineering	3(3-0-9)
2105694	Special Problems in Petrochemical Engineering	3(3-0-9)
2105695	Special Problems in Polymer Engineering	3(3-0-9)
2105696	Special Problems in Biochemical Engineering	3(3-0-9)
2105697	Special Problems in Cleaner Production Engineering	3(3-0-9)
2105698	Special Problems in Particle Technology	3(3-0-9)

6) Thesis

2105811	Thesis	12 credits

Master of Engineering Program
(Research & Innovation)

FIRST SEMESTER

21056xx	Fundamental Course	3
21056xx	Fundamental Course	3
21056xx	Approved Elective Course	3
21056xx	Elective Course	3
		12

SECOND SEMESTER

2105621	DEEP TECH ENTREP	3
21056xx	Fundamental Course	3
21056xx	Approved Elective Course	3
21056xx	Elective Course	3
2105605	CHE SEMINAR I	S/U
		12

THIRD SEMESTER

2105606	CHE SEMINAR II	S/U
2105811	THESIS	9
		9

FOURTH SEMESTER

2105811	THESIS	3
		3

Field of study: Engineering Practice

1) Required Courses

2105605	Chemical Engineering Seminar I	1(1-0-3)
2105606	Chemical Engineering Seminar II	1(1-0-3)

2) Fundamental Course 3 credits

2105615	Integration of Chemical Engineering Fundamentals	3(3-0-9)

3) Core Course 9 credits

2105614	Application Aspect of Thermodynamics in Process Simulation	3(3-0-9)
2105625	Process Analysis and Improvement	3(3-0-9)
2105627	Process Operations	3(3-0-9)

4) Approved Elective Courses 6 credits

Students must choose 2 courses from the following list.

2105607	Chemical Engineering Process Scale-up	3(3-0-9)
2105612	Chemical Engineering Process and Product Development	3(3-0-9)
2105629	Computational Tools in Chemical Engineering	3(3-0-9)
2105689	Safe Process Operation and Design	3(3-0-9)
2105699	Multifunctional Reactor	3(3-0-9)

5) Elective Courses 6 credits

Students must choose 2 courses from the same list as the Research & Innovation field of study.

6) Thesis

2105811	Thesis	12 credits

Master of Engineering Program
(Engineering Practice)

FIRST SEMESTER

2105614	APP TD PROC SIM	3
2105615	INTEGRAT CHE FUND	3
21056xx	Approved Elective Course	3
21056xx	Approved Elective Course	3
		12

SECOND SEMESTER

2105625	PROC ANAL IMPROVE	3
2105627	PROC OPER	3
21056xx	Elective Course	3
21056xx	Elective Course	3
2105605	CHE SEMINAR I	S/U
		12

THIRD SEMESTER

2105606	CHE SEMINAR II	S/U
2105811	THESIS	9
		9

FOURTH SEMESTER

2105811	THESIS	3
		3

Field of study: Biorefinery

1) Required Courses

2105605	Chemical Engineering Seminar I	1(1-0-3)
2105606	Chemical Engineering Seminar II	1(1-0-3)

2) Fundamental Course 3 credits

2105615	Integration of Chemical Engineering Fundamentals	3(3-0-9)

3) Core Course 3 credits

2105640	Aspect in Biorefinery	3(3-0-9)

4) Approved Elective Courses 12 credits

Students must choose 4 courses from the following list.

2105607	Chemical Engineering Process Scale-up	3(3-0-9)
2105612	Chemical Engineering Process and Product Development	3(3-0-9)
2105617	Research Methodology and Statistical Analysis	3(3-0-9)
2105618	Characterization and Instrumental Analysis	3(3-0-9)
2105629	Computational Tools in Chemical Engineering	3(3-0-9)
2105648	Biorefinery for Bioplastic	3(3-0-9)
2105683	Bioenergy Technology	3(3-0-9)
2105689	Safe Process Operation and Design	3(3-0-9)
2105699	Multifunctional Reactor	3(3-0-9)

5) Elective Courses 6 credits

Students must choose 2 courses from the same list as the Research & Innovation field of study.

6) Thesis

2105811	Thesis	12 credits

Master of Engineering Program
(Biorefinery)

FIRST SEMESTER

2105615	INTEGRAT CHE FUND	3
2105640	ASP BIOREFINE	3
21056xx	Approved Elective Course	3
21056xx	Elective Course	3
		12

SECOND SEMESTER

21056xx	Approved Elective Course	3
21056xx	Approved Elective Course	3

21056xx	Approved Elective Course	3
21056xx	Elective Course	3
2105605	CHE SEMINAR I	S/U
		12

THIRD SEMESTER

2105606	CHE SEMINAR II	S/U
2105811	THESIS	9
		9

FOURTH SEMESTER

2105811	THESIS	3
		3

NAME OF THE DEGREE

: Doctor of Engineering
: D.Eng.

PROFESSORS:

Anongnat	Somwangthanaroj,	Ph.D. (Michigan)
Artiwan	Shotipruk,	Ph.D. (Michigan)
Bunjerd	Jongsomjit,	Ph.D. (Pittsburgh)
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Paravee	Vas-Umnuay,	Ph.D. (Oregon State)
Pimporn	Ponpesh,	Ph.D. (California)
Pongtorn	Charoensuppanimit,	Ph.D. (Oklahoma State)
Rungthiwa	Methaapanon,	Ph.D. (Stanford)
Suphot	Phatanasri,	D.Eng. (Kyoto)

LECTURERS:

Akawat	Sirisuk,	Ph.D. (Wisconsin)
Kritchart	Wongwailikhit,	Ph.D. (INSA-Toulouse)
Merika	Chanthanumataporn,	D.Eng. (Tokyo Tech)
Phuet	Prasertcharoensuk,	Ph.D. (Newcastle)
Sirikanya	Singcuna,	M.S. (Waterloo)

ADMISSION

An applicant must hold either a bachelor's degree in chemical engineering or equivalent with second-class honors or a master's degree in chemical engineering, which is required for Pattern II. An additional requirement for Pattern I is that the applicant must complete their master's degree program with a minimum grade point average of 3.5.

Pattern I: for master's degree holder

Degree requirements

Required courses	-
Elective courses	-
Seminar in Chemical Engineering	2 credits
Dissertation	60 credits

Students must take Doctoral Dissertation Seminar every term after completing Seminar in Chemical Engineering IV.

Doctor of Engineering Program
(Pattern I: for master's degree holder)

FIRST SEMESTER

2105717	SEMINAR CHE III	S/U
2105829	DISSERTATION	10
		10

SECOND SEMESTER

2105718	SEMINAR CHE IV	S/U
2105829	DISSERTATION	10
		10

THIRD SEMESTER

2105894	DOC SEMINAR	S/U
2105829	DISSERTATION	10
		10

FOURTH SEMESTER

2105894	DOC SEMINAR	S/U
2105829	DISSERTATION	10
		10

FIFTH SEMESTER

2105894	DOC SEMINAR	S/U
2105829	DISSERTATION	10
		10

SIXTH SEMESTER

2105894	DOC SEMINAR	S/U
2105829	DISSERTATION	10
		10

Pattern II(1): for master's degree holder

Degree requirements

Required courses	12 credits
Seminar in Chemical Engineering	2 credits
Dissertation	48 credits

Students must take Doctoral Dissertation Seminar every term after completing Seminar in Chemical Engineering IV.

Course requirements

1) Approved Elective Course 3 credits

Students must choose 1 course from the following list.

2105601	Advance Engineering Mathematics for Chemical Engineers	3(3-0-9)
2105607	Chemical Engineering Process Scale-up	3(3-0-9)
2105612	Chemical Engineering Process and Product Development	3(3-0-9)
2105617	Research Methodology and Statistical Analysis	3(3-0-9)
2105618	Characterization and Instrumental Analysis	3(3-0-9)
2105623	Optimization of Chemical Processes	3(3-0-9)
2105629	Computational Tools in Chemical Engineering	3(3-0-9)
2105671	Process Dynamics	3(3-0-9)
2105676	Instrumentation in Chemical Process	3(3-0-9)
2105689	Safe Process Operation and Design	3(3-0-9)
2105699	Multifunctional Reactor	3(3-0-9)

2) Elective Courses 9 credits

Students must choose 3 courses from the following list.

2105522	Dynamic Process Simulation	3(3-0-9)
2105526	Total Productive Management for Chemical Process Industry	3(3-0-9)
2105527	Polymer Characterization and Fracture	3(3-0-9)
2105572	Encapsulation Process	3(3-0-9)
2105578	Nanotechnology for Sustainable Society	3(3-0-9)
2105599	Batch Chemical Processes	3(3-0-9)
2105609	Advanced Particulate Technology	3(3-0-9)
2105610	Membrane Technology	3(3-0-9)
2105611	Separation Technology via Liquid Membrane and Application	3(3-0-9)
2105613	Mass Transfer Operation	3(3-0-9)
2105619	Advanced Automatic Process Control	3(3-0-9)
2105620	Research Communication for Chemical Engineers	3(3-0-9)
2105626	Advanced Heat Transfer	3(3-0-9)
2105630	Heterogeneous Catalytic Reactor Modeling	3(3-0-9)
2105631	Advanced Catalysts for Polymers	3(3-0-9)
2105632	Petrochemical Technology	3(3-0-9)
2105633	Catalyst Stability	3(3-0-9)
2105634	Catalysis	3(3-0-9)
2105636	Heterogeneous Catalysis	3(3-0-9)
2105637	Design of Industrial Catalysis	3(3-0-9)
2105638	Advanced Polymer Engineering	3(3-0-9)
2105639	Computational Heterogeneous Catalysis Engineering	3(3-0-9)
2105641	Biodegradable Material Engineering	3(3-0-9)
2105643	Polymer Processing	3(3-0-9)
2105649	Polymer Blends and Composites	3(3-0-9)
2105650	Biochemical Engineering	3(3-0-9)
2105652	Bioreactor Analysis and Control Design	3(3-0-9)
2105654	Biosensors	3(3-0-9)
2105655	Bioprocess Plant Design	3(3-0-9)
2105659	Biochemical Separation Technology	3(3-0-9)
2105663	Heat Transfer Operation	3(3-0-9)
2105666	Source Control of Particulate Emission	3(3-0-9)
2105667	Loss Prevention in Chemical Operations	3(3-0-9)
2105672	Simulation of Particulate and Material Processing	3(3-0-9)
2105675	Polymer Chemistry for Engineers	3(3-0-9)
2105676	Instrumentation in Chemical Process	3(3-0-9)
2105678	Introduction to Nanotechnology	3(3-0-9)
2105679	Bioactive Compounds	3(3-0-9)
2105681	Catalyst Deactivation	3(3-0-9)
2105682	Surface Technology	3(3-0-9)
2105684	Chemical Analysis for Chemical Process Control I	3(3-0-9)
2105690	Independent Study I	3(3-0-9)
2105691	Independent Study II	3(3-0-9)
2105692	Independent Study III	3(3-0-9)
2105693	Special Problems in Process Control Engineering	3(3-0-9)
2105694	Special Problems in Petrochemical Engineering	3(3-0-9)
2105695	Special Problems in Polymer Engineering	3(3-0-9)
2105696	Special Problems in Biochemical Engineering	3(3-0-9)
2105697	Special Problems in Cleaner Production Engineering	3(3-0-9)
2105698	Special Problems in Particle Technology	3(3-0-9)

Doctor of Engineering Program
(Pattern II(1): for master's degree holder)

FIRST SEMESTER

21056XX	Elective Course	3
21056XX	Elective Course	3
2105717	SEMINAR CHE III	S/U
2105828	DISSERTATION	4
		10

SECOND SEMESTER

21056XX	Approved Elective Course	3
21056XX	Elective Course	3
2105718	SEMINAR CHE IV	S/U
2105828	DISSERTATION	4
		10

THIRD SEMESTER

2105894	DOC SEMINAR	S/U
2105828	DISSERTATION	10
		10

FOURTH SEMESTER

2105894	DOC SEMINAR	S/U
2105828	DISSERTATION	10
		10

FIFTH SEMESTER

2105894	DOC SEMINAR	S/U
2105828	DISSERTATION	10
		10

SIXTH SEMESTER

2105894	DOC SEMINAR	S/U
2105828	DISSERTATION	10
		10

Pattern II(2): for bachelor's degree holder

Degree requirements

Required courses 24 credits
Seminar in Chemical Engineering 2 credits
Dissertation 48 credits

Students must take Doctoral Dissertation Seminar every term after completing Seminar in Chemical Engineering IV.

Course requirements

1) Approved Elective Course 15 credits

Students must choose 1 course from each of Group I-III and 2 courses from Group IV.

- **Group I**

2105602	Advanced Transport Phenomena	3(3-0-9)
2105685	Selected Topics in Transport Phenomena	3(3-0-9)

- **Group II**

2105603	Advanced Chemical Engineering Thermodynamics	3(3-0-9)
2105686	Selected Topics in Chemical Engineering Thermodynamics	3(3-0-9)

- **Group III**

2105604	Advanced Chemical Engineering Kinetics and Chemical Reactor Design	3(3-0-9)
2105687	Advanced Chemical Kinetics and Catalysis	3(3-0-9)
2105688	Selected Topics in Chemical Engineering Kinetics	3(3-0-9)

- **Group IV**

2105601	Advance Engineering Mathematics for Chemical Engineers	3(3-0-9)
2105607	Chemical Engineering Process Scale-up	3(3-0-9)
2105612	Chemical Engineering Process and Product Development	3(3-0-9)
2105617	Research Methodology and Statistical Analysis	3(3-0-9)
2105618	Characterization and Instrumental Analysis	3(3-0-9)
2105623	Optimization of Chemical Processes	3(3-0-9)
2105629	Computational Tools in Chemical Engineering	3(3-0-9)
2105671	Process Dynamics	3(3-0-9)
2105676	Instrumentation in Chemical Process	3(3-0-9)
2105689	Safe Process Operation and Design	3(3-0-9)
2105699	Multifunctional Reactor	3(3-0-9)

2) Elective Courses 9 credits

Students must choose 3 courses from the same list of elective courses in Pattern II(1).

Doctor of Engineering Program
(Pattern II(2): for bachelor's degree holder)

FIRST SEMESTER

21056xx	Approved Elective Course	3
21056xx	Approved Elective Course	3
21056xx	Approved Elective Course	3
21056xx	Elective Course	3
2105717	SEMINAR CHE III	S/U
		12

SECOND SEMESTER

21056xx	Approved Elective Course	3
21056xx	Approved Elective Course	3
21056xx	Elective Course	3
21056xx	Elective Course	3
2105718	SEMINAR CHE IV	S/U
		12

THIRD SEMESTER

2105894	DOC SEMINAR	S/U
2105828	DISSERTATION	8
		8

FOURTH SEMESTER

2105894	DOC SEMINAR	S/U
2105828	DISSERTATION	8
		8

FIFTH SEMESTER

2105894	DOC SEMINAR	S/U
2105828	DISSERTATION	8
		8

SIXTH SEMESTER

2105894	DOC SEMINAR	S/U
2105828	DISSERTATION	8
		8

SEVENTH SEMESTER

2105894	DOC SEMINAR	S/U
2105828	DISSERTATION	8
		8

EIGHTH SEMESTER

2105894	DOC SEMINAR	S/U
2105828	DISSERTATION	8
		8

COURSE DESCRIPTIONS
CHEMICAL ENGINEERING (B.ENG., THAI PROGRAM)

2105210 Chemistry for Chemical Engineers 3(3-0-6)

Properties and reactions of organic functional groups such as hydrocarbons, hydroxyl, ether, carbonyl, carboxylic, and organic complexes; application of chemistry in chemical industry.

2105211 Chemistry for Chemical Engineers Laboratory 1(0-3-0)

Practice in chemistry.

2105212 Physical Chemistry for Chemical Engineers 3(3-0-6)

Prediction of thermodynamic properties of pure components and solutions: basic phase equilibrium of pure components and solutions; thermodynamic laws; basic kinetics; relations between thermodynamic properties; heat cycle.

2105213 Thermodynamics for Chemical Engineers 3(3-0-6)

Fundamentals of prediction of thermodynamic properties of pure components and solution; fundamentals of phase equilibrium of pure components and solutions; fundamentals of chemical reaction equilibrium.

2105214 Mathematic for Chemical Engineers 3(3-0-6)

Ordinary differential equation, Laplace transform, system of ordinary differential equations.

2105215 Statistics for Chemical Engineers 3(3-0-6)

Elementary principles of probability theory, random variables and probability distributions, statistical inference, analysis of variance, regression and correlation, stochastic model development, design of experiment.

2105261 Chemical Production Industries 3(3-0-6)

Structure of chemical processes, diagrams, unit, chemical processes.

2105216 Mass and Energy Balance 3(3-0-6)

Principles of chemical engineering, relationship of mass with chemical reactions, conservation of mass and energy, usages of phase equilibrium and thermodynamic properties.

2105217 Kinetics and Reactor Design 3(3-0-6)

Fundamental principles of chemical kinetics; diffusion and catalysis; concepts of reactor design; the effect of reactor geometry, operating conditions, and flow characteristics on mass and energy conservation equations; single and multiple reactor systems

2105218 Fluid Transport Systems 3(3-0-6)

Fluid dynamics, hydrodynamics, pump, compressor, valve, pipe.

2105310 Heat and Mass Transfer Systems 3(3-0-6)

Heat and mass transfer phenomena; equipment for heat and mass transfer.

2105311 Stagewise Separation Systems 3(3-0-6)

Equipment for separation of mixture by principle of equilibrium stages

2105312 Mathematical Modelling In Chemical Engineering 3(3-0-6)

Numerical techniques in chemical engineering; application of numerical techniques for mathmatical modelling in chemical engineering; application of software for numerical techniques.

2105313 Instruments and Electrical System In Chemical Plants 3(3-0-6)

Instruments for measuring and controlling process variables; essential electrical system in chemical plants.

2105314 Computer-aided Calculation in Chemical Engineering 3(3-0-6)

Computer application in calculation and design in chemical engineering.

2105315 Data Analytics in Chemical Engineering 3(3-0-6)

Fundamentals of data analytics: data analytics in chemical engineering.

2105316 Dynamics and Control of Chemical Processes 3(3-0-6)

Mathematical modeling of chemical engineering systems; solution techniques and dynamics of these systems; introduction to automatic control; feedback control concept; stability analysis; frequency response and control system designs; introduction to measurement and control instrument characteristics.

2105317 Safety in Chemical Processes 3(3-0-6)

Principles of industrial safety and loss control. Hazards of chemicals. Hazards of chemical operations, hazards assessment, prevention and control of hazards, control system design for safe operation; personal protective devices, storage and transportation of hazardous materials, industrial safety management, emergency planning.

2105318 Fluid Transport System Laboratory 1(0-3-0)

Condition: corequisite 2105218 or consent of faculty

Practice in fluid dynamics and hydrodynamics.

2105319 Heat and Mass Transfer System Laboratory 1(0-3-0)

Condition: corequisite 2105310 or consent of faculty

Practice in heat and mass transfer.

2105320 Seminar in Chemical Engineering I 1(1-0-2)

Ethics in chemical engineering; development of essential skills for chemical engineers; discussion of various topics relevant for recent chemical engineering development.

2105413 Chemical Process Operation 3(3-0-6)

Relations between process equipment and raw materials, product, and energy; process analysis; waste management; control of environmental impact.

2105414 Chemical Process Economic Assessment 3(3-0-6)

Cost components of chemical industries, chemical industrial cost indexes, capital cost components, capital investment estimates, purchase cost of ptocess equipment, manufacturing cost components, manufacturing cost estimates, chemical process depreciation estimates, feasibility analysis, alternative investments and replacements.

2105415 Chemical Process Design I 4(2-6-4)

Design of chemical processes; development of process model with process simulation software.

2105416 Chemical Process Design II 4(2-6-4)

Condition: prerequisite 2105415 or consent of faculty

Design of heat exchanger network; recovery of process energy; equipment sizing; plant layout.

2105417 Project in Chemical Engineering I 1(0-2-1)

Preliminary study to produce proposals for projects relating to chemical engineering.

2105418 Project in Chemical Engineering II 3(0-6-3)

Condition: prerequisite 2105417 or consent of faculty

Carrying out proposed projects: reporting findings.

2100499 Senior Project 3(0-6-3)

An interesting project in a multidisciplinary field of engineering; project proposal; working on a project; project presentation and doing a complete written report.

2105419 Seminar in Chemical Engineering II 1(1-0-2)

Development of essential skills for chemical engineers; discussion of various topics relating to recent development in chemical engineering.

2105405 Study Abroad I 2(2-0-4)

Condition: consent of faculty

Knowledge in chemical engineering obtains during the study abroad.

2105406 Study Abroad II 2(2-0-4)

Condition: consent of faculty

Knowledge in chemical engineering obtains during the study abroad.

2105407 Study Abroad III 2(2-0-4)

Condition: consent of faculty

Knowledge in chemical engineering obtains during the study abroad.

2105409 Study Abroad IV 3(3-0-6)

Condition: consent of faculty

Knowledge in chemical engineering obtains during the study abroad.

2105410 Study Abroad V 3(3-0-6)

Condition: consent of faculty

Knowledge in chemical engineering obtains during the study abroad.

2105411 Organic Chemistry in Engineering Works 3(3-0-6)

Inactive/active functional groups of organic compounds. Effects of functional groups on physical properties such as boiling point, vapour pressure, electrical conductivity and electrostatic discharge. Differences between laboratory and industrial procedures such as handling techniques, tranfer techniques, fire and explosion prevention, mixing. Chemical reaction condition differences between laboratory and industrial scales. Examles of inductrial applications.

2105412 Process Engineering Problem Solving 3(3-0-6)

Problem solving in momentum transfer unit operation, mass transfer unit operation, heat transfer unit operation and chemical reactor unit.

2105428 From Agri-Waste to Wealth 3(3-0-6)

Role of technology on full utilization of agri-waste or agro-industrial waste. Characterization of agri-waste or agro-industrial waste. Utilization of agri-waste or agro-industrial waste in many applications such as construction materials, porous materials, food and healthcare industries. Project/product evaluation.

2105430 Particle Technology 3(3-0-6)

Particle characterization, transport of powder, selection of transport equipment (screw converyor, belt conveyor, bucket elevator, pneumatic conveyor, air slid, etc.) storage of powder (hopper and silo design), powder feeding and discharging systems, classification of particles, granulation and agglomeration, comminution (size reduction), mixing and agitation of powder, kneading filter press (expression), extrusion.

2105445 Catalyst Reaction Engineering Fundamentals 3(3-0-6)

Catalyst structures and functions, fundamentals of catalyst manufacturing processes and catalyst reaction

engineering; applications of catalysis in petrochemical and chemical engineering processes; catalyst reactor design.

2105452 Fermentation Processes 3(3-0-6)

Detailed study of the processes, operations, technology involved in selected industrial fermentation processes directed towards the production of pharmaceuticals and industrial chemicals.

2105453 Introduction to Biochemical Engineering 3(3-0-6)

Importance of biochemical reactions in the industries, health & medicine, and daily life. A review of biochemical reaction kinetics for enzymes and cells including introduction to bioreactor design and downstream processing of the desire products. Separation of natural derived bioactive agents or cell components. Processes in pharmaceutical industry. Principles and instrumentation of the related techniques. Application of naturally derived biomaterial for various industries, especially for medical products, cosmetics, foods, agriculture, and environment. Molecular genetics, proteis, and metabolic engineering. Entrapeneurship and trends of technology related to biological engineering.

2105456 Introduction to Polymer Science 3(3-0-6)

Polymer structures and physical properties, technology and mechanical properties of polymers, applications of polymers, polymer processing, plastic technology; fibre technology and elastomer technology.

2105466 Natural Gas and Petroleum Oil Conditioning 3(3-0-6)

Condition: Senior Standing

Water content estimate, hydrate formation estimate, prevention of hydrate formation, dehydration methods, methods of acid gas removals, liquefaction of natural gas, petroleum oil refinery, reforming petroleum oil products, sulfur compound removals.

2105475 Total Productive Management for Chemical Process Industry 3(3-0-6)

Related to Total Productive Management in Chemical Process Industries, Calculation of Key Management Index, Application of Chemical Engineering, such as Thermodynamics, Energy and Mass Transfer, and Statistics including Distribution Diagram, Control Chart.

2105476 Process Simulation 3(3-0-6)

Numerical solution of algebraic equations and differential equations; basic modeling; information flow diagram concepts; steady-state simulation; dynamic simulation.

2105478 Petrochemical Engineering Processes 3(3-0-6)

Natural Gas Utilization Plan of Thailand; natural gas liquefaction plant; methanol plant; ethylene plant; gas separation plant; ammonia, urea, and phosphate plants; polypropylene plant; vinyl chloride monomer pant; polyvinyl chloride plant; polyethylene plant; ethylene oxide plant; polyester plant; polystyrene plant.

2105479 Polymer Engineering 3(3-0-6)

Definitions and concepts; crystalline and glassy polymers; molecular architecture; structure, steric factors, conformation and morphology; polymer synthesis; step and chain polymerization; transtiton phenomena, mechanical properties affected by the transition phenomena; elastomer, theory of rubber elasticity; Polymer rheology; ypes of mechanical deformations, simple rheological responses, viscoelastic properties of polymer, linear viscoelastic models; yielding and theories on yielding of glassy polymer.

2105488 Nanotechnology for Engineers 3(3-0-6)

Fundamental of nanotechnology; nanomaterials and nanoparticles fabrications; Structure of nanomaterials; Properties of nanomaterials; Characterization of nanomaterials; Applications of nanomaterials.

COURSE DESCRIPTIONS
CHEMICAL AND PROCESS ENGINEERING
(B.ENG., INTERNATIONAL PROGRAM)

2185101 Introduction to Chemical Engineering 3(3-0-6)

Introducing chemical engineer; Role of chemical engineering; Chemical engineer and industries; Ethics of engineering profession; Solving engineering problems; Introduction to chemical engineering calculation.

2185105 Chemical Engineering Materials 3(3-0-6)

Engineering materials: metals, ceramics, polymers, and composites; relationship between structures and properties of engineering materials; applications of engineering materials; productions and fabrications of engineering materials; engineering materials in chemical engineering.

2185120 Chemical Engineering Principles and Calculations 3(3-0-6)

General introduction to Chemical Engineering: stoichiometry and material balance calculation; recycling, bypassing, and purging; use of chemical and phase equilibrium data; energy balance; use of thermodynamic data; study of typical processes.

2185122 Applied Chemical Engineering Statistics 3(3-0-6)

Probability theory; Random variables and probability distributions; Statistical inference; Analysis of variance; regression analysis Principle of experimental designs; Factorial Designs.

2185211 Chemical Engineering Mathematics 3(3-0-6)

First-order differential equation; Linear Second-order differential equation; Laplace and inverse Laplace transform; System of differential equations; Power series solution; Frobenius Method; Polar, cylindrical, and spherical coordinates; Lines, planes, and surfaces in three-dimensional space; Fundamental of line, surface, and volume integrations; Application in solving chemical engineering problems.

2185222 Chemical Engineering Thermodynamics I 3(3-0-6)

Prediction of thermodynamic properties of single components, ideal gas law, equation of states for gaseous and liquid, thermodynamic laws, relationships of thermodynamic properties, phase equilibrium of single components, refrigeration cycle.

2185223 Chemical Engineering Thermodynamics II 3(3-0-6)

Predictions of thermodynamic properties of pure component and mixtures using split and EOS approaches for descriptions of phase equilibrium such as vapor-liquid equilibrium, liquid-liquid equilibrium and vapor-liquid-liquid equilibrium; chemical equilibrium.

2185241 Fluid Mechanics for Chemical Engineers 3(3-0-6)

The physics of fluid mechanics: fluid properties, fluid statics, fluid kinematics, and the mass, momentum, and energy balances. The fundamental concepts and application of fluid mechanics in chemical engineering unit operations. Conceptual design of unit operations for solid-fluid separation.

2185301 Industrial Training 2(0-6-0)

Engineering practice in related areas under supervision of experienced engineers in private sectors or government agencies.

2185310 Computer Programming for Chemical Engineers 3(3-0-6)

Basic coding in Matlab and Microsoft Excel; Management and analysis of big data; Application of computer programming in solving general and chemical engineering-related problems.

2185312 Chemical Engineering Economy 3(3-0-6)

Introduction to general economics; Accounting data and financial statements in the chemical industry; Economic evaluation in chemical engineering plant design; Economic evaluation for alternative selection and investment of chemical process; Feasibility analysis.

2185343 Heat and Mass Transfer Operations 3(3-0-6)

Basic principles and mechanisms of heat and mass transfer; Conceptual design of heat transfer, mass transfer, and simultaneous heat and mass transfer equipments.

2185345 Chemical Engineering Kinetics and Reactor Design 3(3-0-6)

Application of thermodynamic and kinetic fundamentals to the analysis and design of chemical reactors; type of reactors: single reactor and multiple reactor systems; isothermal and non-isothermal operation: homogeneous reactors and introduction to heterogeneous react.

2185346 Unit Operations Laboratory 1(0-3-0)

Laboratory on unit operations involvong fluid flow, solid-fluid separation, distillation, heat transfer and process dynamics.

2185347 Chemical Process Dynamics and Control 3(3-0-6)

Mathematical modeling of chemical engineering systems; solution techniques and dynamics of these systems; introduction to automatic control; feedback control concept; stability analysis; frequency response and

control system designs; introduction to measurement and control instrument characteristics.

2185351 Instrumentation in Chemical Process **3(3-0-6)**

Characteristics, types and limits of measuring instruments used in chemical process industry; temperature, pressure, flow, level, pH, and composition transducers; valve actuators used in process; interfacing components techniques.

2185353 Chemical Process Simulation **3(3-0-6)**

Selection of thermodynamic models; simulation of separation units: flash drum, distillation column, stabilizer, absorber, heat exchanger and reactor; process performance evaluation in terms of material utilization, energy usage, economics and environmental impact using computation tools such as a process simulator.

2185355 Safety in Chemical Operations **3(3-0-6)**

Principles of industrial safety and loss control. Hazards of chemicals. Hazards of chemical operations, hazards assessment, prevention and control of hazards, control system design for safe operation; personal protective devices, storage and transportation of hazardous materials, industrial safety management, emergency planning.

2185370 Fundamentals of Biochemical Engineering **3(3-0-6)**

Overview of biochemical engineering from a chemical engineering perspective. Biomolecules, enzyme kinetics, genetic engineering, cell growth kinetics, bioreactor design and selection, transport processes, product recovery and purification.

2185371 Recovery and Purifications of Bioproducts **3(3-0-6)**

Separation technology in biological processing industries. Cell separation process. Recovery of intracellular and extracellular product. Technology in liquid-solid separation. Technology in liquid mixture separation. Technology in gas mixture separation.

2185372 Biochemical Engineering Processes **3(3-0-6)**

Overview of biochemical processes from different industries. Relationship between unit operation in process. Impacts on process efficiency, economic and environment upon changing raw materials and key operating parameters.

2185380 Introduction to Sustainable Energy **3(3-0-6)**

An overview of sustainable energy from a chemical engineering perspective including available renewable energy options, various new technologies, future energy challenges, energy conversion kinetics and process system.

2185381 Alternative Fuels and Thermochemical Energy Conversion **3(3-0-6)**

Principles of thermochemical energy conversion processes: pyrolysis, gasification, combustion.

2185382 Chemical Engineering Solution toward Circular Economy **3(3-0-6)**

Circular economy concept from product to process: product design to last longer, reuse and recycle concept, waste minimization, and carbon dioxide conversion.

2185451 Chemical Process Design and Analysis **3(2-3-4)**

Basic principles of chemical process design; Analysis of existing chemical processes for improvement opportunities.

2185461 Environmental Chemical Engineering **3(3-0-6)**

Impacts of environmental pollution. Environmental quality standards. Concepts of environmental management system. Sources and characteristics of industrial wastewater and treatment methods. Sources of air pollutions and control methods of particulates and gaseous emission. Characteristics of hazardous wastes and disposal methods.

2185462 Process Optimization **3(3-0-6)**

Application of optimization methods to problems in chemical engineering; Problem definition, model formulation, software implementation to solve problems, and output analysis.

2185463 Instrumental Analysis **3(3-0-6)**

Theory and application of modern instrumental techniques for chemical analysis.

2185464 Special Topics in Chemical Engineering I **3(3-0-6)**

Special topics in Chemical Engineering including new technology.

2185465 Special Topics in Chemical Engineering II **3(3-0-6)**

Special topics in Chemical Engineering including new technology.

2185466 Co-operative Study I **3(2-3-4)**

Working on projects relating to chemical and process engineering in approved industrial plant under supervision.

2185467 Co-operative Study II **3(2-3-4)**

Working on projects relating to chemical and process engineering in approved industrial plant under supervision.

2185468 Co-operative Study III 3(2-3-4)

Working on projects relating to chemical and process engineering in approved industrial plant under supervision.

2185469 Co-operative Study IV 3(2-3-4)

Working on projects relating to chemical and process engineering in approved industrial plant under supervision.

2185470 Introduction to Transport Phenomena in Biological System 3(3-0-6)

Basic principles of fluid mechanics and energy and mass transport with emphasis on applications to living systems. Membrane permeability and diffusive transport. Convection. Transport across cell membranes. Intra- and inter-cellular transport. Blood rheology and transport of gas and small molecules.

2185471 Biomaterials 3(3-0-6)

Definition and properties of biocompatible materials; Bulk and surface properties of biomaterials; Materials in medicine; Cell-material interaction; Host reaction to biomaterials; Testing of biomaterials; Degradation of biomaterials in biological environment; Surface modification; Biomimetic systems; Applications of biomaterials.

2185472 Biological Waste Treatment and Reutilization 3(3-0-6)

Sources and characteristic of wastes from biochemical processes. Treatment options of solid, liquid and gas wastes using biological methods or processes. Concept of zero-waste production and waste reutilization. Examples of waste reutilization from industries.

2185473 Bioenergy Technology 3(3-0-6)

An overview of biofuel/bioenergy technologies; biomass as a renewable energy source; potential contribution of bioenergy to the energy demand; conversion processes and potential effects on environments. Thermal and thermo-chemical conversion of biomass to heat and fuels, bio/chemical conversion processes to bioethanol, biobutanol, biodiesel and biogases, and catalytic transformation of biofuels to value-added chemicals and fuels.

2185474 Computer Modeling in Biochemical Process 3(3-0-6)

Computational simulation of bioreactors and bioprocess operations (e.g., fermentation unit, photobioreactor, antibiotic production, aerobic/anaerobic processes). Computational methods for unit and process scaling, from small to large-scale industrial bioprocesses.

2185481 Materials in Energy Technology 3(3-0-6)

Introduction to materials in energy technology, e.g., polymers, carbon materials, inorganic particles, biomaterials, nano hybrids; Applications of materials in energy storage: electrochemical super capacitors, batteries, fuel cells; Applications materials in energy conversion: solar cells, photovoltaics, OLEDs; Applications of materials in energy generation: catalytic materials for clean energy production; and Applications of materials for environment: green catalytic materials.

2185482 Electrochemical Devices for Energy Application 3(3-0-6)

Operating principles, materials, design, applications and systems of batteries, fuel cells, and other energy storage devices.

2185483 Design of Environmentally Benign Process 3(3-0-6)

Overviews of environmental effects of energy extraction, conversion and use; Sources of pollution from energy technologies; Chemical plants interact with the environment as an integrated system; Design procedures to minimize unwanted effluents to air, water and solid wastes.

2185484 Solar Energy 3(3-0-6)

A foundation overview of solar power and solar energy systems, including technical and physical principles of solar photovoltaics, solar thermal systems, and solar collectors. This course aims to cover various approaches to employ solar energy in different technological systems, to provide adequate depth of understanding of the operational principles for various solar energy systems, and to evaluate different solar energy technologies through knowledge of the physical function of the devices.

2185491 Independent Study I 3(3-0-6)

Knowledge in chemical and process engineering obtained during the study abroad.

2185492 Independent Study II 3(3-0-6)

Knowledge in chemical and process engineering obtained during the study abroad.

2185493 Independent Study III 3(3-0-6)

Knowledge in chemical and process engineering obtained during the study abroad.

2185494 Independent Study IV 3(3-0-6)

Knowledge in chemical and process engineering obtained during the study abroad.

2185495 Independent Study V 3(3-0-6)

Knowledge in chemical and process engineering obtained during the study abroad.

2185499 Chemical and Process Engineering Project 3(0-6-3)

Group or individual project on a subject related to chemical and process engineering with either a theme in bio or sustainable energy.

COURSE DESCRIPTIONS
CHEMICAL ENGINEERING (M.ENG & D.ENG.)

2105522 Dynamic Process Simulation 3(3-0-9)

Fundamental of dynamic model development, lumped parameter systems, solution strategies for lumped parameter systems, distributed parameter systems, Solution strategies for distributed system, parameter system empirical model development, computer aided process modeling, static and dynamic simulation of chemical processes.

2105526 Total Productive Management For Chemical Process Industry 3(3-0-9)

Total Productive Management, usage of Key Management Index, Key Performance Index, Key Activity Index, cascading of organizational resposibility autonomous management, productive maintenance, focused improvement, expansion based on knowledge transfer, quality management, initial phase management, management of safety, health and environment, management of social responsibility.

2105527 Polymer Characterization and Fracture 3(3-0-9)

Structures-Properties-Performance relationship of polymers, the petrochemical and the plastic processing industrial approaches to polymer characterization, modification of polymers by compounding, blending & alloying and composites and their influences on fracture, transitions in polymers, thermal degradation of polymers, deformation in semi-crystalline and glassy polymers, shear yielding and crazing, fracture of polymers, modes of crack growth, brittle and ductile fracture of polymers, fracture morphology and fractography of polymers.

2105572 Encapsulation Process 3(3-0-9)

Encapsulation process, use of encapsualtion process in chemical industry and related industry, main techniques and methods in encapsualtion process, the selection of wall materials, the selection of appropriate technique for core materials, the application of encapsulation process in industries and their products.

2105578 Nanotechnology for Sustainable Society 3(3-0-9)

What is Nanotechnology? Properties of nanomaterials. Why nano-material is so important? Toxicity of nano-materials. Nano-materials in medical, electronic, energy and other applications.

2105599 Batch Chemical Processes 3(3-0-9)

Batch chemical processes: dynamics behavior, start-up, shut-down, batch distillation, batch reaction, batch mixing, batch extraction.

2105601 Advanced Engineering Mathematics for Chemical Engineers 3(3-0-9)

Matrices and solutions of sets of ordinary differential equations. Solution of partial differential equations using metod of infinite series and separation of variables. Bessel functions and legendre polynomials. Vector and tensor analysis. Complex variables. Analytic functions, harmonic functions, Cauchy's integral theorem, Laurent's expansion, and theory of residues. Calculus of variation.

2105602 Advanced Transport Phenomena 3(3-0-9)

Fundamentals of momentum, energy and mass transport. Determination of transport properties. Conservation of mass, momentum and energy in laminar flow and turbulent flow in microscopic approach. Equation of change for multicomponent systems. Dimensional analysis of equation of change. Simultaneous heat, mass, momentum transfer. Laminar and turbulent boundary layer theory.

2105603 Advanced Chemical Engineering Thermodynamics 3(3-0-9)

Introduction to molecular thermodynamics, equations of state, equations for activity coefficients, thermodynamic property determination, multicomponent phase equilibrium, process analysis.

2105604 Advanced Chemical Engineering Kinetics and Chemical Reactor Design 3(3-0-9)

Review of fundamental principles. Order of reactions and rate equations. Theory of rate processes; diffusion, types of reactors, catalysis, mechanical arrangement of reactors for agitation, heat and mass transfer. Methods of designing chemical reactors with emphasis on continuous processing.

2105605 Chemical Engineering Seminar I 1(1-0-3)

Seminar and discussions on current research in chemical engineering for first year students.

2105606 Chemical Engineering Seminar II 1(1-0-3)

Seminar and discussions on current research in chemical engineering for second year students in the first semester.

2105607 Chemical Engineering Process Scale-up 3(3-0-9)

This course examines the technical isses associated with transforming a chemical process from small scale (e.g.lavoratory)tocommercial operation. The concepts underlying chemical principles, unit operations and transport phenomena are integrated to give students an understanding of the methodology involved in converting a laboratory experiment into a process with commercial potential. Specific topics include the effects of scale on the relative rates of mass, heat and momentum transfer, mixing effects, utility of various reactor operating modes (e.g. batch, semi-batch, continuous).

2105608 Adsorption process 3(3-0-9)

Adsorption phenomena, adsorption equilibrium, kinetics of mass transfers in porous particles, adsorption processes with steady-state and periodic operations, mathematical models of adsorption processes, chromatographic separation and gas separation with pressure swing adsorption

2105609 Advanced Particulate Technology 3(3-0-9)

Particle characterization and measurement of physical and chemical properties of powder; transport phenomena and related topics; advanced powder handling operations in the industry; detonation and dust explosion.

2105610 Membrane Technology 3(3-0-9)

Membrane structure and function; Production of membrane; characterization, selection and use of membrane system. Applications for membrane separations in various chemical and biochemical processes.

2105611 Separation Technology via Liquid Membrane and Application 3(3-0-9)

Variety of separation process via liquid membrane; selection of single/multiple extractant systems; design of a particular metal lon separation fromits mixture; the applications of hollow fiber supported liquid membrane in separation of toxic metals, precious metals, rare earth metals and radioactive metals.

2105612 Chemical Engineering Process and Product Development 3(3-0-9)

Strategies for chemical product design: Needs, Ideas, Selection, Manufacture, Strategies for chemical process design: Process synthesis, Process simulation, selection and design of reactors, synthesis of separation system, energy recovery, environmental protection.

2105613 Mass Transfer Operation 3(3-0-9)

Phase equilibrium, General selection criteria for processes. Fundamental principles and calculation methods, distillation, absorption, extraction and adsorption. Capacities and efficiencies of contracting devices. Energy requirements of mass transfer processes. Optimal design operation.

2105614 Application Aspect of Thermodynamics in Process Simulation 3(3-0-9)

Selection of thermodynamic models; design of separation units: flash drum, distillation column, stabilizer and absorber, process dynamics study using process simulation and control system design in phase separation unit.

2105615 Integration of Chemical Engineering Fundamentals 3(3-0-9)

Fundamental of transport phenomena, chemical engineering thermodynamics, and reaction kinetics; integration of transport phenomena, chemical engineering thermodynamics, and reaction kinetics in chemical engineering applications.

2105617 Research Methodology and Statistical Analysis 3(3-0-9)

Steps employed in planning research and conducting research; Steps employed in writing a thesis or a research paper; Plagiarism; Presentation of the research; Test of statistical hypothesis; Analysis of variance; Design and analysis of experiments, Full and fractional factorial designs; Simple linear regression analysis; Multiple linear regression analysis; Basic nonlinear regression analysis.

2105618 Characterization and Instrumental Analysis 3(3-0-9)

Basic concepts of characterization and instrumental analysis: Thermal analysis, Crystallography, Surface analysis, Microscopy, FTIR, Raman spectroscopy, Chromatography, Mechanical testing.

2105619 Advanced Automatic Process Control 3(3-0-9)

Advanced control techniques, control of multiple-input multiple-output processes, discrete-time models. Dynamic response of discrete-time systems. Non-linear process control.

2105620 Research Communication for Chemical Engineers 3(3-0-9)

Essential skill sets for the communication of research. The skill sets will focus on but not limited to the effective literature review process, critical analysis of published works, evaluation of strengths and weaknesses of a manuscript, development of research manuscripts for publication, etc. The course comprises two parts: (I) analysis and (II) design. In analysis, the students will be trained to do effective literature review, analyze and evaluate of published manuscripts, reverse engineer the manuscript, while in design, they will learn by designing each of their own manuscripts with the evaluation feedback learning system from instructors and experienced colleagues.

2105621 Deep Tech Entrepreneurship 3(3-0-9)

Create, identify, and evaluate new venture opportunities. interpret customer needs and quantify the value proposition; leverage innovation ecosystems; business model canvas; develop a winning business plan; scale startups to be globally successful; start and build a successful innovation-driven company; intellectual property right; big data and data analytics for tech startups; social media and marketing; negotiation; venture finance; legal business documents and tax; financial accounting for entrepreneurs.

2105623 Optimization of Chemical Processes 3(3-0-9)

Nature and organization of optimization problems. Fitting models to data. Formulation of objective functions. Optimization of unconstrained functions. Unconstrained multivariable optimization. Linear programming and

application. Nonlinear programming with constraints. Optimization of staged and discrete processes. Application of optimization to chemical processes.

2105625 Process Analysis and Improvement 3(3-0-9)

Process analysis in the view of materials and energy; determine process bottleneck and improve the process by debottleneck; unit performance analysis and key critical parameters; reliability analysis; hazop analysis.

2105626 Advanced Heat Transfer 3(3-0-9)

Radiative heat transfer, radiative properties of real materials, radition exchange between black surfaces and between diffuse gray surfaces, special radiaive problems. Forced convection heat tranfer, convection processes, similarity theory, correlations of heat transfer coefficients, effect of viscous dissipation, non-contimum effect. Analytical methods in conduction heat transfer. Bessel equation, the method of separation of variables, Laplace transforms, finite differences and finite elements. Heat transfer with vapourization, condensation and natural convection.

2105627 Process Operations 3(3-0-9)

Process control and automation; planning and scheduling; maintenance; process trouble shooting.

2105629 Computational Tools in Chemical Engineering 3(3-0-9)

Apply the computer programing for chemical engineering work as well as the routine calculation for process engineer; apply the computer program to collect the data and using for big data management and analysis.

2105630 Heterogeneous Catalytic Reactor Modelling 3(3-0-9)

Introduction to catalytic reactor modelling; criterriafor selection a suitable model; mathematical models of different types of catalytic reactor; catalyst activity model; steady and transient state model.

2105631 Advanced Catalysts for Polymers 3(3-0-9)

Catalyst preparation and characterization of polymers: ziegler-natta catalysts, metallocene catalysts, and late transition metal complex catalysts the application of these catalysts in polymer production.

2105632 Petrochemical Technology 3(3-0-9)

The position today, the chemistry, the economics and where possible, the solid implications. The basis for petrochemicals: catalysts, economic and engineering Chemical components, or elements recovered from petroleum or natural gas. Petrochemical processes with emphasis on the chemical reactions and their kinetics.

2105633 Catalyst Stability 3(3-0-9)

Fundamentals of catalyst deactivation for various reactions through catalyst screening by theoretical quantum chemistry calculation and experiments; analysis and problem solving for catalyst deactivation.

2105634 Catalysis 3(3-0-9)

Adsorption and kinetics of surface reactions; poisoning, selectivity; and empirical activity patterns in catalysis; surface chemistry, catalytic mechanisms and modern experimental techniques in catalytic research; descriptive examples of industrial catalytic system.

2105636 Heterogeneous Catalysis 3(3-0-9)

Theory of adsorption and catalysis. Preparative methods for catalysts. Techniques for catalyst characterization. Chemical reaction in porous catalyst pellets. Effect of intraparticle diffusion, effect of temperature gradient, criteria for diffusion effect. Kientics of heterogenous catalytic reactions. Experimental methods for developing design data. General aspects of catalytic reactor design.

2105637 Design of Industrial Catalysis 3(3-0-9)

The overall design of catalysts, design of the primary and secondary constituents of the catalyst, choice of support materials, experimental testing, summary of some useful general information for catalyst designers, specific example of catalyst design.

2105638 Advanced Polymer Engineering 3(3-0-9)

Polymers and their applications as engineering materials. Structure and properties of polymers. Crystalline and glassy polymer. Polymerisation. Polymer solutions. Mechanical properties of polymers. Theory of rubber elasticity. Yielding of polymers. Polymers. Polymer rheology; viscoelastic properties of polymers and viscoelastic models. Polymer composites.

2105639 Computational Heterogeneous Catalysis Engineering 3(3-0-9)

Introduction to Computational Catalysis Engineering for heterogeneous catalysts study comprises the fundamental of heterogeneous catalysts, the crossroad between quantum chemistry and catalysis, the rise of artificial-intelligence-based tools in catalysis research, and the present and future of catalysis research.

2105640 Aspects in Biorefinery 3(3-0-9)

Overview of biorefinery; challenges and opportunities; utilization of biomass as feedstock for different products such as biofuels, biochemicals, and biopolymers; biorefinery process; feedstock conversion platform technologies; downstream recovery and separation; case studies.

2105641 Biodegradable Material Engineering 3(3-0-9)

Types of biodegradable materials: synthetic and natural materials, sources and production, properties biocompatibility, biodegradation mechmism, test methods for biodegradable plastics; polysaccharides, biopolyester

protein (collagen, gelatin), biodegradable polymers for tissue engineering and controlled release.

2105643 Polymer Processing 3(3-0-9)

Application of heat transfer, fluid mechanics and thermodynamics to the design and control of polymer processing equipment. Detailed consideration of extrusion, calendering, rotational molding, stamping and injection molding.

2105648 Biorefinery for Bioplastic 3(3-0-9)

Bioplastics: from raw materials to end-of-life options; bioplastic structure: bioplastic molecules, polymerization, molecular weight and molecular weight distribution, polymer morphology, molecular arrangement, bioplastic properties (mechanical, thermal and physical); bioplastic processing; bioplastic characterization.

2105649 Polymer Blends and Composites 3(3-0-9)

Terms and Definitions in multicomponent Polymer Systems, Advantages, Interfaces, Polymer Blends, Thermodynamics of Polymer Blends, Phase Separation, Miscibility, Block Coploymers, Polymer Composites Including Filled Polymers and Reinforced Polymers, Processing and Rheology of Multicomponent Systems, Coatings.

2105650 Biochemical Engineering 3(3-0-9)

Microbial kinetics of growth. Various fermentation reactors for pure cultures. Mass transfer in fermentors. Instrumentation and control of biochemical processes, downstream separation in biotechnology and their importance.

2105652 Bioreactor Design Analysis and Control 3(3-0-9)

Analysis of microbial kinetics for bioreactor design; Design and analysis of batch, continuous, and multiphase bioreactors; Advanced control strategies of bioreactors.

2105654 Biosensors 3(3-0-9)

Biochemical phenomena; Principles of measuring and constructing biosensors for applications in biotechnology, medical science, and environmental engineering; various types of biosensors; current research and development in biosensor technology.

2105655 Bioprocess Plant Design 3(3-0-9)

Design and cost analysis of equipment and plant for bioprocess industries; process waste treatments; Case study of bioprocess design.

2105659 Biochemical Separation Technology 3(3-0-9)

Separation technology in biological processing industries. Cell separation process. Recovery of intracellular and extracellular product. Technology in liquid-solid separation. Technology in liquid mixture separation. Technology in gas mixture separation. Current topics of research.

2105663 Heat Transfer Operation 3(3-0-9)

Heat transfer phenomena in Chemical Process Equipment, Conduction, Convection, Radiation, Overall heat transfer coefficient, mean temperature different, heat exchanger in chemical process, design of double pipe heat exchanger, design of shell and tube heat exchanger, boiling and condensing heat transfer, industrial furnace, heat recovery in chemical process, rating of heat exchanger.

2105666 Source Control of Particulate Emissions 3(3-0-9)

Contents of controlling air pollution emissions. Control of particulate emissions-mechanical collectors, filters, electrostatic precipitators, scrubbers, Modeling, design, equipment selection and cost.

2105667 Loss Prevention in Chemical Operation 3(3-0-9)

Identification of hazards. Risk assessment. Preventive measures: control system design for safe operation. Personal protective devices. Emergency Planning.

2105671 Process Dynamics 3(3-0-9)

Dynamic modeling of chemical engineering process; control system design for chemical engineering process dynamic simulation of controlled manufacturing process.

2105672 Simulation of Particulate and Material Processing 3(3-0-9)

Various approaches to mathematical modeling; modeling and simulation of industrial processes involved with particulate material, such as aerosol filtration with fibrous filters, capturing of suspended dust particles using liquid spraying, pneumatic conveying drying, spray drying, fluidization phenomena as well as multi-phase flow of particles using discrete simulation technique.

2105675 Polymer Chemistry for Engineers 3(3-0-9)

Basic concepts and knowledge of polymer chemistry for engineers and their applications; mechanism of polymerizations, kinetics model of polymerization, chemical and physical characterization methods in polymer chemistry to understand polymerization from engineering basis.

2105676 Instrumentation in Chemical Process 3(3-0-9)

The types and fundamental concepts of instrumentation in chemical process and related industry such as temperature, pressure, flow rate, concentration and level. Sensors and actuators used in process industries; signal conditioning and transmission analog and digital controllers; interfacing and communication; programmable logic controllers; distributed process control systems; safety in process automation.

2105678 Introduction to Nanotechnology 3(3-0-9)

Fundamentals of nanotechnology, instrumentation in nanotechnology, nanopowders and nanomaterials, natural nanomaterials, nanobiometrics, preparation of nanomaterials, properties of nanomaterials, applications of nanomaterials mainly in materials technology mediums, energy, electronics and chemical engineering, preparation of carbon nanomaterials and its applications.

2105679 Bioactive Compounds 3(3-0-9)

Physical, chemical and biological properties of bioactive compounds from plants, animals and microorganisms with significant biological activity and important uses in pharmaceuticals, agriculture, cosmetic industries, including synthesis, extraction techniques and development of bioactive properties by bio/chemical/genetic engineering treatment.

2105681 Catalyst Deactivation 3(3-0-9)

Physical and chemical knowledge of catalyst deactivation by fouling, poisoning and sintering, regeneration of fixed beds.

2105682 Surface Technology 3(3-0-9)

Basic concepts and surface chemistry; and inorganic chemistry, absorption and various techniques for surface analysis.

2105683 Bioenergy Technology 3(3-0-9)

Fundamental concepts for biofuel/bioenergy technology. Renewable feedstocks, availability and attributes for biofuel/bioenergy production, Thermochemical conversion of biomass to heat, power, and fuel. Thermal gasification of biomass, Biochemical engineering for conversion of biomass to fuel; ethanol, butanol, methane, hydrogen and biodiesel production, environmental impacts of biofuel production; value-added processing of biofuel residues; case studies on biofuel production.

2105684 Chemical Analysis for Chemical Process Control 3(3-0-9)

Principles of chromatograph (gas and liquid) and spectroscopy, signal charactyeristic, factors affecting signal interpretation, appliaction in real-time process control.

2105685 Selected Topics in Transport Phenomena 3(3-0-9)

Study of specialized topics of interest in transport phenomena assigned by the lecturer with the consent of the head of the department. Written report and oral examination are required.

2105686 Selected Topics in Chemical Engineering Thermodynamics 3(3-0-9)

Study of specialized topics of interest in chemical engineering thermodynamics assigned by the lecturer with the consent of the head of the department. Written report and oral examination are required.

2105687 Advanced Chemical Kinetics and Catalysis 3(3-0-9)

Thermodynamics of chemical reaction; determination of rate expressions; reaction mechanisms; molecular theories of chemical kinetics; chemical systems involving multiple reactions; elements of heterogeneous catalysis; liquid phase reactions and homogeneous catalysis; mass and heat transport process in porous catalysts.

2105688 Selected Topics in Chemical Engineering Kinetics 3(3-0-9)

Study of specialized topics of interest in chemical engineering kinetics assigned by the lecturer with the consent of the head of the department. Written report and oral examination are required.

2105689 Safe Process Operation and Design 3(3-0-9)

Design and operate chemical process with safety consideration. Preventive measures: control system design for safe operation. Emergency Planning.

2105690 Independent study I 3(3-0-9)

Independent studies course provides the platform for students to be involved in a research or industrial project. Students will need to work closely with a faculty member with the consent of the head of the department and external mentor who can guide them through the process of conducting a research study.

2105691 Independent study II 3(3-0-9)

Independent studies course provides the platform for students to be involved in a research or industrial project. Students will need to work closely with a faculty member with the consent of the head of the department and external mentor who can guide them through the process of conducting a research study.

2105692 Independent study III 3(3-0-9)

Independent studies course provides the platform for students to be involved in a research or industrial project. Students will need to work closely with a faculty member with the consent of the head of the department and external mentor who can guide them through the process of conducting a research study.

2105693 Special Problems in process Control Engineering 3(3-0-9)

Study of investigation of special problems in process control engineering assigned by the instructor with the consent of the head of department. The work must be completed within one semester and an examination taken.

2105694 Special Problems in Petrochemical Engineering 3(3-0-9)

Study of investigation of special problems in petrochemical engineering assigned by the instructor with the consent of the head of department. The work must be completed within one semester and an examination taken.

2105695 Special Problems in Polymer Engineering **3(3-0-9)**

Study of investigation of special problems in polymer engineering assigned by the instructor with the consent of the head of department. The work must be completed within one semester and an examination taken.

2105696 Special Problems in Biochemical Engineering **3(3-0-9)**

Study of investigation of special problems in biochemical engineering assigned by the instructor with the consent of the head of department. The work must be completed within one semester and an examination taken.

2105697 Special Problems in Cleaner Production Engineering **3(3-0-9)**

Study of investigation of special problems in cleaner production engineering assigned by the instructor with the consent of the head of department. The work must be completed within one semester and an examination taken.

2105698 Special Problems in Particle Technology **3(3-0-9)**

Study of investigation of special problems in particle technology assigned by the instructor with the consent of the head of department. The work must be completed within one semester and an examination taken.

2105699 Multifunctional Reactor **3(3-0-9)**

Basic concepts and knowledge of different multifunctional reactors and their applications; mathematical modeling and simulation to understand effects of various operating parameters on the multifunctional reactors performance.

2105717 Seminar in Chemical Engineering III **1(1-0-3)**

Review and presentation of specialized topic of modern progress in Chemical Engineering assigned by program committee. Written report presentation and oral examination are required.

2105718 Seminar in Chemical Engineering IV **1(1-0-3)**

Study and discussion of specialized topics of modern progress in Chemical Engineering assigned by program committee. Written report, presentation and oral examination are required.

2105897 Qualifying Examination **0(0-0-0)**

2105811 Thesis **12 Credits**

2105816 Thesis **36 Credits**

2105828 Dissertation **48 Credits**

2105829 Dissertation **60 Credits**

2105830 Dissertation **72 Credits**

2105894 Doctoral Dissertation Seminar **1(1-0-3)**

Study and discussion of dissertation and presentation of the progress of doctoral dissertation.

DEPARTMENT OF MINING AND PETROLEUM ENGINEERING

The Department of Mining and Petroleum Engineering currently offers two undergraduate programs including Georesources Engineering and Petroleum Engineering. These programs are designed to prepare graduates for georesources, petroleum, and related industries both in Thailand and abroad. These programs also facilitate graduates to carry on to higher education.

Courses are designed to give students basic knowledge in both sciences and engineering fundamentals as well as professional subjects of the fields. Optional courses are also offered as electives to accommodate special interest of students or special need of the industry. Practical training is compulsory to familiarize students with industry. English, humanities, and social sciences courses are also requirement of the programs so that students have opportunity to broaden their views as well as English skill.

Georesources Engineering Program

The undergraduate georesources engineering program provides foundation knowledge in all aspects of georesources development. After having broad background in sciences and basic engineering during the first and the second year, students will receive a thorough background in georesources engineering in the first semester of the third year, which will support advanced georesources engineering courses in the third and fourth year. A broad interdisciplinary coverage of georesources development principles including mining geology, mineral exploration, ore reserve estimation, mine development, mining methods of both surface and underground operations, rock mechanics, geostatistics, georesources economics and management, mineral processing and utilization, and environmental aspects of mining operation and resources will be provided for junior and senior levels.

Petroleum Engineering Program

The petroleum engineering curriculum for undergraduate study provides core courses in all aspects of petroleum engineering including rock and fluid properties, reservoir engineering, well logging, drilling engineering, production engineering, production operations, natural gas processing, and petroleum economics. The department also offers a master's degree program in petroleum engineering discipline. The program is specially designed for Thai and foreign students using English as a program language. It is designed for students who graduate with B.Eng. or B.Sc. in petroleum engineering or other related disciplines.

The graduate study curriculum provides an extensive study in petroleum engineering which emphasizes on upstream activities, oil and gas exploration and production. This program will serve industrial demand of highly competent petroleum engineers who are able to conduct both scientific and engineering investigations to solve various problems related to exploration and production of oil and natural gas.

Due to the rapid progress in engineering and trend toward interdisciplinary environment in industries, the department also emphasizes on learning and communication skills of students. In addition, awareness in environmental problems related to engineering work is also an important element in the programs.

HEAD:

Jirawat	Chewaroungroaj,	Ph.D. (U. of Texas at Austin)

ASSOCIATE PROFESSORS:

Jirawat	Chewaroungroaj,	Ph.D. (U. of Texas at Austin)
Kittiphong	Jongkittinarukorn,	Ph.D. (U. of Oklahoma)
Kreangkrai	Maneeintr,	Ph.D. (U. of Regina)
Raphael	Bissen,	Dr.rer.nat (U. of Freiburg)

ASSISTANT PROFESSORS:

Apisit	Numprasanthai,	Ph.D. (Griffith)
Falan	Srisuriyachai,	Ph.D. (U. of Bologna)
Pet	Pakchotanon,	Ph.D. (U. of Regina)
Pipat	Laowattanabandit,	Ph.D. (Colorado School of Mines)

LECTURERS:

Onchanok	Juntarasakul,	D.Eng. (Kyushu U.)
Peet	Homchuen,	Ph.D. (Hokkaido U.)
Theerayut	Phengsaart,	Ph.D. (Hokkaido U.)
Thotsaphon	Chaianansutcharit,	Ph.D. (New Mexico Tech)

GEORESOURCES ENGINEERING UNDERGRADUATE CURRICULUM
FIRST YEAR CURRICULUM

COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER	
2103213	ENG MECHANICS I	3
2106231	CHEM SEP ANAL	2
2106232	CHEM SEP ANAL LAB	1
2106253	GEN GEO	2
2106254	GEN GEO LAB	1
2301207	CALCULUS III	3
5500208	COM PRES SKIL	3
xxxxxxx	GENERAL EDUCATION	3
		18
	FOURTH SEMESTER	
2100201	INTRO AI	3
2101202	MECH MAT I	3
2104201	ENG STAT I	3
2106255	MIN ROCK	2
2106256	MIN ROCK LAB	1
2106241	SUR MIN DSGN	2
2106242	SUR MIN DSGN LAB	1
Xxxxxxx	GENERAL EDUCATION	3
		17
	FIFTH SEMESTER	
2103295	BASIC THERMO	3
2106334	MIN PROC	2
2106335	MIN PROC LAB	1
2106341	GEOTECH ROCK	2
2106342	GEOTECH ROCK LAB	1
2106444	ENG EXP ROCK BLAST	3
2108298	SURVEYING	3
2112347	FUND HYDRAULICS	2
		17

COURSE NO.	SUBJECT	CREDITS
	SIXTH SEMESTER	
2100202	INTRO SCI BIG DATA	3
2103393	ME LAB NON ME	1
2106336	RES PROC	2
2106337	RES PROC LAB	1
2106343	UNDERGROUND DSGN	3
2106412	RES ECON MGT	3
2108306	FLD PRAC TOPO SURV	1
2112344	HYDRAULIC LAB I	1
5500308	TECH WRIT ENG	3
		18
	SUMMER SEMESTER	
2100301	ENG PRACTICE	**2**
	SEVENTH SEMESTER	
2102391	ELEC ENG I	3
2102392	ELEC ENG LAB I	1
2106485	GEORES PROD DEV	3
2106423	ENVI IMPACTS GE	3
xxxxxxx	GENERAL EDUCATION	3
xxxxxxx	FREE ELECTIVES	3
		16
	EIGHTH SEMESTER	
2106486	IOT GE	1
2106489	GEO-RES ENG PROJ	3
	OR	
2100499	ENG PROJ	3
210xxxx	ELECTIVES COURSE (MULTIDISCIPLINARY OR SKILLS FOR 21ST CENTURY)	3
xxxxxxx	GENERAL EDUCATION	3
		13

TOTAL CREDITS FOR GRADUATION = 138

PETROLEUM ENGINEERING UNDERGRADUATE CURRICULUM
FIRST YEAR CURRICULUM

COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER	
2100201	INTRO AI	3
2103213	ENG MECHANICS	3
2103295	BASIC THERMO	3
2106261	PETROLEUM GEOLOGY	3
2106264	INTRO PE	1
2301207	CALCULUS III	3
xxxxxxx	GENERAL EDUCATION	3
		19
	FOURTH SEMESTER	
2103231	MECH MAT I	3
2103351	FLUID MECHANICS I	3
2104201	ENG STAT I	3
2106265	ROCK FLUID PROP	3
2106362	DRILLING ENG	3
5500208	COM PRES SKILL	3
		18
	FIFTH SEMESTER	
2100202	INTRO SCI BIG DATA	3
2106367	RESERVOIR ENG I	3
2106369	PROD TECH	3
2106464	PRODUCTION ENG	3
2106471	PETROLEUM ENG LAB	1
2301312	DIFF EQUATIONS	3
xxxxxxx	GENERAL EDUCATION	3
		19

COURSE NO.	SUBJECT	CREDITS
	SIXTH SEMESTER	
2103393	ME LAB NON ME	1
2106361	WELL LOGGING	3
2106368	RESERVOIR ENG II	3
5500308	TECH WRIT ENG	3
xxxxxxx	GENERAL EDUCATION	3
xxxxxxx	FREE ELECTIVES	3
		16
	SUMMER SEMESTER	
2100301	ENG PRACTICE	**2**
	SEVENTH SEMESTER	
2102391	ELEC ENG I	3
2102392	ELEC ENG LAB I	1
2106462	PET PROC ENG	3
2106465	PETROL ECONOMICS	3
xxxxxxx	ELECTIVE COURSES	3
xxxxxxx	GENERAL EDUCATION	3
		16
	EIGHTH SEMESTER	
2106474	PETRO RES DEV 3	3
2106479	PETROLEUM PROJECT	3
OR		
2100499	ENG PROJ	
xxxxxxx	FREE ELECTIVES	3
xxxxxxx	ELECTIVE COURSES (MULTIDISCIPLINARY OR SKILLS FOR 21ST CENTURY)	**3**
		12

TOTAL CREDITS FOR GRADUATION = 138

STUDY PROGRAM FOR MASTER DEGREE IN GEORESOURCES AND PETROLEUM ENGINEERING
(MINING ENGINEERING)

First Semester			
2186670	Sustainable Mineral and Petroleum Resources Development	3	Credits
2186608	Resources Environment and Life Cycle Pollution Prevention	3	Credits
2186532	Geomechanics	3	Credits
		9	
Second Semester			
2186642	Resources Economics	3	Credits
2186533	Mine Planning and Design	3	Credits
2186XXX	Elective Courses	3	Credits
2186756	Research Seminar	1	Credits (S/U)
		9	
Third Semester			
2186XXX	Elective Courses	6	Credits
2186811	Thesis	3	Credits
		9	
Fourth Semesters			
2186811	Thesis	9	Credits
		9	

Graduate students with no mining engineering background must complete the following courses within the first year of study.

2186524	Basic Georesources Engineering	3	Credits
2186534	Basic Geology	3	Credits
		6	

STUDY PROGRAM FOR MASTER DEGREE IN GEORESOURCES AND PETROLEUM ENGINEERING
(RESOURCES RECYCLING ENGINEERING)

First Semester

2186670	Sustainable Mineral and Petroleum Resources Development	3	Credits
2186608	Resources Environment and Life Cycle Pollution Prevention	3	Credits
2186509	Resources Process Technology and Utilization	3	Credits
		9	

Second Semester

2186642	Resources Economics	3	Credits
2186623	Process Separation for Resources Recovery	3	Credits
2186XXX	Elective Courses	3	Credits
2186756	Research Seminar	1	Credit (S/U)
		9	

Third Semester

2186XXX	Elective Courses	6	Credits
2186811	Thesis	3	Credits
		9	

Fourth Semesters

2186811	Thesis	9	Credits
		9	

Graduate students with no resources recycling engineering background must complete the following courses within the first year of study.

2186524	Basic Georesources Engineering	3	Credits
2186535	Basic Minerals and Rocks	3	Credits
		6	

STUDY PROGRAM FOR MASTER DEGREE IN GEORESOURCES AND PETROLEUM ENGINEERING
(PETROLEUM ENGINEERING)

First Semester

2186670	Sustainable Mineral and Petroleum Resources Development	3	Credits
2186651	Advanced Reservoir Engineering	3	Credits
2186671	Advanced Natural Gas Engineering	3	Credits
		9	

Second Semester

2186664	Petroleum Well Construction	3	Credits
2186667	Production System Analysis	3	Credits
2186XXX	Elective Courses	3	Credits
2186756	Research Seminar	1	Credit (S/U)
		9	

Third Semester

2186XXX	Elective Courses	6	Credits
2186811	Thesis	3	Credits
		9	

Fourth Semester

2186811	Thesis	9	Credits
		9	

Graduate students with no petroleum engineering background must complete the following courses within the first year of study.

2186565	Basic Petroleum Geology	3	Credits
2186566	Petrophysics	3	Credits
2186567	Basic Reservoir Engineering	3	Credits
2186568	Basic Drilling Engineering	3	Credits
2186569	Basic Production Engineering	3	Credits
		15	

STUDY PROGRAM FOR DOCTOR OF PHILOSOPHY DEGREE IN GEORESOURCES AND PETROLEUM ENGINEERING

First Semester			
2186828	Dissertation	8	Credits
2186894	Doctoral Dissertation Seminar		Credit (S/U)
		8	
Second Semester			
2186828	Dissertation	8	Credits
2186894	Doctoral Dissertation Seminar		Credit (S/U)
2186897	Qualifying Examination		Credit (S/U)
		8	
Third Semester			
2186828	Dissertation	8	Credits
2186894	Doctoral Dissertation Seminar		Credit (S/U)
		8	
Fourth Semester			
2186828	Dissertation	8	Credits
2186894	Doctoral Dissertation Seminar		Credit (S/U)
		8	
Fifth Semester			
2186828	Dissertation	8	Credits
2186894	Doctoral Dissertation Seminar		Credit (S/U)
		8	
Sixth Semester			
2186828	Dissertation	8	Credits
2186894	Doctoral Dissertation Seminar		Credit (S/U)
		8	

COURSE DESCRIPTION INS GEORESOURCES ENGINEERING (B.ENG.)

2106231 Chemistry for Separation and Analysis 2(2-0-4)

Thermochemistry; Phase equilibria and physical properties of matter and heterogeneous mixture; Colligative properties of solution; Colloid and surface chemistry; Surface chemistry and application in materials separation; Electrochemistry and corrosion; Separation and analysis of metal ions in solution; Basic chemical analysis and spectroscopic techniques; Materials characterization by X-ray and microscopic techniques.

2106232 Chemistry for Separation and Analysis Laboratory 1(0-3-0)

Condition: Co-requisite 2106231

Laboratory experiments in chemistry for separation and analysis.

2106241 Surface Mining and Design 2(2-0-4)

Mining and human; Stages of surface mining; Unit operations of surface mining; Reserve estimation; Pit design; Short-and long-term planning; Road layouts; Dump planning; Cost estimation; Equipment machinery selection; Case studies.

2106242 Surface Mining and Design Laboratory 1(0-3-0)

Condition: Co-requisite 2106241

Application using computer for mine planning and design.

2106253 General Geology 2(2-0-4)

Scope of geology; The universe and the earth; Surface of the earth's crust and the geological processes; Deformation of the earth's crust; Rock structures; Problems of dip and strike; Vein intersection; Faulting and folding; Geological maps and sections; Field techniques in geological mapping; Collection of field specimens; Well logging and drill core; Preparation of geological maps and reports.

2106254 General Geology Laboratory 1(0-3-0)

Condition: Co-requisite 2106253

Effects of temperature on liquid viscosity; Effects of temperature and/or surfactant on liquid surface tension molecular weight determination via colligative properties of solution; Preparation of standard solution and standardization; Ore dissolution and fusion; Analysis of metal ion in solution oy redox titration; Potentiometric titration and spectrometry.

2106255 Minerals and Rocks 2(2-0-4)

Basic knowledge of mineralogy; Crystallography; Crystal system; Physical properties; Identification of rock-forming and economic minerals; Origin of igneous; Sedimentary and metamorphic rock; Geological and engineering classification rocks.

2106256 Minerals and Rocks Laboratory 1(0-3-0)

Condition: Co-requisite 2106255

Laboratory experiments in minerals and rocks.

2106334 Mineral Processing 2(2-0-4)

Theory of physical methods of mineral processing; Introduction of material transportation and storage; Sampling; Comminution; Liberation; Screening; Classification; Size determination; Gravity separation; Magnetic separation; Electrical separation, Introduction to flotation; Simple flow sheets for mineral processing plants.

2106335 Mineral Processing Laboratory 1(0-3-0)

Condition: Co-requisite 2106334

Laboratory experiments in mineral processing.

2106336 Resources Processing 2(2-0-4)

Condition: Prerequisite 2106334

Physical and chemical separation technology for mineral processing and resources recycling; Process design and equipment selection for size reduction; Size classification and Separation; Classification and separation efficiency; Particle motion in fluids for classification and separation; Magnetic and electrical separation; Surface chemistry and thermodynamics of particles-bubbles attachment; Mechanisms and processes of mineral flotation; Solid-liquid separation; Size enlargement and agglomeration; Pyrometallurgy and Hydrometallurgy; Advanced resources processing flow sheets design.

2106337 Resources Processing Laboratory 1(0-3-0)

Condition: Co-requisite 2106336

Laboratory experiments in resources separation and recovery.

2106341 Geotechniques and Rock Engineering 2(2-0-4)

Applied geology in engineering works; Rock mechanics, stress, and strain; In-situ stress; Discontinuities; Rock mass classification; Rock engineering applied in georesources engineering; Soil properties; Grain size distribution; Atterberg's limits; Engineering soil classification; Soil mechanics; Permeability; Seepage; Compaction; Compressibility; Consolidation; Soil engineering applied in georesources engineering; Geotechnique laboratory; Geotechnical instrumentation and monitoring.

2106412 Resources Economics and Management 3(3-0-6)

Mineral demand and supply; Mineral trade and markets; Mineral forecasting techniques; Government regulations and taxation; Resources evaluation; Economics of resources development; Project management.

2106414 Resources Process Technology and Utilization 3(3-0-6)

Extraction, processing and utilization of resources; Review of fundamental principles of process technology and utilization of resources; Concepts of technology application; Processes of extraction and improvement of material quality; Review of principle of process design.

2106415 Resources Recovery and Recycling 3(3-0-6)

Recyclable resources; Recycling of non-metal; Recycling of ferrous and non-ferrous metals; Principles of recycling; Criteria for recovery and recycling; Potential benefits of recycling; Recycling technology; Limitation of recycling; Markets for recycle; Factors affecting recycle rates; Environmental aspects of recycling.

2106423 Environmental Impacts and Prevention for Georesources Engineering 3(3-0-6)

Environmental and pollution prevention of geo-resources; Environmental laws and regulations; Major environmental problems impacts from production and utilization of geo-resources; Scope of environmental impact assessment; Environmental technologies to manage and control problems; Waste minimization; Waste disposal and utilization; Environmental planning for the development and utilization of geo-resources.

2106424 Sustainable Development for Georesources Engineering 3(3-0-6)

Mineral and petroleum resources resource development for economic growth; Concept of sustainable development (SD); Overview of benefit-cost analysis for social and environmental consideration; Implications of sustainable development for mining industry; Public participation and community relationship in resource development project.

2106425 Environmental Systems and Modeling for Georesources Engineering 3(3-0-6)

Mining and petroleum processes; Pollutants caused by mining and petroleum activities; Types of environmental models for mining and petroleum activities; Environmental model developing; Applying environmental models to predict; Air qualities; Surface water qualities; Ground water qualities and sea water qualities which are affected by mining and petroleum activities; Model limitations.

2106428 Geostatistics 3(3-0-6)

Introduction to geostatistics; Spatial data and geostatistical approach; Problems and geostatistical solution; Structure of regionalized variable and its applications on sampling analysis and optimization; Kriging system and characteristic features; Estimator and estimation variance; Use of computer codes.

2106433 Material Characterization 3(3-0-6)

Theories and use of techniques in material analysis including mineralogy, microscopic techniques; Differential thermal analysis; Thermogravimetric analysis; X-ray refraction; X-ray fluorescence; Atomic absorption spectrometry; Inductively coupled electron analysis; Chemical analysis.

2106434 Material Handling Engineering 3(3-0-6)

Theories and design of material handling processes; Belt conveyor; Chain; and bucket elevator; Bin and bunker design; Stock piling; Blending and homogenizing; Feed control of bulk solids; Slurry pipeline transportation; Tailing disposal.

2106438 Clean Coal Technologies 3(3-0-6)

Coal utilization; Coal reserve; Coal gasification; Coal dust explosion; Coal storage; Combustion; Pollution management; Carbon capture and storage.

2106444 Engineering Explosive and Rock Blasting 3(3-0-6)

Concepts of rock fragmentation; Drilling and blasting; Type of explosives and accessories; Characteristics and properties of explosives; Safety in the transportation; Storage and handling of explosives; Rock blasting practices; Delay blasting; Bench blasting design; Controlled blasting techniques; The control of ground vibration; Airblast.

2106447 Mine Machinery and Equipment 3(3-0-6)

Unit operations of surface and underground mining; Types and capability of machinery and equipment; Procurement; Machine utilization; Maintenance; Case studies; Progression of technology.

2106449 Quarrying and Crushing Plant 3(3-0-6)

Types and uses of construction stone, dimension stone, and sand for construction purposes; Industrial standards and testing; Stone resources and their geological characteristics in Thailand; Construction sand deposits in Thailand; Reserve estimation; Planning and design for quarry and sand mining; Calculation and design for stone crushing plants and sand processing; Dimension stone mining techniques; Relevant pollution control; Production cost estimation.

2106458 Mining Geology 3(3-0-6)

Origin and occurrence of mineral deposits; Mineral associations; Alterations and classification; Geologic factors controlling characteristics of ore-body; Surface and underground geological; Geochemical and geophysical prospecting; Planning for exploration drilling sampling techniques; Ore reserve estimation; Grade control; Fundamental of geostatistics.

2106481 Advanced Topics in Geo-Resources Engineering I 3(3-0-6)

Topics of current interest and/or new development in various fields of Geo-Resources Engineering.

2106483 Special Problems in Geo-Resources Engineering I 3(2-3-4)

Special problems in Geo-Resources Engineering and their solutions.

2106485 Georesources Production and Development 3(3-0-6)

Georesources engineering project to solve the complex engineering problem by design the methods; Processes; or tools; That can serve of the industrial and community demands.

2106486 Internet of Thing for Georesources Engineering 1(0-3-0)

Change of information technology; Internet of thing; Big Data; Applications of internet of thing in georesources engineering; Case studies.

2106488 Practical Education for Resources Engineering 3(2-3-4)

Practical interesting projects / topics for resources and petroleum engineering

2106489 Geo-Resources Engineering Project 3(3-0-6)

Practical interesting projects of problems in various fields of Geo-Resource Engineering

COURSES DESCRIPTIONS IN PETROLEUM ENGINEERING (B.ENG.)

2106264 Introduction to Petroleum Engineering 1(1-0-2)

Introduction to petroleum industry; Economics and structure of petroleum industry; Petroleum prospecting; Drilling operation; Petroleum production system; Reservoir performance; Petroleum transportation and utilization.

2106265 Rock and Fluid Properties 3(3-0-6)

Porosity; Permeability; Fluid saturation; Resistivity; Wettability; Capillary pressure; Relative permeability; Application of Darcy's equation; Phase behavior; Equations of state; PVT properties and determination.

2106361 WELL LOGGING 3(3-0-6)

Condition: Prerequisite 2106265

Principles, applications, and interpretation of opened-hole logs as used in petroleum exploration and reservoir evaluation.

2106362 Drilling Engineering 3(3-0-6)

Drilling fluids, drilling hydraulics; Drilling bit and drill string; Directional drilling; Casing and cementing; Drilling well control.

2106367 Reservoir Engineering I 3(3-0-6)

Condition: Prerequisite 2106265

Petroleum reserves; Reservoir drive mechanism; Volumetric calculation; Material balance; Decline curve analysis; Fluid flow in porous media; Water influx.

2106368 Reservoir Engineering II 3(3-0-6)

Condition: Prerequisite 2106367

Oil and gas well tests; Water flooding; Introduction to numerical reservoir simulation.

2106369 Production Technology 3(3-0-6)

Condition: Prerequisite 2106362

Well completion; Wireline and coiled tubing operation; Perforating; Formation damage mechanism and migration; Sand production and its control; Well stimulation; Well surveillance and workover.

2106462 Petroleum Process Engineering 3(3-0-6)

Handling, separating of oil, gas and water; Acid gas treating; Gas dehydration; LNG; Transmission; Natural gas.

2106464 Production Engineering 3(3-0-6)

Condition: Prerequisite 2106265

Multiphase flow in pipe; Inflow performance; Nodal analysis; Restricted flow into a wellbore; Artificial lift; Oil and gas production system.

2106465 Petroleum Economics 3(3-0-6)

Economic evaluation of petroleum projects, generating forecasts of key technical and economic parameters for the discounted cash flow (DCF) model of petroleum development projects; World oil markets and price mechanisms; Petroleum fiscal system analysis; Expected value and decision tree analysis for petroleum exploration projects; Baysian analysis and value of information.

2106466 Improved Oil Recovery 3(3-0-6)

Condition: Prerequisite 2106367

Secondary recovery; Mobility- control processes; miscible displacement; Chemical flooding; Thermal recovery.

2106471 Petroleum Engineering Laboratory 1(0-3-0)

Condition: Prerequisite 2106265

Viscosity; Specific gravity; Physical and chemical properties of drilling fluids; Particle size distribution; Porosity and permeability; Fluid saturation; Wettability and relative permeability.

2106472 Well Design and Operations Planning 3(3-0-6)

Condition: Prerequisite 2106362

Petroleum well design and construction; Drilling procedures and well completion practices; Well cost estimation; Drilling program; Wellsite operation and logistics; Well operation planning and reporting.

2106473 Reservoir Management 3(3-0-6)

Condition: Prerequisite 2106367

Numerical reservoir simulation; Enhanced oil recovery techniques; Field development planning; Reservoir management procedures.

2106474 Petroleum Resources Development 3(2-3-4)

Condition: Prerequisite 2106362, 2106367, 2106464

Integrated approach to petroleum resources exploration and development application of geological and petroleum engineering methods in designing petroleum production / injection wells with emphasis on teamwork.

2106475 Advanced Topics in Petroleum Engineering I 3(3-0-6)

Topics of current interest and/or new development in various fields of petroleum engineering.

2106477 Special Problems in Petroleum Engineering I 3(2-3-4)

Study or investigation of special problems in petroleum engineering.

2106479 Petroleum Engineering Project 3(0-6-3)

Practical interesting projects or problems in various fields of petroleum engineering.

COURSE DESCRIPTIONS IN GEORESOURCES AND PETROLEUM ENGINEERING (M.ENG.)

2186509 Resources Process Technology and Utilization 3(3-0-9)

Extraction, processing, and utilization of resources; Review of fundamental principles of process technology and utilization of resources; Concepts of technology application; Processes of extraction and improvement of material quality; Review of principles of process design.

2186510 Materials Handling 3(3-0-9)

Materials handling involving storage and stockpiling; Theory of flow solids in bins and bunkers; Design of bins and bunkers; Conveyors and feeders; Homogenization; Hydraulic transport in pipe, pneumatic transport, and waste sorting and disposal.

2186512 Chemical Process Separation 3(3-0-9)

Chemical processing of materials; Chemical processing according to solid state chemistry and solution chemistry; The studies involve roasting calcination and sintering; Oxidation and reduction of materials, leaching reactions; Kinetics, thermodynamics and electrochemical theory of leaching reactions; Applications of solvent extraction and ion exchange; Equilibrium and kinetics in solvent extraction and ion exchange: halogenation; Calculations and design of chemical processing unit operations and cases study.

2186522 Materials Characterization 3(3-0-9)

Theories and techniques in material analysis including mineralogy, microscopy, differential thermal analysis, atomic absorption, x-ray diffraction, x-ray fluorescence, inductively coupled plasma spectrometry, electron microscope, and electron probe microanalysis.

2186524 Basic Georesources Engineering 3(3-0-9)

Basic principles in mining industry and georesousces development; Exploration; Evaluation of mineral deposits; Mining method; mineral processing and recycling; Environment, health, and safety considerations in mine operation.

2186525 Carbon credits for Oil and Gas Business Sector 3(3-0-9)

Upstream and downstream oil and gas business; Domestic and international policies and guidelines for oil and gas business; Geographical factors to reduce CO_2 emission; Carbon dioxide pricing policies; Evaluation of CO_2 emissions in other measurable units; Credit gain evaluation from CO_2 reduction; Building new carbon managing partners; Creating carbon neutral in oil and gas business. Road mapping for sustainability in oil and gas industries.

2186526 New CO_2 and Methane Emissions Target for Oil and Gas Industries 3(3-0-9)

Carbon capture utilization and storage (CCUS) technologies; Reusing or storing of CO_2; Controlling CO_2 emission; Gas pipeline regulations; Quality and regulations for LNG industries; LNG projects and opening markets for LNG trade.

2186528 Advanced Clean Coal Technology 3(3-0-9)

Coal utilization; Coal reserve; Coal gasification; Coal dust explosion; Coal storage; Combustion; Pollution management; Carbon capture and storage.

2186531 Advanced Geostatistics 3(3-0-9)

Geostatistics principle; Non-linear geostatisics; Cokriging and cross validation; Indicator kriging; Principle of stochastic simulation; Simution with Gaussian-related algorithms and indicator based approaches.

2186532 Geomechanics 3(3-0-9)

Engineering properties of rock; Rock measurement and classification; Stress – strain analysis; In-situ stress; Failure criteria; Rock stability and well bore stability analysis; Geomechanics application to rock excavation; Hydraulic fracturing; Geomechanical monitoring.

2186533 Mine Planning and Design 3(3-0-9)

Review surface and underground mining methods; Stages of mining activities; Ore modeling and reserve estimation; Concept of mine planning and design to maximize profit with less environmental impact; Various elements in mine planning and design processes; Planning and design by using a mining software.

2186534 Basic Geology 3(3-0-9)

Study of the universe and the earth; Surface feature of the earth' s crust and the geological processes; Plate tectonic; Structural geology including problems of dip and strike, vein intersection, faulting and folding; Minerals and rocks; Geological maps and sections; Hydrogeology and geophysical prospecting.

2186535 Basic Minerals and Rocks 3(3-0-9)

Basic knowledge of mineralogy; Crystallography; Crystal system; Physical properties; Identification of rock-forming and economic minerals; Origin of igneous, sedimentary, and metamorphic rock; Geological and engineering classification of rocks.

2186550 Numerical Methods for Georesources Engineering 3(3-0-9)

Particular cases of mathematical calculation and modeling in georesources engineering; Error analysis. Why numerical methods; Various approaches of numerical methods; Application of finite element method (FEM), finite difference method (FDM), and boundary element methods (BEM) to solve particular problems in geo-engineering works.

2186565 Basic Petroleum Geology 3(3-0-9)

Surface features of the earth's crust and the geological processes, deformation of the earth's crust, rock structures, dip and strike, faulting and folding, geological map and section, petroleum origin, migration, and accumulation; Chemical composition of petroleum, stratigraphy, nature of source rocks, reservoirs and traps, geological field methods.

2186566 Petrophysics 3(3-0-9)

Rock mineralogy, porosity, permeability, rock- fluid properties, spontaneous potential logs, resistivity logs, gamma ray logs, porosity logs and porosity crossplots.

2186567 Basic Reservoir Engineering 3(3-0-9)

Reservoir drive mechanisms; Classification of petroleum reserves; Volumetric reserve calculation; Material balance; Decline curve analysis; Fluid flow in porous media.

2186568 Basic Drilling Engineering 3(3-0-9)

Mechanics of rotary drilling; Drilling fluids and their hydraulics; Directional drilling; Formation pore pressure and fracture resistance; Casing and cementing; Well control.

2186569 Basic Production Engineering 3(3-0-9)

Well completion; Subsurface and wellhead equipment; Perforating; sand control; Formation damages and well stimulation; Surface production processes; Production problems and remedies; Well intervention and workover.

2186608 Resources Environment and Life Cycle Pollution Prevention 3(3-0-9)

Major environmental problems from production and utilization of resources; Technology to manage and control the environmental problems; Waste minimization and disposal; Environmental planning for sustainable resources development and utilization, including relevant environmental issues in global arena.

2186623 Process Separation for Resources Recovery 3(3-0-9)

Review of fundamentals of separation processes; Mass balance; Review of fundamentals of separation processes; Mass balance and mass balance adjustment; Separation efficiency; Separation by physical properties; Comminution and classification; Gravity separation; Separation by magnetic and electrical properties; Flocculation and coagulation; Flotation; Introduction to chemical processing.

2186635 Industrial Minerals Technology 3(3-0-9)

The technology of industrial minerals; Extraction, processing and utilization of some major industrial minerals and dimension stones and quality improvement of these industry minerals and dimension stones to meet the industrial requirements; Discussion of advanced technology of these activities with case studies.

2186636 Fuel Minerals Technology 3(3-0-9)

The technology of fuel minerals; Evaluation or assessment; Mining processing and utilization of the fuel minerals and quality improvement of these fuel minerals to meet the industrial requirements; Discussion of advanced technology of these activities with case studies.

2186637 Quarry Technology 3(3-0-9)

The technology of rock and sand aggregate; Deposit evaluation, quarrying, size reduction to various industrial application; Economic aspects of the technology; Quality improvement of products according to industrial specification; Discussion of advanced technology of these activities with case studies.

2186638 Advanced Geotechnique 3(3-0-9)

Review soil and rock mechanics; Investigation and data collection; Application of soil mechanics theory to both mining and civil engineering works; Application of rock mechanics theory to both mining and civil engineering works; Grouting in engineering projects; Rock support and reinforcement; Various analysis methods in Geotechnique; Case studies on either rock slope engineering or underground excavations.

2186639 Resources Recovery and Waste Recycling 3(3-0-9)

Classification of resources: renewable and non-renewable; Resources utilization and recycling; Waste utilization, waste-to-raw materials, and waste-to-energy; Life cycle and sustainable resource management; Sustainable consumption and production: concept and case study.

2186640 Advanced Particle Technologies for Georesources Engineering 3(3-0-9)

Particle characterization, grinding; Powder separation; Mixing; Agglomeration; Transport of powder; Storage of powder; Safety in operation; Dust explosion; Dust collection.

2186641 Space Mining 3(3-0-9)

Legal aspects – mining concession, resource sharing, investments, etc.; Geology of the solar system: planets, asteroids, meteorites, etc.; Mining process: environments, resources, technological challenges, etc.; Mineral processing and handling.

2186642 Resources Economics 3(3-0-9)

Mineral demand and supply; Mineral trade and markets; Minerals market model forecasting techniques; Time series forecasting; Government regulations and taxation; Allocation and distribution of earth resources; Resources evaluation; Utilization; Cost-benefit analysis; Optimal control approach to earth resources development control.

2186651 Advanced Reservoir Engineering 3(3-0-9)

Oil and gas well tests; Waterflooding; Water and gas coning; Reservoir management.

2186652 Reservoir Simulation 3(3-0-9)

Principles and mathematical techniques in numerical simulation for multiphase, multidimensional flow in porous media; Applications of reservoir simulation; History matching techniques; Data preparation.

2186656 Carbon Capture and Storage 3(3-0-9)

Climate change; Fundamental of absorption, adsorption, membrane, cryogenics; Carbon storage; Storage capacity assessment; Monitoring.

2186657 Unconventional Resources Production 3(3-0-9)

Properties of heavy oil; Production of heavy oil; Thermal recovery; Steam flooding; Gas injection; Steam assisted gravity drainage; In-situ combustion; Tar sand or oil sand; Oil shale; Coalbed methane; Gas hydrate.

2186662 Enhanced Oil Recovery 3(3-0-9)

Fundamental of EOR; Miscible flooding; Thermal flooding; Chemical flooding; Current technology in EOR; EOR screening.

2186664 Petroleum Well Construction 3(3-0-9)

Well planning process; Casing and cementing design; Well design and drilling program; Well control operation; Drilling problems and remedies; Modern drilling technology.

2186666 Advanced Petrophysics 3(3- 0- 9)

Electrical property of reservoir rock; Surface properties of different lithologies; Reversal of rock wettability by natural mechanism; Oil recovery mechanism related to surface properties; Petrophysical properties in complex formation; Shaly sand interpretation; Carbonate interpretation; Abnormally overpressure; Fractures.

2186667 Production System Analysis 3(3-0-9)

Single- and multiple- phase flow in pipes and restrictions; Inflow and outflow performances; Nodal analysis; Restricted flow into wellbore; Artificial lift methods.

2186670 Sustainable Mineral and Petroleum Resource Development **3(3-0-9)**

Mineral and petroleum resource development for economic growth; Concept of sustainable development (SD); Overview of resource development technology; The future availability of resources; Implications of sustainable development for mining and petroleum industry; Community relationship in resource development project.

2186671 Advanced Natural Gas Engineering **3(3-0-9)**

Management of oil, natural gas, and water separation from petroleum production; Emulsion; Heat transfer; Heat exchanger; Natural gas processing; Acid gas treating; Gas dehydration; LNG; Gas transmission; Gas compression.

2186676 Advanced Petroleum Economics **3(3-0-9)**

Petroleum exploration and production investment analysis; Deterministic models of petroleum development project; Modeling of petroleum fiscal system; Project evaluation criteria and basic risk considerations; Probabilistic models of petroleum exploration projects; Expected value; Decision tree analysis; Value of information.

2186678 Petroleum Field Development **3(3-0-9)**

Petroleum engineering works in exploratory drilling; Development of oil and gas fields; Production forecast; Reservoir dynamics; Managing producing and declining fields; Uncertainty propagation assessment; Decommissioning.

2186721 Advanced Resources Recovery and Recycling **3(3-0-9)**

Principles of Resource Recycling; Types of secondary resources; Criteria for recovery and recycling; Benefits and limitations of recycling; Rates of recycling and resource depletion; Energy conservation from recycling; Review of separation processes, physical, chemical and bacterial processes; Recycling of metals, ferrous and non-ferrous metals; Non-metals; Industrial wastes; Electronic and electrical equipment wastes; End of Life Vehicle wastes; Packaging wastes; Construction and demolition wastes; Liquid and waste water from processes; Sub-marginal mineral deposits and low grade tailings; Energy recovery from wastes; Unconventional resources; Economic aspects in resource recovery and recycling; Environmental aspects relating to recovery and recycling; Current legal and administrative management in Thailand and international; Trade and market for recycles; Planning and design of material recovery facilities; feasibility study case studies.

2186756 Research Seminar **1(1-0-3)(S/U)**

Condition: Consent of faculty

Department seminar on current research or research seminar on current interesting issues.

2186811 Thesis **12 Credits**

COURSE DESCRIPTIONS IN GEORESOURCES AND PETROLEUM ENGINEERING (Ph.D.)

2186828 Dissertation **48 Credits**
2186894 Doctoral Dissertation Seminar **(S/U)**
2186897 Qualifying Examination **(S/U)**

DEPARTMENT OF ENVIRONMENTAL ENGINEERING AND SUSTAINABILITY

The aim of the Department of Environmental Engineering and Sustainability is to teach and train students to be engineers with a competent knowledge (theoretical and practical) of surveying, planning and design, consulting and operating in the following fields:

1. water supply and treatment
2. drainage system and wastewater treatment
3. environmental sanitation
4. industrial environment
5. air pollution control
6. water pollution control and management
7. urban and rural sanitation
8. solid waste management
9. hazardous wastes treatment
10. environmental management

Moreover, students are obliged to use their own creative idea and self-responsibility. They are also encouraged to take an interest in techniques, foresee problems in the future and develop a sustainability of man and nature

HEAD:

Jenyuk	Lohwacharin	Ph.D. (Tokyo)

PROFESSORS:

Orathai	Chavalparit	Ph.D. (Wageningen)
Chavalit	Ratanatamskul,	Ph.D. (Tokyo)
Viboon	Sricharoenchaikul,	Ph.D. (Georgia Tech)
Chanathip	Pharino,	Ph.D. (MIT)
Pisut	Painmanakul	Ph.D. (INSA-Toulouse)

ASSOCIATE PROFESSORS:

Benjaporn	Suwannasilp	Ph.D. (Stanford)
Jenyuk	Lohwacharin	Ph.D. (Tokyo)
Khemarath	Osathaphan,	Ph.D. (Oregon State)
Manaskorn	Rachakornkij,	Ph.D. (New Jersey)
Patiparn	Punyapalakul,	Ph.D. (Tokyo)
Pichaya	Rachdawong,	Ph.D. (Wisconsin-Milwaukee)
Sirima	Panyametheekul,	Ph.D. (Imperial College)
Sutha	Khaodhiar,	Ph.D. (Oregon State)
Tawan	Limpiyakorn,	Ph.D. (Tokyo)
Wiboonluk	Pungrasmi,	Ph.D. (Tokyo)
Dao Suwansang	Jancharoen	Ph.D. (Illinois at Urbana-Champaign)

ASSISTANT PROFESSORS:

Achariya	Suriyawong,	Ph.D. (Washington)
Chaiyaporn	Puprasert,	Ph.D. (INSA-Toulouse)
On-anong	Larpparisudthi,	Ph.D. (Coventry)
Sarun	Tejasen,	Ph.D. (Oregon State)

LECTURERS:

Win	Trivitayanurak,	Ph.D. (Carnegie Mellon)

ENVIRONMENTAL ENGINEEING CURRICULUM
FIRST YEAR CURRICULUM

COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER	
2103213	ENG MECHANICS I	3
2107311	BIO ENV ENG	3
2107214	AQUA CHEM ENV ENG	3
2107217	EMER PROB ENV ENG	3
xxxxxxx	GENERAL EDUCATION	3
xxxxxxx	FREE ELECTIVE	3
		18
	FOURTH SEMESTER	
2107216	CHEM LAB ENV ENG	1
2112347	FUND HYDRAULICS	2
2107451	PRIN PUB HLTH	2
2100201	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	3
2104201	ENG STAT I	3
2107321	AIR QUA ENG	4
xxxxxxx	GENERAL EDUCATION	3
		18
	FIFTH SEMESTER	
2112344	HYDRAULICS LAB I	1
2107314	PHYCHEM UNIT PROC ENV ENG	3
2107218	FUND SEP PRO ENV ENG	2
2107484	SOLID WASTE ENG	3
2108298	SURVEYING	3
xxxxxxx	GENERAL EDUCATION	3
		15

COURSE NO.	SUBJECT	CREDITS
	SIXTH SEMESTER	
2112342	PRIN HYDROLOGY	3
2107462	HAZ WASTE TREAT	3
2107444	BUILDING SAN	3
2107449	IND SAFE MANAGE	2
2107481	INT ENV IMP ASSESSMENT	3
xxxxxxx	GENERAL EDUCATION	3
		17
	SUMMER SEMESTER	
2100301	ENGINEERING PRACTICE	2
	SEVENTH SEMESTER	
2107413	WASTEWATER ENG	3
2107471	ECON ENV ENG	3
2107485	WASTE UTILIZATION	2
2107446	AIR QUA TOOL DATA ANA	3
2107491	CAP PROJ	1
5500208	COMMUNICATION AND PRESENTATION SKILL	3
		15
	EIGHTH SEMESTER	
2107414	WAT SUP ENG	3
2112581	CC MIT ADAP RES	3
2107450	ENV SYS AND MANAGE	3
2107492	ENV ENG PROJ	2
5500308	TECHNICAL WRITING FOR ENGINEERING	3
xxxxxxx	FREE ELECTIVE	3
		17

TOTAL CREDITS FOR GRADUATION = 138

NAME OF THE DEGREE

: Master of Engineering
: M.Eng.

DEPARTMENT STAFFS

HEAD:

Jenyuk	Lohwacharin	Ph.D. (Tokyo)

PROFESSORS:

Chavalit	Ratanatamskul,	Ph.D. (Tokyo)
Viboon	Sricharoenchaikul,	Ph.D. (Georgia Tech)
Chanathip	Pharino,	Ph.D. (MIT)
Pisut	Painmanakul	Ph.D. (INSA-Toulouse)

ASSOCIATE PROFESSORS:

Benjaporn	Suwannasilp	Ph.D. (Stanford)
Khemarath	Osathaphan,	Ph.D. (Oregon State)
Manaskorn	Rachakornkij,	Ph.D. (New Jersey)
Patiparn	Punyapalakul,	Ph.D. (Tokyo)
Pichaya	Rachdawong,	Ph.D. (Wisconsin-Milwaukee)
Sirima	Panyametheekul,	Ph.D. (Imperial College)
Sutha	Khaodhiar,	Ph.D. (Oregon State)
Tawan	Limpiyakorn,	Ph.D. (Tokyo)
Wiboonluk	Pungrasmi,	Ph.D. (Tokyo)
Khemarath	Osathaphan,	Ph.D. (Oregon State)
Dao Suwansang	Jancharoen	Ph.D. (Illinois at Urbana-Champaign)

ASSISTANT PROFESSORS:

Achariya	Suriyawong,	Ph.D. (Washington)
Chaiyaporn	Puprasert,	Ph.D. (INSA-Toulouse)
On-anong	Larpparisudthi	Ph.D. (Coventry)
Sarun	Tejasen,	Ph.D. (Oregon State)

LECTURERS:

Win	Trivitayanurak	Ph.D. (Carnegie Mellon)

ADMISSION

The applicant must hold either a Bachelor's Degree in Engineering or related degrees and met the requirements of the Graduate School.

DEGREE REQUIREMENTS

This program consists of 24 credits of course work, of which 20 are required and 4 are electives.

A student must present an acceptable thesis and pass an oral examination in the field of specialization for a quantity of not less than 12 credits.

COURSE REQUIREMENTS

1) Prerequisite Courses

Students with bachelor's degree other than environmental engineering degree must take and pass these following four prerequisite courses with S/U grade or obtain the exemption from the department:

2107667	Fundamental Engineering for Environmental Engineering	3(3-0-9)

All Students must take and pass the following prerequisite course with S/U grade:

2107685	AND RESEARCH DEVELOPMENT TECHNOLOGIES IN ENVIRONMENTAL ENGINEERING	1(1-0-3)

2) Required Courses 20 credits

2107681	WATER MANAGEMENT	3(3-3-9)
2107682	WASTE ENGINEERING	3(3-3-9)
2107683	ENVIRONMENTALENGINEERING DESIGN I	3(3-3-9)
2107684	ENVIRONMENTALENGINEERING DESIGN I I	3(3-3-9)
2107616	Air Quality Management	3(3-0-9)
2107673	Principles for Environmental Engineering Management	3(3-0-9)
2107686	SEMINAR SERIES ON PROFESSIONAL AND RESEARCH DEVELOPMENT	1(1-0-3)

3) Elective Courses 4 credits

Students must choose at least two elective courses from one particular field and at least another elective course from any fields with consent from the advisor.

2107530	Advanced Techniques in Physical And Chemical Treatment	3(3-0-9)
2107607	Environmental Analysis	3(3-0-9)
2107646	Technology of Solid and Hazardous Waste Treatment	3(3-0-9)
2107616	Air Quality Management	3(3-0-9)
2107622	Environmental Control Planning	2(2-0-6)
2107626	Stream Sanitation	2(2-0-6)
2107627	Advanced Sanitary Engineering Laboratory	3(1-6-5)
2107628	Design of Water Retaining Structures	3(1-6-5)
2107630	Treatment and Disposal of Industrial Waste	3(2-3-7)

2107632	Environmental Impact Assessment	2(2-0-6)
2107633	Water Quality and Agriculture Practice	3(3-0-9)
2107634	Advances in Environmental Pollution Research	2(2-0-6)
2107635	Reading in Environmental Engineering	1(1-0-3)
2107638	Plumbing Design	3(3-0-9)
2107639	Atmospheric Chemistry	3(3-0-9)
2107641	Air Polluting Control Technology	3(3-0-9)
2107642	Engineering Practices for Solid Waste Disposal	3(3-0-9)
2107644	Advanced Study in Environmental Engineering I	3(3-0-9)
2107645	Advanced Study in Environmental Engineering II	3(3-0-9)
2107646	Chemistry for Water and Wastewater Treatment	3(3-0-9)
2107654	Sampling and Analysis of Air Pollutants	3(2-3-7)
2107656	Thermal Processes for Waste Minimization and Utilization	3(3-0-9)
2107657	Energy and Environment	3(3-0-9)
2107660	Industrial and Hazardous Waste Management	3(3-0-9)
2107663	Industrial Waste Management	3(3-0-9)
2107664	Anaerobic Wastewater Treatment Technology	3(3-0-9)
2107665	Mass Transfer and Separation Processes in Environmental Engineering	3(3-0-9)
2107668	Clean-up of Contaminated Sites by Biological Processes	3(3-0-9)
2107669	Environmental Impact Assessment	3(3-0-9)
2107672	Adsorption for Water and Wastewater Treatment	3(3-0-9)
2107674	Treatment of Wastewater Contaminated with Oil and Small Particles in Environmental Engineering	3(3-0-9)

4) Thesis

2107811	Thesis	12	credits
2107816	Thesis	36	credits

NAME OF THE DEGREE

: Doctor of Philosophy
: Ph.D.

DEPARTMENT STAFFS

HEAD:

Jenyuk	Lohwacharin	Ph.D. (Tokyo)

PROFESSORS:

Orathai	Chavalparit	Ph.D. (Wageningen)
ChavalitRatanatamskul,		Ph.D. (Tokyo)
Viboon	Sricharoenchaikul,	Ph.D. (Georgia Tech)
Chanathip	Pharino,	Ph.D. (MIT)
Pisut	Painmanakul	Ph.D. (INSA-Toulouse)

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Pichaya Rachdawong,		Ph.D. (Wisconsin-Milwaukee)
Sirima	Panyametheekul,	Ph.D. (Imperial College)
Sutha	Khaodhiar,	Ph.D. (Oregon State)
Tawan	Limpiyakorn,	Ph.D. (Tokyo)
Wiboonluk	Pungrasmi,	Ph.D. (Tokyo)
Dao Suwansang Jancharoen		Ph.D. (Illinois at Urbana-Champaign)

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Sarun	Tejasen,	Ph.D. (Oregon State)

LECTURERS:

Win	Trivitayanurak	Ph.D. (Carnegie Mellon)

ADMISSION

Pattern 1.1 and 1.2

1) The applicant must have a Master's Degree in Environmental Engineering or Sanitary Engineering or equivalent with a grade point average minimum of 3.25

Pattern 2.1 and 2.2

2) The applicant must have a Bachelor's Degree in Environmental Engineering or Sanitary Engineering or equivalent with a least a second-class honor.

DEGREE REQUIREMENTS

Pattern 1.1 requires 48 credits of which 6 credits are required courses (not counted, S/U) and 48 credits are dissertation.

Pattern 1.2 requires 72 credits of which 6 credits are required courses (not counted, S/U) and 72 credits are dissertation.

Pattern 2.1 requires 48 credits of which 6 credits are required courses (not counted, S/U), 12 credits are elective courses, and 36 credits are dissertation.

Pattern 2.2 requires 72 credits of which 6 credits are required courses (not counted, S/U), 24 credits are elective courses, and 48 credits are dissertation.

COURSE REQUIREMENTS

1) Required Courses 6 credits

2107791	Advanced Seminar in Environmental Engineering I	1(1-0-3)
2107792	Advanced Seminar in Environmental Engineering II	1(1-0-3)
2107793	Advanced Seminar in Environmental Engineering III	1(1-0-3)
2107794	Advanced Seminar in Environmental Engineering IV	1(1-0-3)
2107795	Advanced Seminar in Environmental Engineering V	1(1-0-3)
2107796	Advanced Seminar in Environmental Engineering VI	1(1-0-3)

2) Elective Courses 12 or 24 credits

2107607	Environmental Analysis	3(3-0-9)
2107616	Air Quality Management	3(3-0-9)
2107622	Environmental Control Planning	2(2-0-6)
2107626	Stream Sanitation	2(2-0-6)
2107627	Advanced Sanitary Engineering Laboratory	3(1-6-5)
2107628	Design of Water Retaining Structures	3(1-6-5)
2107630	Treatment and Disposal of Industrial Wastes	3(2-3-7)
2107632	Environmental Impact Assessment	2(2-0-6)
2107633	Water Quality and Agriculture Practice	3(3-0-9)
2107634	Environmental Pollution Research	2(2-0-6
2107635	Reading in Environmental Engineering	1(1-0-3)
2107638	Plumbing Design	3(3-0-9)
2107639	Atmospheric Chemistry	3(3-0-9)
2107641	Air Polluting Control Technology	3(3-0-9)
2107642	Engineering Practices for Solid Waste Disposal	3(3-0-9)
2107644	Advanced Study in Environmental Engineering I	3(3-0-9)
2107645	Advanced Study in Environmental Engineering II	3(3-0-9)
2107646	Chemistry for Water and Wastewater Treatment	3(3-0-9)
2107654	Sampling and Analysis of Air Pollutants	3(2-3-7)
2107656	Thermal Processes for Waste Minimization and Utilization	3(3-0-9)
2107657	Energy and Environment	3(3-0-9)
2107658	Theory and Design of Advanced Water Treatment Processes	4(3-3-10)
2107659	Theory and Design of Advanced Wastewater Treatment Processes	4(3-3-10)
2107660	Industrial and Hazardous Waste Management	3(3-0-9)
2107663	Industrial Waste Management	3(3-0-9)
2107664	Anaerobic Wastewater Treatment Technology	3(3-0-9)
2107665	Mass Transfer and Separation Processes in Environmental Engineering	3(3-0-9)
2107668	Clean-up of Contaminated Sites by Biological Processes	3(3-0-9)
2107673	Principles for Environmental Engineering Management	3(3-0-9)
2107677	Membrane Technology for Wastewater Reuse	3(3-0-6)
2107681	Water Management	3(3-0-9)
2107682	Waste Engineering	3(3-0-9)
2107683	Environmental Engineering Design I	3(1-6-5)
2107684	Environmental Engineering Design II	3(1-6-5)
2107530	Advanced Techniques in Physical And Chemical Treatment	3(3-0-9)
2107608	Technology of Solid and Hazardous Waste treatment	3(3-0-9)
2107669	Environmental Impact Assessment	3(3-0-9)
2107672	Adsorption for Water and Wastewater Treatment	3(3-0-9)
2107674	Treatment of Wastewater Contaminated with Oil and Small Particles in Environmental Engineering	3(3-0-9)

3) Dissertation

2107826	Dissertation	36 credits
2107828	Dissertation	48 credits
2107830	Dissertation	72 credits
2107894	Doctoral Dissertation Seminar	0(0-0-0)
2107897	Qualifying Examination	0(0-0-0)

COURSE DESCRIPTIONS IN ENVIRONMENTAL ENGINEERING (B.ENG.)

2107214 Aquatic Chemistry for Environmental Engineering 3(2-3-4)

Chemical and physical characteristics of water, general considerations, methods for determination and application

of data to environmental engineering practice; instrumentation; laboratory analysis of water; interpretation of water analysis results as related to their treatment; neutralization, precipitation, coagulation, water softening, ion exchange, corrosion, absorption, chlorination; basic principles of acid-base equilibria, solubility equilibria, oxidation-reduction equilibria, fundamentals of process kinetics, fundamental of surface and colloidal chemistry, water stabilization, water softening and neutralization.

2107216 Chemistry Laboratory for Environmental Engineering **1(0-3-0)**

Determinations of solids, DO, BOD, COD, nitrogen, grease and oil, volatile acids, sulfide and gas analysis; instrumentation for wastewater analysis.

2107217 Emerging Problems for Environmental Engineering **3(3-0-6)**

Conventional environmental problems; overall pictures of current environmental problems; emerging environmental problems; present and future scopes of environmental engineering responsibilities; environmental problems analysis; environmental engineering trends

2107218 Fundamental of Separation Process in Environmental Engineering **2(2-0-4)**

Definition, principles, and basic units; Principles of fluid flow; Fluid dynamics; Reynolds transport theorem; Principles of mass transfer; Mechanical-physical processes.

2107219* Urban Environments Engineering **3(3-0-6)**

Urban environments in general, pollution problems in urban area : wastewater, solid waste, noise pollution, air pollution, and hazardous waste : sources of pollution; destruction of the urban environment; especially solution to its urban problems in such scientific, especially engineering aspect; management of pollution, especially pollution control and treatment; improvement guidelines for urban development; regulations and laws related to buildings in urban area, participation of people living in urban are, and case studies.

2107220* Environments and Daily life **3(3-0-6)**

A learning process of environment in daily life; the un of case studies and social knowledge which are key information in analyzing the importance of in dairy life; integrated ecological system; natural resources and related environment; integration the of outcome of the study with related disciplines in order to understand and realize the importance of environment and guidelines for participation for better environment.

2107221* Environmenal Studies **3(3-0-6)**

Basic knowledge and important perspectives on global environment with emphasis on case studies; ecosystem; biogeochemical cycles; population studies; energy; wetland; water pollution; air pollution; noise pollution; solid waste disposal; hazardous waste; waste treatment system design; environmental responsibility.

2107311 Biology for Environmental Engineering **3(2-3-7)**

Cell and its structure, principles of bacteriology, population growth, roles of bacteria in public health, coliform bacteria, methods of collection and bacteriological examination of water & sewage, principles of immunization, disinfection and sterilization, actions of enzymes as related to stabilization of organic matter, biodegradation of organic compounds, fundamental concepts related to energy, food chain, productivity and limiting factors, positive and negative interactions among microbial populations, basic concept of ecology, habitat and ecological niche, Nitrogen, Carbon, Sulfur, Phosphorus cycles, freshwater ecology and biota dynamics in wastewater treatment environments.

2107314 Physicochemical Unit Process for Environmental Engineering **3(2-3-4)**

Introduction to water treatment and wastewater treatment plants; unit conversion; mass balance and kinetics of reactors; chemistry equilibrium; reactor design, flow pattern and RTD; sedimentation and flotation; gravity filtration; membrane filtration; aeration; absorption and stripping; adsorption; ion exchange; coagulation; disinfection

2107321 Air Quality Engineering **4(3-3-6)**

Basic science and engineering of outdoor and indoor air quality; Engineering design for preventing or reducing air pollutant emissions; Meteorological factors; Dispersion of air pollutants; Linkages between air pollution and global climate change; Selected case studies, economics and cost estimation.

2107413 Wastewater Engineering **3(2-3-4)**
Prerequisite : 2107311 or 2107312 or 2107213

Wastewater flow rates and characteristics; collection, transportation and pumping; wastewater treatment objectives; methods and design fundamental of process analysis; facility design of physical, chemical and biological treatment for primary and secondary processes; concept of resource recovery and water reuse.

2107414 Water Supply Engineering **3(2-3-4)**
Prerequisite : 2107212 and 2107312

Water resources for water supply systems; water quantity prediction; water quality standards; design of water convey and distribution systems; design of water

treatment systems for community and industry; water reuse.

2107444 Building Sanitation 3(3-0-6)

Fundamentals of Building Sanitation; law & regulations; design of building water supply (hot, cold & drinking water), building drainage and vent systems; fire protection; site drainage; building wastewater and solid wastes disposal and treatment, swimming pool system design.

2107446 Air Quality Tools and Data Analysis 3(3-0-6)

Students will learn about tools that support air quality management and aspects related to air quality such as healthcare, smart city solutions. Data relevant to air quality will be introduced along with the framework for collecting and acquiring such data. Concepts in data analysis will be discussed. Case studies in which data analysis plays an important role in generating information that support improvement of human well-being and promoting sustainability will be presented.

2107449 Industrial Safety Management 2(2-0-4)

Nature of accident in industry and need of accident prevention; planning for safety such as plant layout, machine guarding and maintenance, etc; safety in industry; management of safety program; safety training; case studies in accident analysis.

2107450 Environmental Systems and Management 3(3-0-6)

Basic interrelating effects on environmental in terms of environmental engineering aspects; the functions of government and other agencies in environmental management; an analysis for decision making in environmental protection programs; public policy and action; arrangement of organizations and institutes related to environmental management including their structures and roles; policy development; management approaches and program implementation; case studies of specific environmental protection.

2107451 Principles of Public Health 2(2-0-4)

Health aspects of environmental quality; some principles of epidemiology with special emphasis on community and occupational environment; environmental health standards and requirements; engineering control of some urban and rural pollution problems; other topics in application of engineering principles in environmental protection.

2107462 Hazardous Waste Treatment 3(3-0-6)

Basic principles of management and treatment of both organic and inorganic hazardous waste; the treatment system includes physical, chemical, biological, or thermal process as well as final disposal method.

2107471 Economics for Environmental Engineering 3(3-0-6)

Definition; concept; and application of economics theory; theory of marketing; demand, supply; economics concepts and techniques for environmental engineering application; theories of economic evaluation and values of the environmental engineering's activities; emission tax and permission

2107481 Introduction to Environmental Impact Assessment 3(3-0-6)

Development of environmental impact study with exphasis on environment parameters including physical resources, ecological resources, human use values and quality of life values. Interrelationship between engineering aspects and environmental parameters and case studies.

2107484 Solid Waste Engineering 3(3-0-6)

Condition : Prerequisite 2107213

Quantity and composition of solid wastes; impacts to environment; disposal methods - alternatives and selection; leachate problem; volume and size reduction; transportation; components separation; landfilling; incineration; composting; integrated process and management.

2107485 Waste Utilization 2(2-0-4)

Zero waste concept, purpose, motivation and relation to SDGs and BCG models. Present state of waste utilization. Characteristics and types of waste that can be recycled. Pros and cons of utilizing industrial, municipal, and agricultural waste. Principles and various technologies of waste recycling, including energy generation, renewable materials, and value-added products. Challenges on storage, transportation, and feasibility of waste utilization. Case studies from industrial processes as well as business guidelines for creating products from upcycling waste.

2107491 Capstone Project 1(0-3-2)

Capstone projects for environmental engineering that apply mathematics, science and engineering for problem analysis, design and solutions; investigate problems and find out the facts; teamwork; communication; consideration of environment and sustainability; life-long learning

2107492 Environmental Engineering Project 2(0-6-4)

Practical interesting project on problems in various fields of Environmental Engineering.

(*Elective course for non Environmental Engineering Students)

COURSE DESCRIPTIONS IN ENVIRONMENTAL ENGINEERING (M.ENG., PH.D.)

2107607 Environmental Analysis 3 (3-0-9)

Procedures and details of environmental sample analysis; methods of sample collection, sample handling; analytical method selection; details of analysis and data presentation.

2107616 Air Quality Management 3 (3-0-9)

In this course, students will learn the concepts and principles of air quality management with emphasis on analysis of key elements of Air Quality Management Process and exploring Air Quality Management scheme, both locally and internationally, through case studies. Fundamental topics taught in class include emission sources; meteorological phenomena and their impact on pollution dispersion; air pollution control technologies; air quality measurements and monitoring; effects of air pollutants; and regulatory standards. Along with these basic knowledge, actual case studies of both locally and internationally will be explored and brought to in-class discussion on the advantages and disadvantages of different types of air quality management practices, and students will be asked to develop and propose the effective and sustainable air quality management strategies related to the case of their interest.

2107622 Environmental Control Planning 2 (2-0-6)

Environmental basis for the Comprehensive Plan. Planning and environmental standards. The planning process. Rural development and political. Concept of ecology, energy, environmental and health standards related to the environment. The economics of the practices and decisions. Social losses and environmental aspects. Guidelines for the choice of programs to control pollution and environmental management. Local and national plan related with objectives related to policies, objectives, scope and the short and long term plans.

2107626 Stream Sanitation 2 (2-0-6)

Patterns of pollution and natural purifications; bacterial self purification; deoxygenation rate; reoxygenation rate; DO sag curve; detection and measurement of pollution; pollution of tidal & coastal waters; BDO loading of receiving waters.

2107627 Advanced Sanitary Engineering Laboratory 3 (1-6-5)

Laboratory and pilot plant techniques used to obtain design data, to control plant operation, and to investigate processes for the treatment of water, sewage and wastes.

2107628 Design of Water Retaining Structures 3 (1-6-5)

General design principles of water retaining structures; cylindrical and rectangular tanks; open and covered reservoirs; tanks with conical and pyramidal bottoms; swimming pools and tanks with sloping floors; water tower storage; some special design problems.

2107630 Treatment and Disposal of Industrial Wastes 3 (2-3-7)

Industrial waste problems; categories of waste; nature and characteristics of liquid waste; effect of waste on environment; laws for disposal of waste in Thailand and other countries; method of treatment of various kinds of waste; preventive measures.

2107632 Environmental Impact Assessment 2 (2-0-6)

Environmental changes and its impact on communities; assessment methodology; environmental planning and decision making; case studies.

2107633 Water Quality and Agriculture Practice 3 (3-0-9)

Water pollution from agricultural practices; sediment, plant nutrients, pesticides, and animal waste; implications of agricultural pollution; control policy and methods.

2107634 Environmental Pollution Research 2 (2-0-6)

Selected research topics in water and wastewater treatment, air pollution control and abatement, and solid waste disposal and management.

2107635 Reading in Environmental Engineering 1 (1-0-3)

Selected topics in environmental engineering issues and discussion.

2107638 Plumbing Design 3 (3-0-9)

Plumbing systems, materials, and flow in pipes. Design of water supply systems, hot water supply systems, sanitary drainage and vent systems, storm drainage, fire protection system, public swimming pools, valves, pumps. Installation and testing a system.

2107639 Atmospheric Chemistry 3 (3-0-9)

Photochemistry of small quantity gas; surface reaction and adsorption phenomena; physical and chemical of aerosol; origin; coagulation and precipitation of dust in ambient and reaction with gas.

2107641 Air Pollution Control Technology 3 (3-0-9)

Overview of air pollution control methods. Control of particulates and gaseous emissions by settling chambers, cyclones, scrubbers, filters, and electrostatic precipitators. Design of equipment, maintenance and evaluation of control efficiency.

2107642 Engineering Practices for Solid Waste Disposal 3 (3-0-9)

Municipal and industrial solid wasters, their volume and characteristics; heat value methods of handling, storage and disposal. Size and volume reduction. Separation of components. Landfill and leachate effects. Ocean disposal. Incineration.

2107644 Advanced Study in Environmental Engineering I **3 (3-0-9)**

Study of recent topic and technology development in various fields of environmental engineering.

2107645 Advanced Study in Environmental Engineering II **3(3-0-9)**

Study of recent topic and technology development in various fields of environmental engineering.

2107646 Chemistry for Water and Wastewater Treatment **3 (3-0-9)**

Basic principles, acid-baseequilibria, solubility equilibria, oxidation-reduction equilibria, fundamentals of process kinetics fundamental of surface and colloidal chemistry, coagulation in water treatment, water stabilization, water softening and neutralization, ion exchange, carbon adsorption.

2107654 Sampling and Analysis of Air Pollutants **3 (2-3-7)**

Sampling of particulate and gaseous pollutants from source and atmosphere, flow measuring devices and their calibration techniques of pollutant identification and analysis, particle measurement, use of techniques in performance test of air control equipment.

2107656 Thermal Processes for Waste Minimization and Utilization **3 (3-0-9)**

Introduction to potential agricultural and industrial wastes for thermal conversion processes. Kinetics in thermal pyrolysis and gasification.Innovative heat source systems including plasma and microwave. Low and high temperature processes, short and long residence time processes. Potential pollution problems and amendment. Design considerations of different types of thermal conversion reactors. Treatment and conversion of immediate products into useful chemical and fuel. Ash and tar formation and their remediation.

2107657 Energy and Environment **3 (3-0-9)**

Energy resources and utilization in the global context and case studies in Thailand; fossil-based energy; environmental impact of mining and fuel processing; air pollution greenhouse gas, and global warming from fuel utilizaiton; energy conservation and renewable energy technologies; hydro energy harmessing and its environmental impact and mitigation; other non-fossil fuel options: biomass solar, and wind energy; synthetic fuel conversion technology including pyrolysis and gasification; biogas from fermentation; prospect of hydrogen economy.

2107658 Theory and Design of Advanced Water Treatment Processes **4 (3-3-10)**

Water sources; water chemistry and quality, aeration, coagulation, sedimentation, filtration, ion exchange, membrane processes, disinfection} absorption, neutralization and stabilization; water conditioning for boiler and cooling system; design criteria for water sources, lines distribution and storage facilities, water treatment and softening, engineering design of water distribution system, functional and hydraulic design of complete water treatment.

2107659 Theory and Design of Advanced Wastewater Treatment Processes **4 (3-3-10)**

Development of wastewater technology; wastewater collection and transportation; design of sewers and appurtenances; advanced wastewater treatment by microbial and biological control techniques, law related to effluent disposal; wastewater law relating to effluent disposal, wastewater treatment plant organization and management; combined and separate system pumping stations; functional and hydraulic design of complete wastewater treatment system.

2107660 Industrial and Hazardous Waste Management **3 (3-0-9)**

Terms and definitions, types and sources of waste, law, regulations, disposal and management standards, related organizations; reduction of waste and case studies, unit operations for waste management; reuse and recycle of industrial waste and case studies; treatment of industrial waste; sample collection and characterization of waste; physical and chemical treatment of industrial waste, stabilization and solidification; disposal of industrial waste and monitoring, disposal guidelines; design of industrial waste landfill, monitoring and checking of the landfill; international industrial waste management, transport of hazardous waste across international borders, case studies, Basel accord.

2107663 Industrial Waste Management **3 (3-0-9)**

Analysis of material and energy flow in industrial system to enhance eco-efficiency; relationships between industrial production and economic development; waste minimization, pollution prevention design for environment, life cycle analysis (LCA) and waste exchange; linkage of industrial activity with environment and social science; integration of environmental management and environmental ethics; environmental policies and laws

2107664 Anaerobic Wastewater Treatment Technology **3 (3-0-9)**

Types of biological wastewater treatment; Theory and basic mechanism of anaerobic wastewater treatment; microbiology and biochemistry of anaerobic fermentation;

Kinetics of anaerobic treatment system; various types of anaerobic wastewater treatment system; design and operation of anaerobic treatment processes; current status of anaerobic technology; consideration and selection of anaerobic process in industrial, municipal and agricultural wastewater treatment

2107665 Mass transfer and Separation processes in Environmental Engineering **3 (3-0-9)**

Theory of molecular diffusion and mass transfer; Fundamental of phase equilibrium; Mass transfer operation and separation process; Interface mass transfer; Absorption and Desorption; Adsorption and Ion exchange; Distillation; Physical separation process; Membrane separation process; Finishing process

2107668 Clean-up of Contaminated Sites by Biological Processes **3 (3-0-9)**

Pollutants and their properties: site characterization: physical and chemical properties of a site: risk assessment: fate and transport of pollutants: fundamental of microbiology: microbial metabolism: microbial destruction of pollutants: bioremediation approach: factors influencing bioremediation: bioremediation technology: design of bioremediation systems: detection of microorganisms by molecular tools: phytoremediation: case study

2107677 Membrane Technology for Wastewater Reuse **3 (3-0-9)**

Membrane technology in wastewater treatment; membrane biological reactor (MBR); filtering mechanism; modeling; design of bio-membrane system; operation and maintenance; biofouling and control; membrane cleaning; wastewater reuse; water recycling and reuse in industry; membrane application in wastewater treatment and reuse; state-of-the-art of novel bio-membrane system in environmental engineering; case studies in environmental engineering projects

2107791 Advanced Seminar in Environmental Engineering I **1 (1-0-3)**

Dissertation progress

2107792 Advanced Seminar in Environmental Engineering II **1 (1-0-3)**

Dissertation progress

2107793 Advanced Seminar in Environmental Engineering III **1 (1-0-3)**

Dissertation progress

2107794 Advanced Seminar in Environmental Engineering IV **1 (1-0-3)**

Seminar on recent and interesting topics in the field of environmental engineering, and report presentation. (S/U)

2107795 Advanced Seminar in Environmental Engineering V **1 (1-0-3)**

Seminar on recent and interesting topics in the field of environmental engineering, and report presentation. (S/U)

2107796 Advanced Seminar in Environmental Engineering VI **1 (1-0-3)**

Seminar on recent and interesting topics in the field of environmental engineering, and report presentation. (S/U)

2107673 Principles for Environmental Engineering Management **3 (3-0-9)**

In this study, students will learn the concepts and principles of making policies and plans for managing natural resources and the environment, as well as the organizing tools used to achieve the goals of environmental management policies and plans and performance analysis. Tools for analyzing the cost-effectiveness of each type of environmental management approach, such as laws and policies for environmental quality control and economics management, is used in conjunction with knowledge of environmental engineering to maximize efficiency. Along with the implementation of actual case study samples in today's society, both domestically and internationally are explained to help analyze and compare the advantages and disadvantages of different types of environmental management practices and offer appropriate management options to effectively solve each type of environmental problem.

2107681 Water Management **3 (3-0-9)**

In this course students will learn about basic theory of water and wastewater treatment technology and water reclamation. They will understand the principles and design criteria for water, wastewater treatment and water reclamation processes. This class includes water sources, water chemistry, mass balances and reactor analysis, water and wastewater treatment processes including coagulation, flocculation, sedimentation, gravity filtration, membrane filtration, adsorption, ion exchange, membrane, advanced oxidation process and disinfection. Students will also learn about water distribution system as well as water, wastewater plant design.

2107682 Waste Engineering **3 (3-0-9)**

Global and Thailand situations, laws and regulations, functional elements, sources, physical, chemical, and biological characteristics, thermal processes for generation of renewable energy, fuel, and value-added products from solid waste including combustion, gasification, pyrolysis, and torrefaction, recycling, composting and landfill disposal. Landmark episodes involving hazardous waste mismanagement, definition, technology, health impacts, risk assessment and law and policy issues associated with hazardous materials and

wastes are examined. Methods of managing hazardous waste are introduced and regulations presented where appropriate. Special cases on hazardous waste management technology, such as co-processing in cement industry will be discussed.

2107683 Environmental Engineering Design I **3 (1-6-5)**

In this course, students will learn about concept design practices used in developing efficient environmental engineering systems for water supply, wastewater treatment, air pollution control systems, greenhouse gases management system, and solid waste disposal facilities. This includes data survey and analysis, project planning, process design and step in design, as well as operation and maintenance of the systems. Students will learn basics of feasibility and sustainability.

2107684 Environmental Engineering Design II **3 (1-6-5)**

In this course, students will learn the principles and concepts of sustainable system design and develop skills to analyze components of system design, factors and elements essential to sustainability. Students will learn about utilizing data and analysis tools towards designing of sustainable environmental systems. Students will apply knowledge and experiences from the course Environmental Engineering System Design I for advanced design practice. The contents focus on learning and applying quantitative tool for assessing design alternatives and navigating tradeoffs between different sustainability dimensions.

2107826 Dissertation **36 Credits**

2107828 Dissertation **48 Credits**

2107830 Dissertation **72 Credits**

2107894 Doctoral Dissertation Seminar **0 (0-0-0)**

Doctoral Dissertation Seminar(S/U)

Dissertation progress

2107897 Qualifying Examination **0 (0-0-0)**

QUALIFYING EXAMINATION(S/U)

DEPARTMENT OF SURVEY ENGINEERING

The objective of the department is aimed at providing theoretical principles and practical techniques on surveying mapping and geoinformation necessary for various engineering and development projects. Courses offering in the department both at undergraduate and graduate levels cover broad fields of surveying, photogrammetry and remote sensing, cartography, geodesy, and spatial information technology.

The department currently have three curriculums:

1. The bachelor degree in survey engineering
2. The master of engineering program in survey engineering
3. The doctor of philosophy program in geomatic engineering

The bachelor degree curriculum (revised curriculume 2023) which is four years is designed such that the student will have basic knowledge in engineering in general and a more intensive knowledge of surveying mapping and geoinformation technology in particular. The curriculum is blended with theories and practices. Students will have experiences on various surveying instruments , computer mapping and geoinformation technology. Confidence and competence to solve practical problems in the domain of survey engineering is strengthened through field practices and on the job training. A more insight to the subject is possible, upon the department's approval, through senior project, special study, and approved elective courses according to the student's interest. It is expected that the program would enable the students to

1. understand the structures and requirements of surveying, mapping and geoinformation technology;
2. apply the theories and techniques to general surveying and mapping tasks effectively, efficiently, and economically;
3. Analyse and make use the instrumental mechanics for evaluating the accuracy and precision attained;
4. follow new technology and development in the field of surveying and mapping and geoinformation technology.

The master of engineering in survey engineering program (revised curriculume 1994) is a two-year program designed to respond social needs which keep changing according to technological advances. The program objectives are

1. To allow more flexible curriculum structure in order to be more responsive to social needs and;
2. To produce graduates highly capable in both theory and practice;
3. To study and research in fields related to survey engineering and mapping, in order to improve the quality of the graduates.

The program of master of science in spatial information in engineering is a two-year program commenced in academic year 1999. The curriculum is designed to respond social needs of people highly capable in spatial information technology or geographic information system. The program objectives are:

1. To produce graduates who have a deep understanding of spatial information technology for engineering enterprises in both business and public sectors;
2. To generate new body of knowledge in spatial information system for the research and development of the department and the university.

Ph.D. in survey engineering is a three-years program for full-time candidates with the possibility of two years extensions. Candidates undertake a research program which is supervised normally through a supervisory panel with one principle supervisor. The program objectives are:

1. To generate new body of knowledge in the specifie field of survey engineering through a research work;
2. To produce graduates.

HEAD :

Chalermchon Satirapod, Ph.D. (New South Wales)

PROFESSORS :

Chalermchon Satirapod, Ph.D. (New South Wales)

ASSOCIATE PROFESSORS :

Somchai Kriengkraiwasin, M.Eng. (Chula)
Sanphet Chunithipaisarn, Ph.D. (Newcastle upon Tyne)

ASSISTANT PROFESSORS :

Colonel Kanok Weerawong, Ph.D. (Purdue)
Garavig Tanaksaranond, Ph.D. (UCL)
Teetat Charoenkalunyuta, Ph.D. (Chula)
Chaiyut Charoenphon Ph.D. (Chula)

LECTURERS :

Chaichoke Vaiphasa, Ph.D. (ITC, The Netherlands)
Thongthit Chayakula, Ph.D. (London)
Valanon Uaratanawong Ph.D. (Chula)
Pawan Piromthong Ph.D. (Leeds)
Chaiyaporn Kitpracha Dr.-Ing. (TUB)

SURVEY ENGINEERING CURRICULUM

COURSE	SUBJECT	CREDITS
	THIRD SEMESTER	
2100201	INTRO ARTIFICIAL INTELLIGENCE	3
2301207	CALCULUS III	3
2108205	FUNDAMENTAL OF GEOMATICS	3
2106251	GENERAL GEOLOGY	3
5500208	COMMUNICATION AND PRESENTATION SKILLS	3
xxxxxxxx	GENERAL EDUCATION (1)	3
		18
	FOURTH SEMESTER	
2100202	INTRO DATA SCIENCE & BIG DATA	3
2101344	FUNDAMENTAL OF CIVIL ENGINEERING	3
2108202	SURVEYING ENGINEERING	3
2108234	NUMERICAL ANALYSIS IN GEOMATICS	3
2112343	HYDROLOGY FOR ENGINEER	3
xxxxxxxx	GENERAL EDUCATION (2)	3
		18
	FIFTH SEMESTER	
2108301	SURVEYING WITH CONSTRUCTION APPLICATIONS	3
2108371 AND 2108311	PHOTOGRAMMETRY 3 REMOTE SENSING SYSTEM GLOBAL GEODESY	3
2108325	GEOGRAPHIC INFORMATION SYSTEM AND APPLICATIONS	3
2108332	ADJUSTMENT COMPUTATION	3
		15
	SIXTH SEMESTER	
2108372 SENSING	ADVANCED REMOTE 3	
2108375	ADV PHOTO UAV MAPPING	3
2108306	FIELD PRACTICE ON TOPOGRAPHIC SURVEYING	1
2108307	FIELD PRACTICE ON ROUTE SURVEYING	1
2108412	SATELLITE SURVEYING	3
2108343	MATHEMATICAL CARTOGRAPHY	3
5500308	TECHNICAL WRITING FOR ENGINEERING	3
		17

COURSE	SUBJECT	CREDITS
	SUMMER SEMESTER	
2100301	ENGINEERING PRACTICE	2
	SEVENTH SEMESTER	
2108326	GEOS INFO ANAL VIS	3
2108415	GEODETIC SURVEYING	3
2108462	CADAST SURV AND LAND MGMT	3
2108xxx	APPROVED ELECTIVES (1)	3
xxxxxxxx	GENERAL EDUCATION (3)	3
xxxxxxxx	FREE ELECTIVES (1)	3
		18
	EIGHTH SEMESTER	
2108416	FIELD PRACTICE ON GEODETIC SURVEYING	1
2108414	FIELD PRACTICE ON DIGITAL MAPPING	1
2108499	SURVEY ENGINEERING PROJECT -OR -	3
(2100499)	ENGINEERING PROJECT	
xxxxxxxx	APPROVED ELECTIVES (2)	3
xxxxxxxx	APPROVED ELECTIVES (3)	3
xxxxxxxx	GENERAL EDUCATION (4)	3
xxxxxxxx	FREE ELECTIVES (2)	3
		17

TOTAL CREDITS FOR GRADUATION = ***137***

NAME OF THE DEGREE

: Master of Engineering
: M.Eng.

PROFESSORS:

Chalermchon Satirapod, Ph.D. (New South Wales)

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LECTURERS :

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Pawan Piromthong Ph.D. (Leeds)
Chaiyaporn Kitpracha Dr.-Ing. (TUB)

ADMISSION

An applicant must hold a Bachelor's Degree in Survey Engineering or a Bachelor's Degree in other fields of study as approved by the Department. The applicant must also meet the requirements of the Graduate School.

DEGREE REQUIREMENTS

Students are required to fulfill the following specific requirements

A. A minimum of 24 credits of courses which consists of

1. 18 credits of the required courses.
2. At least 6 credits of elective course approved by the department.

B. An acceptable thesis of 12 credits

A student who fulfilled the requirements of the program with a cumulative grade point average not less than 3.00 with a period of study not less than 4 regular semesters and not more than 8 regular semesters will be awarded the Degree of Master of Engineering.

COURSE REQUIREMENTS

1) Required Courses (18 credits)

2108511	Numerical Techniques in Geomatics	3(2-3-7)
2108512	Adjustment Computation in Geomatics	3(2-3-7)
2108532	Satellite Surveying and Modern Techniques	3(2-3-7)
2108557	Spatial Data Structure and Models	3(3-0-9)
2108592	Seminar in Geoinformatic Technology	3(3-0-9)
2108627	Geoimage Processing	3(2-3-7)

2) Elective Courses (21 credits)

2108502	Fundamentals of Positioning and Mapping	3(2-3-7)
2108513	Geodesy and Geodetic Methods	3(3-0-9)
2108556	Online Spatial Information Technoloties	3(2-3-7)
2108558	Spatial Data Handling and Analysis	3(2-3-7)
2108601	Advanced Adjustment Computation	3(2-3-7)
2108628	Radar Remote Sensing	3(2-3-7)
2108629	Advanced Geoimage Processing	3(2-3-7)
2108632	Advanced GNSS Surveying	3(2-3-7)

3) Thesis

2108811	Thesis	12 credits

NAME OF THE DEGREE

: Doctor of Philosophy
: Ph.D.

PROFESSORS :

Chalermchon Satirapod, Ph.D. (New South Wales)

ASSOCIATE PROFESSORS :

/
Sanphet Chunithipaisarn, Ph.D. (Newcastle upon Tyne)
/Somchai Kriengkraiwasin M.Eng. (Chula)

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/Valanon Uaratanawong Ph.D. (Chula)
/Pawan Piromthong Ph.D. (Leeds)

SPEACIAL LECTURERS :

Dr.Chaowalit Silpathong, Ph.D. (Toulouse III)
Dr.Chris Rizos, Professor, Ph.D. (UNSW)
Dr.Clive Frasser, Professor, Ph.D. (Wash)
Dr.Shunji Murai, Professor, D.Eng. (Univ. of Tokyo)

Dr.Wicha	Jiwalai,	Ph.D. (Ohio State U.)
Dr.Sukit	Viseshsin,	D.Eng. (Univ.of Tokyo)
Dr.Suvit	Vibulsresth,	D.Eng. (Univ. of Tokyo

COURSES DESCRIPTIONS
IN SURVEY ENGINEERING (B.ENG.)

2108202 Surveying Engineering 3(2-3-4)

Concepts of surveying and mapping; theory of measurements and errors; basic survey measurements; distance and angle measurements, theodolite and total station, traversing and computation, vertical distance measurements; leveling; reciprocal leveling and trigonometric leveling, contours, topographic mapping procedure; control and topographic surveying; map accuracy; specification, profile and cross section, areas and volumes.

2108205 Fundamental of Geomatics 3(3-0-6)

Roles of geospatial information in society; overview of geospatial data capturing, processing, and utilizing procedures; representing the Earth digitally; modeling reality into spatial database, geospatial data model: concept of coordinate system; mapping the Earth; Earth figure and its impact on position; map scale and accuracy of geospatial data; surveying and mapping techniques for geospatial data acquisition; applications of geospatial information technology.

2108234 Numerical Analysis in Geomatics 3(2-3-4)

Condition : Prerequisite 2108233

Numerical Techniques for Solving Set of Linear Equations; Algorithmic Solutions to Non-Linear System; Interpolation and Curve Fitting; 2-D and 3-D Coordinate Transformations; Purposes and Necessity of Coordinate Transformation, Affine Transformation, Polynomial and Rational Polynomial Transformation, Introduction to Spherical Trigonometry, Solving Direct Problem and Inverse Problem.

2108298 Surveying 3(2-3-4)

Introduction to surveying work; basic field works, leveling; principles and applications of theodolites and total stations; distance and direction measurements; errors in surveying, acceptable errors, data correction, triangulation; precise determination of azimuth; precise traverse; plane coordinate system, precise leveling; topographic survey; map plotting.

2108301 Surveying with Construction Applications 3(2-3-4)

Condition : Prerequisite 2108202

Alignment, grade and equipment for construction surveys, route location and design; horizontal curve; spiral curve; vertical curve; earth work, UTM/TM for route surveying, tunnel surveying, survey project planning, management, and economy.

2108306 Field Practice on Topographic Surveying 1 (field practice)

Condition : Prerequisite 2108202or 2108298

Field practices at surveying camp to complete fair drawing of planimetric and topographic maps of given areas; third order levelling and traverse; topographic detailing.

2108307 Field Practice on Route Surveying 1(field practice)

Condition : Prerequisite 2108301

Planning, scheduling, and carrying out a complete strip topographic map for feasibility study of route location; design and staking-out; earthwork computation.

2108311 Global Geodesy 3(3-0-6)

Condition : Prerequisite 2108234

Definition of geodesy, space-geodetic techniques, reference system and reference frame GRS80 WGS84 and ITRF, geodetic earth model, computation on the ellipsoid, direct and inverse geodetic problem, geodesic, method of positioning, introduction to gravity field of the Earth and geoid, Earth gravitational modeling, height system, global and local geoid model (EGM96, EGM2008, EGM2020 and TGM2017) datum transformation Indian datum 1975), National CORS Data Center (NCDC)

2108325 Geographic Information System and Applications 3(2-3-4)

Condition : Prerequisite 2108201

Definition, basic principles and components of Geographic Information System (GIS); geospatial data models : vector, raster, and surface(3D) data models; different types of data sources and data input techniques; basic geospatial data management and query; basic geospatial data analysis and manipulation; spatial analysis of discrete entities in space; spatial analysis using continuous fields; applications of Geo-Information Systems in various fields; introduction to web GIS and location-based services; quality and metadata of geospatial data; geospatial data standards.

2108326 Geospatial Information Analysis and Visualization 3(2-3-4)

Condition : Prerequisite 2108325

Analysis functions of geospatial data, network, and surface data (3D); spatial interpolation and surface modeling; exploratory spatial data analysis; process modeling and simulation; cartographic fundamentals: principles of graphic design, map annotation and name placement, visualization; spatio temporal visualization; geospatial data generalization; database; web GIS and location-based services; cloud computing.

2108332 Adjustment Computation 3(2-3-6)

Condition : Prerequisite 2108234

Measurements and errors; Review of mathematical concepts; Concept of adjustment; Error and covariance matrix propagation; Linearization; Principle of Least squares adjustment; Techniques of least-squares adjustment for linear and non-linear models; Statistical analysis; Applications of least-squares adjustment in surveying

2108344 Mathematical Map Projection 3(2-3-6)

Condition : Prerequisite 2108234

Rectangular and Polar Coordinate Systems, Horizontal Datum, Geodetic Coordinate System; General Transformation Formulae, The First Gaussian

Fundamental Quatitites on Sphere and Plane, Differential Parallelograms; Theory of Map Projection, Computation of Distortions on Map Plane, Properties of Map Projections; Analysis of Map Projections, Scale Factor, Principal Direction, Tissot's Indicatrix, Analytical Construction of Map Projections; Conformal Projections and National Plane Coordinate System, The Importance of Conformal Projections, UTM and UPS Coordinate System, Reduction of Survey Measurements onto Plane, Georeferencing Spatial Data to National Plane Coordinate System; Reprojection and Transformation of Geo-spatial Data.

2108371 Photogrammetry and Remote Sensing System **3(2-3-6)**

Condition : Prerequisite 2108202

Concepts and basic principles of remote sensing, electromagnetic energy, sources and radiation principles, energy interaction with atmosphere and earth surface features, sensors and digital image characteristics, multispectral-thermal-hyperspectral sensing, radar imagery, Earth observation satellite, an ideal remote sensing system, characteristics of real remote sensing systems, elements of photographic systems, history of aerial photography, basic principles of photogrammetry, geometry of aerial photographs, monoscopic measurement, stereoscopic of photogrammetry, mapping with photogrammetry.

2108372 Advanced Remote Sensing **3(2-3-6)**

Condition : Prerequisite 2108371

Digital imagery, vector and raster data, Image rectification and restoration, image enhancement, contrast manipulation, multi-image manipulation, Image classification, fourier analysis for image processing, hyperspectral image analysis, radar image analysis, feature extraction, pattern recognition, colour systems, colour image processing.

2108375 Advanced Photogrammetry and UAV **3(2-3-6)**

Condition : Prerequisite 2108371

Airborne Imaging and UAV Mission, geometry on single image frame, 3D measurement from stereo images and mulit-view geometry, aerial triangulation and bundle block adjusment, sensor positioning and orientation, best practices for mapping and other data products from photogrammetry, applications of photogrammetric products, corridor mapping and infrastructure inspection using UAV.

2108412 Satellite Surveying **3(2-3-6)**

Condition : Prerequisite 2108311

Concept of satellite positioning, global navigation satellite systems, GNSS concept, errors in GNSS measurements, observables in GNSS, survey planning, field methods, data processing, practical applications, trend and future of GNSS.

2108413 Field Practice on Precise Surveying **1(field practice)**

Condition : Prerequisite 2108411, 2108412

Field practice on geodetic horizontal and vertical controls surveying, computation, photo control surveying.

2108414 Field Practice on Digital Mapping **1(field practice)**

Condition : Prerequisite 2108325, 2108371

Rectification of Satellite and Aerial Images; Various Techniques for Detail Survey and Field Data Acquisition; Map Updating; GIS Database Construction.

2108415 Geodetic Surveying **3(2-3-4)**

Condition : Prerequisite 2108205, 2108311 and 2108412

Introduction to physical geodesy, Height systems, Height from GNSS (GPS), High precision instruments, Standard, Benchmark and Geodetic control point, Datum transformation, Horizontal and Vertical measurement methods, 3D measurement methods, Computation technique on UTM (Universal Transvers Meritor) and TM (Transvers Mercator).

2108462 Cadastral Survey & Land Mgmt. **3(0-6-3)**

Condition : Prerequisite 2108412

Introduction to cadastral surveying, public land, private land, GNSS surveying for cadastral surveying, cadastral surveying techniques, cadastral map and its system, cadastral surveying Practice and its regulation, real estate valuation, Private surveyor, Cadastre, land management for construction project.

2108499 Survey Engineering Project **3(0-6-3)**

Condition : Senior Standing or Consent of Faculty

Practice interesting project or problem in various fields of survey engineering.

COURSES DESCRIPTIONS IN SURVEY ENGINEERING (M.ENG.) and GEOMATIC ENGINEERING (PH.D.)

2108502 Fundamentals of Positioning and Mapping 3(2-3-7)

Figure of earth, geodetic datum, earth coordinate reference frame, map projection, general techniques of positioning, 2-D and 3-D coordinate transformation, measurement sampling and interpolation, position determination by modern ground-based instruments, mapping from digital satellite/aerial imagery.

2108511 Numerical Techniques in Geomatics 3(2-3-7)

Overview of matrix and linear systems, solutions of non-linear systems, overdetermined system, functional and stochastic model, measurement error and error propagation, statistical analysis of observation and parameters.

2108512 Adjustment Computation in Geomatics 3(2-3-7)

Review of statistical concepts and linear algebra; principle of covariance propagation; non-linearity, linearization and iteration procedure; math models for least-squares adjustment computation; unified least-squares adjustment; statistical analysis of adjustment results; reliability of networks; data snooping and blunder detection.

2108513 Geodesy and Geodetic Methods 3(3-0-9)

Earth's gravity field; geoid, reference ellipsoid and geodetic datum; geodetic survey, astronomic observations; direction, distance and calculation on the ellipsoid; geodetic height and elevation; satellite orbit, positioning.

2108516 Engineering Geodesy 3(2-3-7)

Condition : Senior Standing

The course build on student active participation by integration of theory and practice. The main objective is to demonstrate how four different geomatic technologies (Global Navigation Satellite System, Total Station, Digital Levelling and Terrestrial Laser Scanning) may be integrated to resemble the technical measurement design and precise positioning production in engineering projects. The course does not teach details of any of the above-mentioned technologies but rather how to use them in an integrated approach.

2108532 Satellite Surveying and Modern Techniques 3(2-3-7)

Satellite datum, coordinate systems, concept of satellite positioning, global positioning system, observable in GPS, errors in GPS measurements, survey planning, field procedures, data processing, principle of inertial navigation system (INS), practical applications of GPS, principles of electronics, electronic surveying systems and basic components, geometry of electronic surveying, instrumentation and modern surveying technology.

2108533 Remote Sensing of Environment 3(3-0-6)

Condition : Senior Standing

Remote Sensing of Environment brings the student through recent publication on theory, science, applications and technology of remote sensing of earth resources and environment.

2108534 Microwave Remote Sensing 3(3-0-6)

Condition : Senior Standing

Fundamental of microwave, microwave and human health, microwave in remote sensing, SLAR, SAR, InSAR, Lidar, basic SAR data processing, basic Lidar processing, SAR and Lidar applications and case studies.

2108536 Spatial Database 3(3-0-6)

Condition : Senior Standing

Introduction to Spatial Database; spatial concept and data model; spatial query language; simple feature for SQL; spatial storage and spattial indexing; query processing and optimization; introduction to spatial data mining; trends in DBMS.

2108556 Online Spatial Information Technology 3(2-3-7)

Condition : Senior Standing

Introduction to GIS, and internet GIS, fundamental of computer networking, client/server computing, technology evolution of web GIS, DHTML, standards for distributed geospatial services (ISO & OGC), XML, GML and SVG, mobile GIS, case studies and web GIS applications.

2108557 Spatial Data Structure and Models 3(3-0-9)

Conceptual model of space: entities & fields; vector data model, raster data model; data organization in raster: chain, block, run length, quadtrees, binary; data organization in vector: point, line, network, polygon, topology; comparisons of vector and raster data; database structure; file and data access; hierarchical structure; network structure, relational structure, object-oriented structure; introduction to geo-spatial relational database system, graph theory; optimal path.

2108558 Spatial Data Handing and Analysis 3(2-3-7)

Data capture technique, coordinate systems, data quality; intersections of lines and curves, calculation of length and area, coordinate adjustment, geometric searching; range searching; proximity searching; buffering; rubber sheeting, edge matching, image warping, conflation, feature editing; feature alignment; generalization; densification; topology reconstruction; surface modeling; viewsheds; intervisibility; contouring; linear referencing, mapping accuracy standard and determination method.

2108559 Geospatial Database and OpenGIS 3(2-3-7)

Introduction to relational database management system (RDBMS), Data Model: Entity Relationship Model, Normalizatioin of Database Tables, Introduction to Structured Query Language(SQL), Data Types, SQL Commands, Function and Operation, OGC/ISO Simple Feature (SF), OGC SF Object and Structure, Spatial Database and Table, Simple Feature Access using SQL/SF and SQL for Multimedia (SQL/MM), attribute and spatial querying, OpenGIS Functions, Procedural Language / Structure Query Language (PL/SQL), database optimization and spatial indexing, interface to geospatial RDBMS via web-based applications, Roles of geo-spatial RDBMS in information services and Open Geospatial Information System

2108560 Advanced Map Design and Prototyping **3(2-3-7)**

Condition : Senior Standing

Introduction to various types of maps focusing on user-centered design, including generating new ideas, system analysis, user requirement analysis, prototyping, evaluation and improving; interaction design principle; the effects of interactive functions to map design principle; map prototyping methods, including drawing and using software.

2108592 Seminar in Geoinformatic Technology **3(3-0-9)**

Case studies in geoinformation technology, special lectures on advanced/emerging geoinformation technology, experimental design, research topic development.

2108601 Advanced Adjustment Computation **3(2-3-7)**

Sequential least-squares adjustment; Helmert-Wolf blocking; generalizied inverse matrics; Kalman filter for geomatics; approximation, interpolation and prediction; least-squares collocation.

2108627 Geoimage Processing **3(2-3-7)**

Concepts of digital image: air borne, space borne; electromagnetic wave; optical and microwave sensor; digital image processing; classification; image coordinate and photo coordinate; sensor orientation; Stereo-photogrammetry; photogrammetric triangulation; orthorectification, mosaic, photo map production.

2108628 Radar Remote Sensing **3(2-3-7)**

Characteristics of Microwave, Microwave Interaction with Atmosphere and Target, Radar Equation and Radar Cross Section, Principles of Imaging Radar, Measureable Phase/Amplitude/Polarization in Radar Imagery, Geometric and Radiometric Properties of Radar Imagery, Synthetic Aperture Radar, Airborne/ Spaceborne SAR Systems, Interferometric SAR, Processing Stages in Inteferogram Generation, Differential Interferometric SAR, InSAR/ DInSAR as Measurement Tools, Geodetic and Geophysical Applications of InSAR/ DInSAR, Polarimetric SAR, Classification/ Analysis of Polarimetric SAR, Landuse/ Landcover Mapping Applications using Polarimetric SAR.

2108629 Advanced Geoimage Processing and Applications **3(2-3-7)**

Digital photogrammetry, digital photogrammetric workstation and workflow, digital sensor types: line, area/frame and TDI/staggered CCD, sensor models and sensor orientation, airborne digital camera systems, mapping from space, Digital Elevation Model (DEM), light detection and ranging (Lidar), high-resolution satellites imageries, high-resolution satellite imageries processing, relief displacement, orthorectification, geo-image compression, tile and pyramid image structure, oblique photogrammetry and 3-D geoinformation system, orthophoto service and mash-up mapping, tile-caching management service, acquisition of panorama view and information service.

2108632 Advanced GNSS Surveying **3(2-3-7)**

GPS system, coordinate and reference systems, GPS observations and equations, GPS error mitigation techniques, computation of GPS satellite positions, principles of least-squares estimation, mathematical models for GPS positioning, standard format of GPS data, GPS data processing by least-squares method, interpretation of baseline results, GPS network adjustment, quality control for GPS surveying, GPS heighting, trends and applications in GNSS technology.

2108502 Fundamentals of Positioning and Mapping **3(2-3-7)**

Figure of earth, geodetic datum, earth coordinate reference frame, map projection, general techniques of positioning, 2-D and 3-D coordinate transformation, measurement sampling and interpolation, position determination by modern ground-based instruments, mapping from digital satellite/aerial imagery.

2108511 Geodetic Astronomy **3(2-3-7)**

Precise determination of time, astronomic latitude, longitude and azimuth.

2108512 Physical Geodesy **3(3-0-9)**

The gravity and its potential; the disturbing potential and its representation; Applications and current methods.

2108513 Geodesy and Geodetic Methods **3(3-0-9)**

Earth's gravity field; geoid, reference ellipsoid and geodetic datum; geodetic survey, astronomic observations; direction, distance and calculation on the ellipsoid; geodetic height and elevation; satellite orbit, positioning.

2108514 Mathematical Projections in Geodesy **3(3-0-9)**

Use of analytic functions; representation of the ellipsoid on a sphere; geometry of the projected geodesic; mercator, transverse mercator, bolique mercator, conformal comic projections.

2108515 Introduction to Advance Geodetic Surveying **3(3-0-9)**

Geometry of reference ellipsoid; triangulations and trilaterations, Traverses and levelling for major geodetic control; position determination of points by geometric, gravimetric and astronomical methods.

2108521 Aerial Triangulation **3(1-6-5)**

Ground control points; aeropolygon aerial triangulation, graphical and numerical strip adjustment and independent model aerial triangulation.

2108522 Analytical Photogrammetry **3(2-3-7)**

Comparator, measurement of plate coordinates; transformation of plate coordinates and corrections; relative and absolute orientations; computation of ground coordinates from plate coordinates.

2108523 Terrestrail and Close-Range Photogrammetry **2(1-3-4)**

Introduction to terrestrial and closed-range cameras and their orientations; geometry of photographs; control surveys; graphical and analytical determination of

horizontal and vertical positions of point; parallax equations; space coordinates of point by direction cosines.

2108532 Satellite Surveying and Modern Techniques **3(2-3-7)**

Satellite datum, coordinate systems, concept of satellite positioning, Global Positioning System (GPS), observable in GPS, errors in GPS measurements, survey planning, field procedures, data processing, principles of inertial navigation system (INS), practical applications of GPS, principles of electronics, electronic surveying systems and basic components, geometry of electronic surveying, instrumentation and modern surveying technology.

2108551 Spatial Data Structures and Algorithms **2(2-0-6)**

n- depth examination of geographic information system components; representation of spatial data; storage and retrieval techniques; algorithms for spatial data manipulation and analysis; aster/vector conversion algorithms; advanced spatial data models; user interface; knowledge-based system.

2108552 GIS Design and Evaluation **2(2-0-6)**

Nature of design; feasibility studies & requirements analysis ; software engineering techniques; detailed system design; program design & implementation; design of spatial database; system selection.

2108556 Online Spatial Information Technology **3(2-3-7)**

Prerequisite : 2108352 or 2108453 or 2108460

Introduction to GIS; introduction to Internet GIS; fundamental of computer networking, client/servey computing, technology evolutions of web GIS; standards for distributed geospatial services (ISO & OGC), GML and SVG, Mobile GIS; case studies and web GIS applications.

2108557 Spatial Data Structure and Models **2(3-0-9)**

Conceptual models of space: entities and fields; vector data model, raster data model; data organization in raster: chain, block, run length, quadtrees, binary; data organization in vector: point, line, network, polygon, topology; comparisons of vector and raster data; database structure; file and data access; hierarchical structure; network structure, relational structure, object-oriented structure; graph theory; optimal path.

2108558 Spatial Data Handling and Analysis **2(2-3-7)**

Data capture techniques, coordinate systems, data quality; intersections of lines and curves, calculation of length and area, coordinate adjustment, geometric searching; range searching; proximity searching; buffering; rubber sheeting, edge matching, image warping, conflation, feature editing; feature alignment; generalization; densification; topology reconstruction; surface modeling; viewsheds; intervisibility; contouring.

2108559 Geospatial Database and OpenGIS **3 (2-3-7)**

Introduction to relational database management system (RDBMS), data model: Entity Relationship model, normalizatioin of database tables, Structured Query Language (SQL), data types, SQL commands, function and operation, OGC/ISO Simple Feature (SF), OGC SF object and structure, spatial database and table, Simple Feature Access using SQL/SF and SQL for multimedia (SQL/MM), attribute and spatial querying, OpenGIS functions, Procedural Language / Structure Query Language (PL/SQL), database optimization and spatial indexing, interface to geospatial RDBMS via web-based applications, roles of geospatial RDBMS in information services and open geospatial information system

2108592 Seminar in Geoinformatic Technology **2(2-3-7)**

Advanced and emerging geoinformation technology; case studies; experimental design, research topic development.

2108601 Advanced Adjustment Computation **3(3-0-9)**

Prerequisite :2108331 or Consent of Faculty

Generalized minimum variance solution for hybrid measuring systems, constraints, statistical tests, empirical fitting of polynomials, correlations, inner adjustment, multivariate statistical analysis, advanced least squares, generalized matrices in adjustment.

2108604 System Engineering and Management for Survey Engineer **3(3-0-9)**

A study of methodologies and processes of system engineering. A discipline concerned with the planning, organization and management of programs for designing and operating systems. Application of systems engineering to surveying projects.

2108606 Development Planning Survey **3(3-0-9)**

Function of surveyor in a multidisciplinary investigations for development planning; the concepts and working methods in related disciplines, their possibilities and limitations; interdisciplinary execution of surveys and for the presentation of collected data.

2108621 Analog Photogrammetry **3(2-3-7)**

Theory of orientation, method and accuracy; review of various plotting instruments; testing of instrument; rectification and orthophotography.

2108622 Metric Photography **2(1-3-4)**

Properties, design and calibration of various photogrammetric cameras; physical characteristics and quality control of photography; navigation and auxiliary devices; image evaluation.

2108623 Photogrammetry in Practice **3(3-0-9)**

Prerequisite : 2108621 and 2108625

Photogrammetric planning; digital terrain model; applications to various fields, e.g. cadastral survey, highway planning and design, damsite study, architecture,

museum and monument preservations, biostereometric and medicine, etc.

2108624 Advanced Analytical Hotogrammetry 3(2-3-7)

Systematic errors, system calibration and self-calibration, analytical strip and block triangulation with and without auxiliary data, constraints, structure and solution of the normal matrix. Reseau photography and specialized comparator techniques.

2108625 Remote Sensing I 3(3-0-9)

A study on theory, instrumentation, and techniques employed in remote sensing.

2108626 Remote Sensing II 3(2-3-7)

Prerequisite : 2108625 and Consent of Faculty

Applications and interpretation of remote sensing data, in general and in particular. An indepth study of an application chosen by individual participant.

2108627 Geoimage Processing 3(2-3-7)

Concepts of digital image: air borne, space borne; electromagnetic wave; optical and microwave sensor; digital image processing; classification; image coordinate and photo coordinate; sensor orientation; stereo-photogrammetry; photogrammetric triangulation; orthorectification.

2108628 Radar Remote Sensing 3(2-3-7)

Characteristics of microwave, microwave interaction with atmosphere and target, radar equation and radar cross section, principles of imaging radar, measurable phase/amplitude/polarization in radar imagery, geometric and radiometric properties of radar imagery, synthetic aperture radar, airborne/spaceborne SAR systems, interferometric SAR, processing stages in interferogram generation, differential interferometric SAR, InSAR/DInSAR as measurement tools, geodetic and geophysical applications of InSAR/DInSAR, polarimetric SAR, classification/analysis of polarimetric SAR, landuse/landcover mapping applications using polarimetric SAR.

2108629 Advanced Geoimage Processing 3(2-3-7)

Special problems to be carried out under staff direction. Digital photogrammetry, digital photogrammetric workstation and workflow, digital sensor types: line, area/frame and TDI/staggered CCD, sensor models and sensor orientation, airborne digital camera systems, mapping from space, digital elevation model (DEM), light detection and ranging (Lidar), high-resolution satellites imageries, high-resolution satellite imageries processing, relief displacement, orthorectification, geo-image compression, tile and pyramid image structure, oblique photogrammetry and 3-D geoinformation system, orthophoto service and mash-up mapping, tile-caching management service, acquisition of panorama view, data collection and information service.

2108632 Advanced GNSS Surveying 3(2-3-7)

GPS system, coordinate and reference systems, GPS observations and equations, GPS error mitigation techniques, computation of GPS satellite positions, principles of least-squares estimation, mathematical models for GPS positioning, standard format of GPS data, GPS data processing by least-squares method, interpretation of baseline results, GPS network adjustment, quality control for GPS surveying, GPS heighting, trends and applications of GNSS technology.

2108691 Special Studies 3(2-3-7)

Special problems to be carried out under staff direction.

2108790 Seminar in Geomatic Engineering I 3(0-9-3)

Review of and discussion on special topics related to problems and progress in Geomatic engineering.

2108791 Seminar in Geomatic Engineering II 3(0-9-3)

Condition : PRER 2108790

Discussion on special topics related to progress in Geomatic engineering; analysis of related data, conclusion, data presentation and report of findings.

2108792 Seminar in Geomatic Engineering III 3(0-9-3)

Prerequisite : 2108791

Discussion on special topics related to progress in Geomatic engineering concerning research projects; analysis of related data, conclusion, data presentation and report of findings.

2108811 Thesis 12 credits

2108828 Dissertation 48(0-0-0)

(S/U)(1/2548)

2108894 Doctoral Dissertation Seminar 0(0-0-0)

(S/U)(1/2548)

COURSE DESCRIPTIONS IN SPATIAL INFORMATION SYSTEM (M.SC.)

2108501 Fundamentals of Surveying and Mapping 3(2-3-7)

Shape of earth; reference ellipsoids; positioning on earth surface; map projections; scale and distortion; 2-D and 3-D coordinate transformation; model of measurements; error and error propagation; Mapping and map updating techniques.

2108502 Fundamentals of Positioning and Mapping 3(2-3-7)

Figure of earth, geodetic datum, earth coordinate reference frame, map projection, general techniques of positioning, 2-D and 3-D coordinate transformation, measurement sampling and interpolation, position determination by modern ground-based instruments, mapping from digital satellite/aerial imagery.

2108511 Numerical Techniques in Geomatics 3(2-3-7)

Overview of matrix and linear systems, solutions of non-linear systems, overdetermined system, functional and stochastic model, measurement error and error

propagation, statistical analysis of observation and parameters.

2108512 Adjustment Computation in Geomatics 3(2-3-7)

Review of statistical concepts and linear algebra; principle of covariance propagation; non-linearity, linearization and iteration procedure; math models for least-squares adjustment computation; unified least-squares adjustment; statistical analysis of adjustment results; reliability of networks; data snooping and blunder detection.

2108513 Geodesy and Geodetic Methods 3(3-0-9)

Earth's gravity field; geoid, reference ellipsoid and geodetic datum; geodetic survey, astronomic observations; direction, distance and calculation on the ellipsoid; geodetic height and elevation; satellite orbit, positioning.

2108524 Analysis of Aerial and Satellite Imageries 3(2-3-7)

Operations on image, point operations, local operations, geometric operations; image segmentation by clustering, theresholding, spectral classification, spatial classification, edge detection; iterative segmentation by probabilistic relaxation, fuzzy relaxation.

2108531 GPS Satellite Surveying 3(2-3-7)

Condition : PRER 2108501 or C.F.

Fundamental of satellite orbit motion; global positioning system; GPS observables and errors; surveying method; data processing; applications in Thailand.

2108541 Computer Assisted Cartography 3(2-3-7)

Condition : PRER 2108501 or C.F.

Development, production and application of computer-assisted mapmaking; survey of computer cartography terms , concepts and equipment; conceptual and development aspects of computer-produced maps; digitizing; coordinate data structures; spatial databases; computer map design; turnkey cartographic systems; computer map production.

2108553 Spatial Data Model 3(3-0-9)

Vector data model, vector data organization, spaghetti model, topological models; raster data model, representation of raster data, runs, binary trees, blocks, quadtrees, borders; comparisons of vector and raster data model; conversion between raster and vector data.

2108554 Spatial Data Handling 3(2-3-7)

Data capture techniques; coordinate systems; intersections of lines and curves; calculation of length and area; coordinate adjustment; rubber sheeting; edge matching; image warping; conflation; feature editing; feature alignment; generalization; densification; topology reconstruction; surface modeling; viewsheds; intervisibility; contouring.

2108532 Satellite Surveying and Modern Techniques 3(2-3-7)

Satellite datum, coordinate systems, concept of satellite positioning, global positioning system, observable in GPS, errors in GPS measurements, survey planning, field procedures, data processing, principle of inertial navigation system (INS), practical applications of GPS, principles of electronics, electronic surveying systems and basic components, geometry of electronic surveying, instrumentation and modern surveying technology.

2108556 Online Spatial Information Technology 3 (2-3-7)

Introduction to GIS, Introduction to Internet GIS, Fundamental of Computer Networking, Client/Server Computing, Technology Evolutions of Web GIS, DHTML, Standards for Distributed Geospatial Services (ISO & OGC), XML, GML and SVG, Mobile GIS, Case Studies and WebGIS Applications.

2108557 Spatial Data Structure and Models 3(3-0-9)

Conceptual model of space: entities & fields; vector data model, raster data model; data organization in raster: chain, block, run length, quadtrees, binary; data organization in vector: point, line, network, polygon, topology; comparisons of vector and raster data; database structure; file and data access; hierarchical structure; network structure, relational structure, object-oriented structure; introduction to geo-spatial relational database system, graph theory; optimal path.

2108558 Spatial Data Handing and Analysis 3(2-3-7)

Data capture technique, coordinate systems, data quality; intersections of lines and curves, calculation of length and area, coordinate adjustment, geometric searching; range searching; proximity searching; buffering; rubber sheeting, edge matching, image warping, conflation, feature editing; feature alignment; generalization; densification; topology reconstruction; surface modeling; viewsheds; intervisibility; contouring; linear referencing, mapping accuracy standard and determination method.

2108559 Geospatial Database and OpenGIS 3(2-3-7)

Introduction to relational database management system (RDBMS), Data Model: Entity Relationship Model, Normalizatioin of Database Tables, Introduction to Structured Query Language(SQL), Data Types, SQL Commands, Function and Operation, OGC/ISO Simple Feature (SF), OGC SF Object and Structure, Spatial Database and Table, Simple Feature Access using SQL/SF and SQL for Multimedia (SQL/MM), attribute and spatial querying, OpenGIS Functions, Procedural Language / Structure Query Language (PL/SQL), database optimization and spatial indexing, interface to geospatial RDBMS via web-based applications, Roles of geo-spatial RDBMS in information services and Open Geospatial Information System

2108592 Seminar in Geoinformatic Technology 3(3-0-9)

Case studies in geoinformation technology, special lectures on advanced/emerging geoinformation technology, experimental design, research topic development.

2108601 Advanced Adjustment Computation 3(2-3-7)

Sequential least-squares adjustment; Helmert-Wolf blocking; generalizied inverse matrics; Kalman filter for geomatics; approximation, interpolation and prediction; least-squares collocation.

2108627 Geoimage Processing 3(2-3-7)

Concepts of digital image: air borne, space borne; electromagnetic wave; optical and microwave sensor; digital image processing; classification; image coordinate and photo coordinate; sensor orientation; Stereo-photogrammetry; photogrammetric triangulation; orthorectification, mosaic, photo map production.

2108628 Radar Remote Sensing 3(2-3-7)

Characteristics of Microwave, Microwave Interaction with Atmosphere and Target, Radar Equation and Radar Cross Section, Principles of Imaging Radar, Measureable ase/Amplitude/Polarization in Radar Imagery, Geometric and Radiometric Properties of Radar Imagery, Synthetic Aperture Radar, Airborne/Spaceborne SAR Systems, Interferometric SAR, Processing Stages in Inteferogram Generation, Differential Interferometric SAR, InSAR/DInSAR as Measurement Tools, Geodetic and Geophysical Applications of InSAR/DInSAR, Polarimetric SAR, Classification/Analysis of Polarimetric SAR, Landuse/Landcover Mapping Applications using Polarimetric SAR.

2108629 Advanced Geoimage Processing and Applications 3(2-3-7)

Digital photogrammetry, digital photogrammetric workstation and workflow, digital sensor types: line, area/frame and TDI/staggered CCD, sensor models and sensor orientation, airborne digital camera systems, mapping from space, Digital Elevation Model (DEM), light detection and ranging (Lidar), high-resolution satellites imageries, high-resolution satellite imageries processing, relief displacement, orthorectification, geo-image compression, tile and pyramid image structure, oblique photogrammetry and 3-D geoinformation system, orthophoto service and mash-up mapping, tile-caching management service, acquisition of panorama view and information service

2108632 Advanced GNSS Surveying 3(2-3-7)

GPS system, coordinate and reference systems, GPS observations and equations, GPS error mitigation techniques, computation of GPS satellite positions, principles of least-squares estimation, mathematical models for GPS positioning, standard format of GPS data, GPS data processing by least-squares method, interpretation of baseline results, GPS network adjustment, quality control for GPS surveying, GPS heighting, trends and applications in GNSS technology.

2108555 Spatial Analysis 3(3-0-9)

Data quality; measures of dispersion; measures of arrangements; geometric searching; range searching; proximity searching; buffer generation; polygon overlays; spanning trees and graph travesal; shortest part routing.

2108591 Seminar in AM/FM/GIS 3(3-0-9)

Group discussion, special lectures on various topics, research paper, presentation of research paper, site visits.

2108623 Photogrammetry in Practice 3(3-0-9)

Photogrammetric planning; digital terrain model; applications to various fields, e.g. cadastral survey, highway planning and design, damsite study, architecture, museum and monument preservations, biostereometric and medicine, etc.

2108625 Remote Sensing I 3(3-0-9)

A study on theory, instrumentation, and techniques employed in remote sensing

2108626 Remote Sensing II 3(2-3-7)

Condition : PRER 2108625 or C.F.

Applications and interpretation of remote sensing data, in general and in particular. An indepth study of an application chosen by individual participant.

2108631 Advanced GPS Satellite Surveying 3(2-3-7)

Condition : Prerequisite : 2108531

GPS system; coordinate and reference systems, computation of GPS satellite position; GPS observations and equations; principles of least-squares estimation; mathematical models for GPS positioning; standard format of GPS data; GPS error mitigation techniques; GPS data processing by least-squares method; interpretation of baseline results; GPS network adjustment; quality control for GPS surveying; GPS heighting; trends and applications of GNSS technology.

2108651 Implementation of Spatial Information System 3(3-0-9)

Condition : Prerequisite 2108501 and 2108553 or C.F.

Components of a spatial information system; roles of spatial information system; development cycle of spatial information system; characteristics of GIS software; applications of spatial informations system; investment issues; data warehousing; data standard; copyright issues; trend and future of spatial technology.

2108671 Geoinformation Technologies for Infrastructure Development 3(3-0-9)

Overview of geoinformation technologies for infrastructure planning construction, monitoring and maintenance; coordinate system and map projection; GPS and GNSS, mapping by remote sensing and photogrammetry techniques; GIS technologies for infrastructure project planning and management; emerging geoinformation technologies for infrastructure development.

2108691 Special Studies 3(2-3-7)

Special problems to be carried out under staff direction.

2108811 Thesis 12 Credits

COURSE DESCRIPTIONS IN GEOMATIC ENGINEERING (PH.D.)

Discussion on special topics related to progress in Geomatic engineering; analysis of related data, conclusion, data presentation and report of findings.

DEPARTMENT OF METALLURGICAL ENGINEERING

Department of Metallurgical Engineering provides a program of metallurgical and materials engineering. The program is designed to give a broad understanding of all types of materials, including metals, ceramics, and polymers, with the emphasis on metals. The undergraduate course covers the fundamental techniques of science and engineering used in the profession. There are subjects concerning with the basic principles of materials science and engineering, materials processings and formings, materials properties and applications, and designing of materials and processes. The course also has many engineering practice subjects such as various laboratories, engineering project, engineering practice, and industrial visit.

HEAD :

Suvanchai	Pongsugitwat,	M.Eng. (Tokyo)

ASSOCIATE PROFESSORS :

Boonrat	Lohwongwatana,	Ph.D. (Caltech)
Tachai	Luangvaranunt,	Ph.D. (Tokyo)
Seksak	Asavavisithchai,	Ph.D. (Nottingham)
Patama	Visuttipitukul,	Ph.D. (Tokyo)

ASSISTANT PROFESSORS :

Panyawat	Wangyao,	Ph.D. (T.U. Kosice)
Suvanchai	Pongsugitwat,	M.Eng. (Tokyo)
Chedtha	Puncreobutr,	Ph.D. (I.C. London)
Sirichai	Leelachao,	Ph.D.(TIT)
Jirapon	Khamwannah,	Ph.D. (U.C. San Diego)
Nithi	Saenarjhan	Ph.D. (Postech)

LECTURERS:

Jatupon	Opapaiboon	D.Eng. (Chulalongkorn)
Charasphat	Preuksarattanawut	D.Eng. (Chulalongkorn)
Atchara	Khamkongkaew	Ph.D. (Khon Kaen)

METALLURGICAL AND MATERIALS ENGINEERING CURRICULUM

COURSE NO.	SUBJECT	CREDITS
	FIRST SEMESTER	
2103106	ENG DRAWING	3
2301107	CALCULUS I	3
2302127	GEN CHEM	3
2302163	GEN CHEM LAB	1
2304103	GEN PHYS I	3
2304183	GEN PHYS LAB I	1
5500111	EXP ENG I	3
		17
	SECOND SEMESTER	
2100111	EXPL ENG WORLD	3
2109101	ENG MATERIALS	3
2301108	CALCULUS II	3
2304104	GEN PHYS II	3
2304184	GEN PHYS LAB II	1
5500112	EXP ENG II	3
xxxxxxx	GENERAL EDUCATION	3
		19
	THIRD SEMESTER	
2103213	ENG MECH I	3
2109210	THERMO MAT	3
2109211	PRIN ENG MAT I	3
2109276	ENG MAT LAB	1
2301207	CALCULUS III	3
xxxxxxx	GENERAL EDUCATION	3
xxxxxxx	GENERAL EDUCATION	3
		19
	FOURTH SEMESTER	
2110101	COMP PROG	3
2109212	PRIN ENG MAT II	3
2109213	TRAN PHEN MAT PROC	3
2109277	MAT MANU LAB	1
2603284	STAT PHYS SCIENCE	3
xxxxxxx	GENERAL EDUCATION	3
xxxxxxx	FREE ELECTIVES	3
		19

COURSE NO.	SUBJECT	CREDITS
	FIFTH SEMESTER	
2109310	CHEM ENG MAT	3
2109333	MET MAT	3
2109377	MICROSTRUC LAB	1
2109313	BASIC MECH MAT	2
xxxxxxx	ELECTIVES	3
xxxxxxx	ELECTIVES	3
xxxxxxx	FREE ELECTIVES	3
		18
	SIXTH SEMESTER	
2109334	POLY MAT	3
2109335	CERAMIC MAT	3
xxxxxxx	AI & BIG DATA	3
2109341	MAT CHAR	3
5500208	COM PRES SKIL	3 OR
2109400	COM PRES MET	
		15
	SUMMER SEMESTER	
2100301	ENGINEERING PRACTICE	2
	SEVENTH SEMESTER	
2109411	MECH BEHAV MAT	3
2109478	MECH TEST LAB	1
2109428	MAT PROC	3
xxxxxxx	21ST CENTURY SKILLS	3
2109498	PRE PROJ	1
xxxxxxx	ELECTIVES	3
		14
	EIGHTH SEMESTER	
5500308	TECH WRIT ENG	3 OR
2109300	CON VOC MAT	
xxxxxxx	AI & BIG DATA	3
xxxxxxx	21ST CENTURY SKILLS	3
2109499	MET MAT ENG PROJ	3
xxxxxxx	ELECTIVES	3
		15

Applicants must take at least 12 credits of electives in which they must select at least one course offered in both two groups including Advanced Processing group and Advanced Materials group. If seminar (2109480) course is chosen, the applicant has to take another course offered in the advance processing group.

TOTAL CREDITS FOR GRADUATION = 138

METALLURGICAL ENGINEERING

NAME OF DEGREE

: Master of Engineering
: M. Eng.

HEAD :

Suvanchai	Pongsugitwat,	M.Eng. (Tokyo)

ASSOCIATE PROFESSORS :

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Tachai	Luangvaranunt,	Ph.D. (Tokyo)
Seksak	Asavavisithchai,	Ph.D. (Nottingham)
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Sirichai	Leelachao,	Ph.D.(TIT)
Jirapon	Khamwannah,	Ph.D. (U.C. San Diego)
Nithi	Saenarjhan	Ph.D. (Postech)

LECTURERS:

Jatupon	Opapaiboon	D.Eng. (Chulalongkorn)
Charasphat	Preuksarattanawut	D.Eng. (Chulalongkorn)
Atchara	Khamkongkaew	Ph.D. (Khon Kaen)

ADMISSION

The applicant must hold a Bachelor's Degree in Engineering or consent of faculty.

The admitted students whose degrees are not Metallurgical Engineering are required to take at least 15 credits of undergraduate courses in Engineering as approved by the Graduate Program Committee during their studies.

DEGREE REQUIREMENTS

The Program consists of 36 credits of coursework and thesis. Candidates must earn a minimum of 24 credits of graduate coursework and 12 credits of thesis. The candidate is required to maintain at least a "B" average.

COURSE REQUIREMENTS

1) Required Courses 6 credits

2109601	Thermodynamics and Phase Equilibria in Multicomponent System	3(3-0-9)
2109602	Transport Phenomena in Solids	3(3-0-9)
2109603	Concepts in Metallurgical and Materials Engineering	3(3-0-9)
2109604	Applications of Metallurgical and Materials Theories in Industries	3(3-0-9)
2109711	Seminar in Metallurgical and Materials Engineering I	S/U
2109712	Seminar in Metallurgical and Materials Engineering II	S/U
2109713	Seminar in Metallurgical and Materials Engineering III	S/U

2) Elective Courses 18 credits

2109504	Advanced Physical Metallurgy I	3(2-3-7)
2109507	Advanced Mechanical Metallurgy.	3(2-3-7)
2109508	Rate Phenomena and Modelling in Process Metallurgy.	3(3-0-9)
2109509	Stainless Steel Technology	3(3-0-9)
2109510	Instrumental Analysis	3(2-3-7)
2109514	Advanced Corrosion	3(3-0-9)
2109515	Quantitative Analysis of Microstructure	3(3-0-9)
2109516	Advanced Topics in Physical Metallurgy	3(3-0-9)
2109517	Composite Materials I	3(3-0-9)
2109518	Surface Technology	3(3-0-9)
2109519	Solidification of Casting	3(3-0-9)
2109520	Physical Ceramics	3(3-0-9)
2109525	Welding Engineering	3(3-0-9)
2109526	Advanced Topics in Chemical Metallurgy	3(3-0-9)
2109527	High Temperature Materials	3(3-0-9)
2109528	Properties of Solids	3(3-0-9)
2109530	Physical Metallurgy of Steels	3(3-0-9)
2109533	Powder Metallurgy	3(3-0-9)
2109535	Cellular Metal	3(3-0-9)
2109536	Advanced Topics in Production Metallurgy	3(3-0-9)
2109537	Tribology of Materials	3(3-0-9)
2109555	Nano and Amorphous Materials	3(3-0-9)
2109605	Physical Chemistry of Iron and Steel Manufacture	3(3-0-9)
2109610	Physical Chemistry of Chemical Metallurgy	3(3-0-9)
2109617	Composite Materials II	3(3-0-9)
2109620	Solution Concentration and Purification	3(3-0-9)
2109623	Fracture Analysis	3(3-0-9)
2109630	Forming Process Analysis	3(3-0-9)
2109659	Aluminium Technology	3(3-0-9)
2109811	Thesis	12 credits

METALLURGICAL ENGINEERING

MAME OF DEGREE

: Doctor of Engineering
: D. Eng.

HEAD :

Suvanchai	Pongsugitwat,	M.Eng. (Tokyo)

ASSOCIATE PROFESSORS :

Boonrat	Lohwongwatana,	Ph.D. (Caltech)
Tachai	Luangvaranunt,	Ph.D. (Tokyo)
Seksak	Asavavisithchai,	Ph.D. (Nottingham)
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Jirapon	Khamwannah,	Ph.D. (U.C. San Diego)
Nithi	Saenarjhan	Ph.D. (Postech)

LECTURERS:

Jatupon	Opapaiboon	D.Eng. (Chulalongkorn)
Charasphat	Preuksarattanawut	D.Eng. (Chulalongkorn)
Atchara	Khamkongkaew	Ph.D. (Khon Kaen)

ADMISSION

1. The applicant must hold a Degree of Master of Engineering or consent of faculty.

2. The other qualifications must meet the regulations of the Graduate School, Chulalongkorn University, which will be annually announced or earned approval to be the candidate by the graduate committee of the Faculty of Engineering.

DEGREE REQUIREMENTS

Number of credit units for graduation not less than 48 credits : 4 credits for core courses and 48 credits for Dissertation.

A student who has fulfilled the requirement of the program and of the Graduate School and satisfactorily pass an oral examination, will be awarded the Degree of Doctor of Engineering.

COURSE REQUIREMENTS

1) Core Courses ***4 credits***

2109714	Seminar in Metallurgical and Materials Engineering IV	1(1-0-3)
2109715	Seminar in Metallurgical and Materials Engineering V	1(1-0-3)
2109716	Seminar in Metallurgical and Materials Engineering VI	1(1-0-3)
2109717	Seminar in Metallurgical and Materials Engineering VII	1(1-0-3)

2) ***Dissertation***

2109828	Dissertation	48 credits

Study Program for Doctoral Degree in Metallurgical Engineering

First Semester			
2109828	Dissertation	8	Credits
2109714	Seminar in Metallurgical and Materials Engineering IV	1	Credits
Second Semester			
2109828	Dissertation	8	Credits
2109715	Seminar in Metallurgical and Materials Engineering V	1	Credits
Third Semester			
2109828	Dissertation	8	Credits
2109716	Seminar in Metallurgical and Materials Engineering VI	1	Credits
Fourth Semester			
2109828	Dissertation	8	Credits
2109717	Seminar in Metallurgical and Materials Engineering VII	1	Credits
Fifth Semester			
2109828	Dissertation	8	Credits
Sixth Semester			
2109828	Dissertation	8	Credits
	Total credits for graduation	48	Credits

COURSE DESCRIPTIONS IN METALLURGICAL AND MATERIALS ENGINEERING (B.ENG.)

2109101 Engineering Materials 3(3-0-6)

Relationship between structures, properties, production processes and applications of main groups of engineering materials; crystal structure of solids; crystal defects; mechanical properties of materials; dislocation and strengthening mechanism of metals; mechanical failure of materials; phase diagram and solid state reaction; fabrication and applications of metals; structure, properties and applications of ceramic; structure, properties and applications of polymers; structure, properties and applications of composite materials; corrosion and degradation of materials; properties and applications of electronic materials; electrical properties of materials; magnetic properties of materials; innovation in material technology.

2109210 Thermodynamics of Materials 3(3-0-6)

First and second laws of thermodynamics; criteria for equilibria in constant pressure processes; free energies as a function of temperature, pressure and chemical potential; numerical calculation of free energies from available thermodynamic data; equilibrium in gas mixtures; equilibrium between condensed phases and gas phases; Richardson's free energy diagram; reduction of oxides and sulphides; activities of various substances in metals and slags; application of thermodynamics to extractive metallurgical processes, smelting and refining, solution behavior.

2109211 Principles of Engineering Materials I 3(3-0-6)

Electron; atomic structure; molecules and bonding; crystal structure; x-ray diffraction in crystalline solid; crystal defects; crystal interfaces and microstructure; solid solution and compound; thermodynamics and phase diagrams; solidification.

2109212 Principles of Engineering Materials II 3(3-0-6)

Condition : *PRER 2109211*

Diffusion; principles of solid-state phase transformation; plastic deformation in crystalline solid recovery, recrystallization, grain growth; strengthening mechanism and microstructural control.

2109213 Transport Phenomena in Materials Processing 3(3-0-6)

Fluid flow: laminar and turbulent flow, flow and vacuum production; materials and energy balance; energy transport; mass transport.

2109276 Engineering Materials Laboratory 1(0-3-0)

Crystal structure; metallographic sample preparation; macro and microstructure; structure examination; cooling curve.

2109277 Material and Manufacturing Processes Laboratory 3(3-0-9)

Heat treatment of steels; hardening, tempering, full annealing and normalizing; practice in sand mold casting of metals; welding practice.

2109300 Basic Concepts and Vocabulary in Metallurgical and Materials Engineering 3(2-2-5)

Introduction to concepts and technical terminologies of materials used for different machines and industries: automotive, aerospace, ship, power plant and petrochemical; working mechanism of machine components produced from different materials.

2109310 Chemistry of Engineering Materials 3(3-0-6)

Thermodynamics of aqueous solutions; kinetics of leaching and precipitation, pressure leaching and reduction; solvent extraction and ion exchange; principles of electrochemistry of aqueous solutions; conductance and transference; electrolytic cell types and potential; current and energy efficiency; principles of pyrometallurgy, including calculation of the values of thermodynamics functions, calcination, roasting, reduction and reduction at slag-metal interfaces; extraction of ferrous and nonferrous metals.

2109313 Basic Mechanics of Materials for Materials Engineering 2(2-0-4)

Definition and concept of stress and strain as the important basics to understand the mechanical behavior of materials; stress and strain components; plane stress and plane strain; Mohr's circle of plane stress; Hooke's law and elastic deformation; engineering stress-strain relationship; working stress; factor of safety; problems concerned with stress in various conditions: thin-walled pressure vessel, torsion of circular shaft, beam, Euler's formula for column, combined stress.

2109333 Metallic Materials 3(3-0-6)

Condition : *PRER 2109212*

Microstructures, properties, and application of ferrous and non-ferrous alloys including plain carbon steels, alloy steels, cast irons, aluminium alloys, copper alloys, and white metals.

2109334 Polymeric Materials 3(3-0-6)

Monomer and polymerization; basic polymer molecular concepts; polymer additives; structures, properties, and application of polymers including thermoplastic, thermoset, elastomer, and composite polymers.

2109335 Ceramic Materials 3(3-0-6)

Structure of ceramic crystals; structure of glass; structural imperfection: structural defects, association of

defects, non-stoichiometric solids; properties and application of ceramics in Engineering.

2109341 Materials Characterisation 3(3-0-6)

Principles and operation of scanning electron microscopy, transmission electron microscopy, x-ray fluorescence, x-ray diffraction, atomic absorption, emission spectrometer, image analyser; non-destructive testing.

2109342 Computation and AI for Materials Discovery and Design 3(3-0-6)

Computer system components and interactions; programming: data types, operators, expressions, statements, control structures, aggregate data; programming tools; programming styles and conventions; debugging; program design and development with applications to engineering problems using a high level programming language and numerical libraries

2109377 Microstructure Laboratory 1(0-3-0)

Analysis of microstructure of metallic materials.

2109400 Communication and Presentation Skills for Metallurgical Engineers 3(3-0-6)

Necessary skills needed for a winning presentation performance in various settings: academic presentations, project demonstrations, and job interviews; a systematic approach to a great stress-free presentation and a personal design to effectively interact with an audience, sell their ideas, and share their enthusiasm; workshop dealing with common mistakes, miscues, and unexpected surprises that may arise during any meeting encounter.

2109411 Mechanical behaviour of Materials 3(3-0-6)

Condition : PRER 2109212, 2109313

Elastic behaviour; theory of plasticity; dislocation theory; mechanical failure: fractures, fatigue, creep, embrittlement; materials testing: tension, hardness, torsion, impact, fatigue, creep; fracture mechanics; mechanical behaviour of composite materials.

2109428 Materials Processing 3(3-0-6)

Theory and modern development of foundry processes; pattern design; casting design; runner and riser design; finishing and inspection of casting products; causes and elimination of defects and design limitations; injection moulding; rapid solidification; theory and practice of rolling, forging, extrusion, wire and tube drawing, deep drawing; causes and elimination of defects.

2109478 Mechanical Testing Laboratory 1(0-3-0)

Mechanical properties testing: tension test, bending and torsion test, impact test and hardness test.

2109491 Materials and Sustainable Development 3(3-0-6)

Principles of sustainability analysis; sustainability indexes; materials technology and nanotechnology enabling sustainable development sustainability in materials production; renewable energy; fuel cell; photovoltaic; bioenergy; green-house gas emissions; sustainable environment; materials life cycle analysis; materials recycling.

2109492 Innovative Engineering Entrepreneurship 3(3-0-6)

Ideation and creativity; Innovative engineering and entrepreneurship; Engineering technology for high value-added products and service; Transforming innovation to commercialized products; Business model canvas; Brand strategy; Finance; Marketing; Pitching; Sustaining innovation for business.

2109498 Pre-senior Project and Industrial Visit 3(3-0-6)

Practicing and presentation engineering projects under problems in real situation; method design, processing, equipment. Solving engineering problems for industrial requirement. Visiting the factories related to metal and materials processings.

2109499 Metallurgical and Materials Engineering Project 3(0-6-3)

Practical interesting projects or problems in various fields of metallurgical and materials engineering.

Course group in Advanced Processing

2109312 Chemical Metallurgy II 3(3-0-6)

Condition : PRER 2109310

Physical chemistry in iron and steel making; blast furnace; steel making processes; direct reduction processes; reaction of carbon, silicon and chromium; removal of sulphur and phosphorus; deoxidation; vacuum degassing of steel; hydro and pyrometallurgy of ores commonly found in Thailand.

2109321 Quality Control and Quality Management for Materials Engineering 3(3-0-6)

Quality philosophy; quality management strategies in Materials Engineering, organizing for quality. quality concepts; quality control techniques in Materials Engineering.

2109419 Directional Solidification 3(3-0-6)

Solidification behaviour of ferrous and non-ferrous alloys; modulus of cooling and feeder head calculation; the use of internal and external chills; exothermic anti-piping powder and exothermic feeder head.

2109423 Electroplating 2(1-3-2)

Condition : PRER 2109310

Fundamentals of electrochemistry; technology and control of various electroplating processes including chromium plating, nickel plating, copper plating, tin and tin alloys plating, and zinc and zinc alloys plating.

2109424 Iron-making and Steel-making 2(2-0-4)

Condition : PRER 2109310

Fundamentals of iron-making and steel-making processes including blast furnace, direct reduction, direct smelting, basic oxygen process, electric arc furnace, secondary metallurgy and continuous casting processes; physical chemistry of iron-making and steel-making processes.

2109425 Materials Joining 3(3-0-6)

Introduction to materials joining: soldering, brazing and welding, wetting, solid-phase welding, adhesive joining, joining of ceramic, fusion welding processes, mass and heat flow in fusion welding, metallurgical effects of the weld thermal cycle, weld defect, hot and cold cracking, porosity in welds, residual stress in welds. destructive and non-destructive testing of the joints, safety in welding, welding laborary demonstration.

2109430 Corrosion of Metals 3(3-0-6)

Principles of corrosion; anode and cathode processes; origin and characteristic of corrosion currents; standard electrochemical series; passivity and protective films; effects of environment on corrosion rate; forms of corrosion; corrosion testing; measures to minimize or protect the corrosion, cathodic protection, inhibitors, coating and non-metallic materials in combating corrosion; other materials degradation; materials selection.

2109445 Failure Analysis 3(3-0-6)

General practice in failure analysis: data collection, non-destructive testing, mechanical testing, macro and micro analysis, determination of failure mechanism; failure mechanisms and related environmental factors: fractures in ductile, brittle and fatigue modes; failure due to creep, corrosion and stress-corrosion, weld decay; defects due to heat treatment, case studies.

2109454 Computational Materials Engineering 3(2-3-4)

Information technology (IT) in materials engineering. Introduction to some basic tools/computer software for programming and computation. Review of heat transfer in solid. Introduction to computational materials engineering with some applications.

2109463 Jewelry Metals and Processing 3(3-0-6)

Gold, Silver and Metals in PGMs, Metals for fashion jewelry. Effects of alloying elements, Metallurgy in jewelry metals. Physical property, Mechanical property, Anti-tarnish property, Jewelry process, Investment casting, Forming processes, Defects in jewelry production and solution methods.

2109496 Special Problems in Metallurgical and Materials Engineering 3(3-0-6)

Interesting issues in metallurgical and materials engineering.

2109508 Rate Phenomena and Modeling in Process Metallurgy 3(3-0-9)

Rate of metallurgical processes with engineering application to process simulation and control; special attention to processes important to iron and steelmaking homogeneous and heterogeneous reaction kinetics; mass and energy transport; steady-state and nonsteady-state reaction systems; development of process models.

2109510 Instrumental Analysis 3(2-3-7)

Operation principles of transmission electron microscopy and scanning electron microscopy, Xray diffraction, X-ray fluorescence , atomic absorption and spectro analysis, ESCA and Auger electron spectrometer; interpretation of instrumental results in terms of mechanical properties.

2109516 Advanced Topics in Physical Metallurgy 3(3-0-9)

Advanced topics of current research interests in physical metallurgy.

2109518 Surface Technology 3(3-0-9)

Carburizing, nitriding, flame hardening, diffusion hardening; chemical vapor deposition and physical vapor deposition; electroplating; hot dip coating; metal spraying and ion implantation.

2109519 Solidification of Casting 3(3-0-9)

Study of solidification of metal in molds; characteristics of liquid-solid phase transformations; Sand and metal thermal behavior; macroscopic structures; mechanical properties, and casting defects.

2109525 Welding Engineering 3(3-0-9)

Types and processes of welding; mass and heat flow during welding; metallurgy effects of heat thermal cycle; solid-phase welding and joining of ceramics; welding of ferrous and non-ferrous metals; behavior of welds in service.

2109526 Advanced Topics in Chemical Metallurgy 3(3-0-9)

Advanced topics of current research interests in chemical metallurgy.

2109536 Advanced Topics in Production Metallurgy 3(3-0-9)

Advanced topics of current research interests in production metallurgy.

2109537 Tribology of Materials 3(3-0-9)

Solid lubrication and surface treatment; fundamentals of contacts between solids; abrasive, erosive, and cavitation wear; adhesion and adhesive wear, corrosive and oxidative wear; fatigue wear; fretting and minor wear mechanism; wear of non-metallic materials; case study.

Course group in Advance Materials

2109381 Superalloys 3(3-0-6)

Types of superalloys, production processes and its microstructures, superalloys applications. The relationship among heat treatments, forming processes, microstructures and mechanical properties at high temperatures of nickel, cobalt and iron based superalloys, HIP restoration, microstructure analysis by SEM and TEM.

2109426 Engineering Ceramic Manufacturing Process 3(3-0-6)

Ceramic manufacturing process; ceramic raw materials; ceramic powder synthesis; body preparation; rheology; organic additives; thermal process; sintering; slip casting; tape casting; extrusion; injection moulding; pressing; porous ceramic; sol-gel process; ceramic matrix composite; research and development of engineering ceramic manufacturing process.

2109432 Refractory Materials 3(3-0-6)

Classification of refractory materials; properties of important refractory materials; application of refractories in materials processing units; failures of refractories in materials processing units.

2109433 Electronic Materials 3(3-0-6)

Elementary quantum physics; the band theory of solids semiconductors; semiconductor devices; dielectric materials and insulation; superconductivity.

2109434 Technology Development of Advanced Materials for Medical Application 3(3-0-6)

Properties and types of materials for medical uses; mechanical, structural, chemical and biological characterization; production technology and formation of materials for medical application; research and technology development for advanced materials; advanced material used as biosensor; future trends in biomedical engineering.

2109435 Defects in Solids 3(3-0-6)

Point defects; thermodynamics of points defects; extended defects; structural aspects of composition variation; defects and diffusion; intrinsic defect and extrinsic defect in insulators, nonstoichiometry and intrinsic electronic conductivity, nonstoichiometry and extrinsic electronic conductivity; magnetic and optical defects.

2109450 Materials Selection and Design 3(3-0-6)

Criteria and concept in design of component and products and economic consideration; materials selection process; material property charts; effects of composition, processing, and structure on materials properties; properties versus performance of materials; case studies of materials processing and design; case studies of materials selection.

2109494 Selected Topics in Metallurgical and Materials Engineering 3(3-0-6)

Topics of current interest and new development in various fields of metallurgical and materials engineering.

2109504 Advanced Physical Metallurgy I 3(2-3-7)

Condition : Consent of Faculty

Classification of phase transformations continuous and discontinuous precipitation from solid solution; eutectoidal transformation, massive and martensitic transformation, order-disorder changes; relation of properties to microstructure; techniques and methodology used to study microstructure.

2109509 Stainless Steel Technology 3(3-0-9)

Condition : Consent of Faculty

Stainless steel development; stainless steel grades; phase equilibrium diagram; microstructure and metallography; passive film; martensitic, ferritic, austenitic, duplex and precipitation hardening stainless steels ; production technology; improvement of mechanical and corrosion properties and selection.

2109514 Advanced Corrosion 3(3-0-9)

Condition : Consent of Faculty

Engineering aspects of corrosion and its control; forms by which corrosion manifests itself; simplified mechanisms of corrosion and methods of combating corrosion; electrode processes; activation, ohmic, and concentration polarization; passivation; potentiostatic studies and alloy design; applications to engineering systems.

2109517 Composite Materials I 3(3-0-9)

Condition : Consent of Faculty

Properties of engineering composite materials; types of composite materials; fiber and their interfaces; geometrical properties; elasticity; case studies.

2109520 Physical Ceramics 3(3-0-9)

Physical and chemical process responsible for microstructure development; modern electronic ceramics; structual defects, sintering of ceramics and grain growth; mechanical, thermal, electrical, magnetic properties and dielectric property.

2109527 High Temperature Materials 3(3-0-9)

Condition : Consent of Faculty

Theory of alloying and relationship among temperature, structure, and mechanical properties in nickel, cobalt, and iron base alloys; effect of thermomechanical processing; analysis of microstructures by transmission electron microscopy, scanning electron microscopy, X-ray diffraction, and X-ray microprobe.

2109530 Physical Metallurgy of Steels 3(3-0-9)

Condition : Consent of Faculty

Properties of high purity iron; interstitial and substitutional solutes; carbon steels; high strength low alloy steels; thermomechanical treatment of steels; alloy steels; steels for magnetic and electrical application.

2109533 Powder Metallurgy 3(3-0-9)

Condition : Consent of Faculty

Preparation and fabrication of metal powder; engineering properties and industrial uses; theory of compaction and sintering.

2109535 Cellular Metal 3(3-0-9)

The structure, manufacturing methods, characterization techniques, mechanics. Physical and mechanical properties of cellular metals; energy absorption; sandwich structures and case studies.

2109555 Nano-structured Materials and Amorphous Materials 3(3-0-9)

Definition and classifications of nano-structured materials and amorphous materials; nanomaterials and amorphous materials in nature; processing pathways in relation to metastability and free energy; zero-dimensional, one-dimensional, two-dimensional and three-dimensional nanomaterials; nanomaterials characterizations; environmental and health impacts of nanomaterials.

COURSES DESCRIPTIONS IN METALLURGICAL ENGINEERING (M.ENG., D.ENG.)

2109501 Physical Metallurgy 3(3-0-9)

Structures of metals; physical properties of single crystals, and polycrystals; defects in crystals; diffusion in metals; recovery recrystallization and grain growth; binary and ternary phase equilibrium diagrams; principles of phase transformation.

2109502 Structures and Properties of Metals 3(3-0-9)

Structures and properties of metals and its alloy; relationship between microstructures and mechanical properties of metals.

2109503 Metallographic Examination 1(3-0-1)

Macro and microscopic examinations of important ferrous and non-ferrous metals.

2109504 Advanced Physical Metallurgy I 3(2-3-7)

Classification of phase transformations continuous and discontinuous precipitation from solid solution; eutectoidal transformation, massive and martensitic transformation, order-disorder changes; relation of properties to microstructure; techniques and methodology used to study microstructure.

2109507 Advance Mechanical Metallurgy 3(3-0-9)

Behavior of metals under simple and combined stress systems; elements of elastic theory, plastic deformation, dislocation theory, strength theories, and fracture; experiment in mechanical metallurgy.

2109508 Rate Phenomena and Modeling in Process Metallurgy 3(3-0-9)

Rate of metallurgical processes with engineering application to process simulation and control; special attention to processes important to iron and steelmaking homogeneous and heterogeneous reaction kinetics; mass and energy transport; steady-state and nonsteady-state reaction systems; development of process models.

2109509 Stainless Steel Technology 3(3-0-9)

Stainless steel development; stainless steel grades; phase equilibrium diagram; microstructure and metallography; passive film; martensitic, ferritic, austenitic, duplex and precipitation hardening stainless steels; production technology; improvement of mechanical and corrosion properties and selection.

2109510 Instrumental Analysis 3(2-3-7)

Operation principles of transmission electron microscopy and scanning electron microscopy, Xray diffraction, X-ray fluorescence, atomic absorption and spectro analysis, ESCA and Auger electron spectrometer; interpretation of instrumental results in terms of mechanical properties.

2109514 Advanced Corrosion 3(3-0-9)

Engineering aspects of corrosion and its control; forms by which corrosion manifests itself; simplified mechanisms of corrosion and methods of combating corrosion; electrode processes; activation, ohmic, and concentration polarization; passivation; potentiostatic studies and alloy design; applications to engineering systems.

2109515 Quantitative Analysis of Microstructure 3(3-0-9)

Basic probability theory and statistical analysis relevant to the quantitative description of a microstructure stereological relationships and the mathematical foundation and the microstructural tools needed to quantify the structure; applications of quantitative metallography to problems in failure analysis; solidification, heat treatment, phase equilibria, and deformation behavior.

2109516 Advanced Topics in Physical Metallurgy 3(3-0-9)

Advanced topics of current research interests in physical metallurgy.

2109517 Composite Materials I 3(3-0-9)

Properties of engineering composite materials; types of composite materials; fiber and their interfaces; geometrical properties; elasticity; case studies.

2109518 Surface Technology 3(3-0-9)

Carburizing, nitriding, flame hardening, diffusion hardening; chemical vapor deposition and physical vapor deposition; electroplating; hot dip coating; metal spraying and ion implantation.

2109519 Solidification of Casting 3(3-0-9)

Study of solidification of metal in molds; characteristics of liquid-solid phase transformations; Sand and metal thermal behavior; macroscopic structures; mechanical properties, and casting defects.

2109525 Welding Engineering 3(3-0-9)

Type and process of welding; mass and heat flow during welding; metallurgical effects of heat thermal cycle; solid-phase welding and joining of ceramic; welding of ferrous and non-ferrous metals; behavior of welds in service.

2109526 Advanced Topics in Chemical Metallurgy 3(3-0-9)

Advanced topics of current research interests in chemical metallurgy.

2109527 High Temperature Materials 3(3-0-9)

Theory of alloying and relationship among temperature, structure, and mechanical properties in nickel, cobalt, and iron base alloys; effect of thermomechanical processing; analysis of microstructures by transmission electron microscopy, scanning electron microscopy, X-ray diffraction, and X-ray microprobe.

2109528 Properties of Solids 3(3-0-9)

Atomistic approach of metal physics, crystal structure, lattice vibration, energy band; electric, electronic, optical and thermal properties of metal; electron spins; introduction to basic quantum mechanics.

2109530 Physical Metallurgy of Steels 3(3-0-9)

Properties of high purity iron; interstitial and substitutional solutes; carbon steels; HSLA steel; thermomechanical treatment of steel, alloy steels, steels for magnetic and electrical applications.

2109533 Powder Metallurgy 3(3-0-9)

Preparation and fabrication of metal powder; engineering properties and industrial uses; theory of compaction and sintering.

2109535 Cellular Metal 3(3-0-9)

The structure, manufacturing methods, characterization techniques, mechanics. Physical and mechanical properties of cellular metals; energy absorption; sandwich structures and case studies.

2109536 Advanced Topics in Production Metallurgy 3(3-0-9)

Advanced topics of current research interests in production metallurgy.

2109537 Tribology of Materials 3(3-0-9)

Solid lubrication and surface treatment; fundamentals of contacts between solids; abrasive, erosive, and cavitation wear; adhesion and adhesive wear, corrosive and oxidative wear; fatigue wear; fretting and minor wear mechanism; wear of non-metallic materials; case study.

2109541 Principles of Metallurgical Processing 3(3-0-9)

Introduction to the science of metallurgy; metallurgical furnaces; refractories; metallurgical fuels; temperature measurement and control; metallurgical calculation; energy and mass balances; analysis of steady and non-steady state processes, heat and mass transfer applied to metallurgical processes.

2109555 Nano-structured and Amorphous Materials 3(3-0-9)

Definition and classification of nano-structured materials and amorphous materials; nanomaterials and amorphous materials in nature; processing pathways in relation to metastability and free energy; zero-dimension, one-dimensional, two-dimensional and three-dimensional nanomaterials; nanomaterials characterizations; environmental and health impacts of nanomaterials.

2109601 Thermodynamics and Phase Equilibria in Multicomponent System 3(3-0-9)

Examination and study of thermodynamics of phase equilibria in multicomponent systems; measurements of thermodynamic activity, graphical presentation of phase equilibrium, solid and liquid solution models, development of equations of state using statistical models.

2109602 Transport Phenomena in Solids 3(3-0-9)

Fick's first and second law and their solutions; continuity equation; diffusion couples; interaction between diffusing atoms rate of diffusion; quantitative analysis of diffusion problems; energy and rate at which solid-state transformation occurs in pure metal and alloys; influences of defects on nucleation and grain growth.

2109603 Concepts in Metallurgy and Materials Engineering 3(3-0-9)

Physical metallurgy aspect to metallurgy and materials engineering which includes crystallography, defects and dislocations; microstructure, phase, phase

boundaries and related energies; solidification theories; phase transformations and phase equilibria; continuous and discontinuous precipitations.

2109604 Applications of Metallurgical and Materials Theories in Industries 3(3-0-9)

Forming process, Annealing, Alloy theories, Practical refractory in industries, Lubricant roles, Welding phenomena, Metals and materials under extreme conditions, Heat transfer, Transport phenomena, Problems in industries, Apply theories to solve industrial problems.

2109605 Steel Manufacture 3(3-0-9)

Structure and properties of slags; ionic theory and reactions in slags gas reactions in the blast furnace, partitioning of solute elements between iron and slag in blast furnace; steelmaking processes; refining slags; oxidation and deoxidation reactions; distribution of sulphur between the slag and the metals; removal of phosphorus from the metal.

2109606 Advnced Physical Metallurgy II 3(3-0-9)

Point symmetry and property of crystal; statistical mechanical treatment of phase transformation; spinodal decomposition and other topics of current research interest.

2109610 Physical Chemistry of Chemical Metallurgy 3(3-0-9)

Kinetics and mechanisms of reaction in chemical metallurgical systems; high temperature oxidation and reduction; slag metal reactions and other related processes; direct reduction.

2109617 Composite Materials II 3(3-0-9)

Theory of laminate, unidirectional strength of laminate Fiber strength, Short fiberous composite, other topics and case study.

2109620 Solution Concentration and Purification 3(3-0-9)

Study of aqueous solution chemistry including estimation of activity coefficients and complex equilibria calculations; application of solution chemistry of reaction kinetics and mass transfer phenomena in cementation; solvent extraction; and precipitation reactions.

2109623 Fracture Analysis 3(3-0-9)

Deformation and fracture mechanics of engineering materials; fracture, microstructural aspects of fracture toughness; environment-assisted cracking; fatigue crack propagation; analysis of engineering failures.

2109630 Forming Process Analysis 3(3-0-9)

Plastic forming of metals bending, forging rollings forge rolling, drawing; sheet metal forming; forging of complicated shapes; geometry of plastic area; formability; asymmetry of plastic deformation; computer analysis of forming process.

2109659 Aluminium Technology 3(3-0-9)

Physical metallurgy of aluminium and its alloys; productions of aluminium; deformation process such as rolling extrusion; relationship between microstructure and materials properties of aluminium alloys; recrystallization recovery; structural developments from the as cast to the worked and quenched state; surface finishes and treatments.

2109711 Seminar in Metallurgical and Materials Engineering I 1(1-0-3)

Seminar in selected research topics of interest in Metallurgical and Materials Engineering.

2109712 Seminar in Metallurgical and Materials Engineering II 1(1-0-3)

Seminar in Metallurgical and Materials Engineering II

2109713 Seminar in Metallurgical and Materials Engineering III 1(1-0-3)

Seminar in Metallurgical and Materials Engineering III

2109714 Seminar in Metallurgical and Materials Engineering IV 1(1-0-3)

Selected research topics of interest in metallurgical and materials engineering.

2109715 Seminar in Metallurgical and Materials Engineering V 1(1-0-3)

Selected research topics of interest in metallurgical and materials engineering.

2109716 Seminar in Metallurgical and Materials Engineering VI 1(1-0-3)

Selected research topics of interest in metallurgical and materials engineering.

2109717 Seminar in Metallurgical and Materials Engineering VII 1(1-0-3)

Selected research topics of interest in metallurgical and materials engineering.

2109811 Thesis 12 Credits

2109828 Dissertation 48 Credits

2109894 Doctoral Dissertation Seminar 0(0-0-0)

2109897 Qualifying Examination 0(0-0-0)

DEPARTMENT OF COMPUTER ENGINEERING

Objectives

1. Technical skills: Graduates successfully practice in the field of computer engineering, demonstrating contemporary knowledge, and applying their computational and analytical skills to solve problems.
2. Professional development: Graduates update and adapt their skills with best practices, new tools, innovative solutions, and engage in life-long learning.
3. Global citizenship: Graduates participate in their communities as productive citizens, using communication, leadership, and teamwork skills.

The undergraduate program in Computer Engineering is relatively broad-based. The program covers various aspects in computer science and engineering which include the design, analysis, organization, and applications of computer systems. The department offers courses which can be divided into three major areas.

1. Digital System Engineering : Courses cover the design and analysis of digital computer systems which include logic design, microprocessors, microcomputer systems, assembly language, VLSI design, computer architectures, data communications and computer networks.

2. Systems & Software Engineering : Courses cover the principles of design and analysis of algorithms, systems software, programming languages, compilers, and operating systems. The students will, in addition, understand the interactions between software and hardware at various interface levels.

3. Information Processing and Analytics : Courses cover the design and analysis of information processing systems, information technology, software engineering, database management system, computer graphics, data analytics, artificial intelligence, and their applications.

A bachelor degree in Computer Engineering will be awarded upon successful completion of the four year curriculum. Being highly competent in the design, analysis, and applications of systems software, digital systems, and information processing, the graduate will be able to work as a systems programmer, a systems analyst or a system engineer.

The department also offers four additional curriculums leading to the Master Degree in Computer Science, Master Degree in Software Engineering, Master Degree in Computer Engineering, and Doctor of Philosophy in Computer Engineering.

HEAD :

Attawith	Sudsang,	Ph.D. (U. of Illinois)

PROFESSORS :

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Wiwat	Vatanawood,	Ph.D. (Chulalongkorn U.)

ASSOCIATE PROFESSORS :

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Kultida	Rojviboonchai,	Ph.D (U. of Tokyo)
Nakornthip	Prompoon,	M.Sc. (George Wash. U.)
Nuttapong	Chentanez,	Ph.D. (U. of California, Berkeley)
Peerapon	Vateekul,	Ph.D. (U. of Miami)
Proadpran	Punyabukkana Pitsatorn,	Ph.D. (Claremont U.)
Setha	Pan-Ngum,	Ph.D. (U. of Warwick)
Taratip	Suwannasart,	Ph.D. (Illinois Institute of Technology)
Thanarat	Chalidabhongse,	Ph.D. (U. of Maryland)
Twittie	Senivongse,	Ph.D. (U. of Kent)
Veera	Muangsin,	Ph.D. (U. of Manchester)
Vishnu	Kotrajaras,	Ph.D. (Imperial College)
Yachai	Limpiyakorn,	Ph.D. (Illinois Institute of Technology)

ASSISTANT PROFESSORS :

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Ekapol	Chuangsuwanich,	Ph.D. (Massachusetts Institute of Technology)
Kunwadee	Sripanidkulchai	Ph.D. (Carnegie Mellon U.)
Narongdech	Keeratipranon,	Ph.D. (Queensland U.)
Natawut	Nupairoj,	Ph.D. (Michigan St. U.)
Nattee	Niparnan,	Ph.D. (Chulalongkorn U.)

Nuengwong	Tuaycharoen,	Ph.D. (U. of Maryland College Park)
Sukree	Sinthupinyo,	Ph.D. (Chulalongkorn U.)
Pitchaya	Sitthi-Amorn	Ph.D. (U. of Virginia)
Pittipol	Kantavat,	Ph.D. (Chulalongkorn U.)
Pizzanu	Kanongchaiyos,	Ph.D. (U. of Tokyo)
Punnarai	Siricharoen,	Ph.D. (Ulster U.)

LECTURERS :

Jessada	Thutkawkornpin,	Ph.D. (Kavolinsha Institute)
Kamonluk	Suksen	Ph.D. (Chulalongkorn U.)
Machigar	Ongtang	Ph.D. (Pennsylvania State U.)
Thongchai	Rojkangsadan,	M.Sc. (U. of Delaware)
Warisa	Sritriratanarak	Ph.D. (Chulalongkorn U.)

COMPUTER ENGINEERING CURRICULUM

COURSE NO.	SUBJECT	CREDITS
	FIRST SEMESTER	
2100111	EXPL ENG WORLD	3
2110101	COMP PROG	3
2301107	CALCULUS I	3
2304103	GEN PHYS I	3
2304183	GEN PHYS LAB I	1
5500111	EXP ENG I	3
		16
	SECOND SEMESTER	
2110215	PROG METH I	3
2110221	COMP ENG ESS	3
2301108	CALCULUS II	3
2302127	GEN CHEM	3
2302163	GEN CHEM LAB I	1
2304104	GEN PHYS II	3
2304184	GEN PHYS LAB II	1
5500112	EXP ENG II	3
		20
	THIRD SEMESTER	
2110200	DISCRETE STRUC	3
2110211	INTRO DATA STRUCT	3
2110251	DIG COMP LOGIC	3
2110263	DIG COMP LAB I	1
2603284	STAT PHYS SCIENCE	3
xxxxxxx	GENERAL EDUCATION	3
		16
	FOURTH SEMESTER	
2110201	COMP ENG MATH	3
2110313	OS SYS PROG	3
2110322	DB SYS	3
2110327	ALGORITHM DESIGN	3
2110352	COMP SYS ARCH	3
2110363	HW SYN LAB I	1
5500208	COM PRES SKIL	3
		19

Two required electives are chosen from the followings:

- 2110404 Computational Theory
- 2110415 Software-Defined Systems
- 2110446 Data Science and Data Engineer
- 2110452 High Performance Architecture
- 2110521 Software Architecture

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COURSE NO.	SUBJECT	CREDITS
	FIFTH SEMESTER	
2110203	COMP ENG MATH II	3
2110426	SE LAB	1
2110318	Distributed Systems Essentials	1
2110366	EMBEDDED SYS LAB I	1
2110423	Software Engineering	3
2110471	COMP NETWORK I	3
2110xxx	APPROVED ELECTIVES	3
xxxxxxx	GENERAL EDUCATION	3
		18
	SIXTH SEMESTER	
2110xxx	ELECT. FOR 21ST CENTURY	3
2110xxx	REQUIRED ELECTIVES	3
2110xxx	APPROVED ELECTIVES	3
xxxxxxx	FREE ELECTIVES	3
5500308	TECH WRIT ENG	3
		15
	SUMMER SEMESTER	
2100301	ENGINEERING PRACTICE	2
	SEVENTH SEMESTER	
2110488	CAP PROJ I	2
2110xxx	REQUIRED ELECTIVES	3
2110xxx	APPROVED ELECTIVES	3
2110xxx	APPROVED ELECTIVES	3
xxxxxxx	GENERAL EDUCATION	3
xxxxxxx	FREE ELECTIVES	3
		17
	EIGHTH SEMESTER	
2110489	CAP PROJ II	3
2110xxx	ELECT. FOR 21ST CENTURY	3
2110xxx	APPROVED ELECTIVES	3
2110xxx	APPROVED ELECTIVES	3
xxxxxxx	FREE ELECTIVES	3
		15

TOTAL CREDITS FOR GRADUATION = 138

COMPUTER ENGINEERING AND DIGITAL TECHNOLOGY CURRICULUM

COURSE NO.	SUBJECT	CREDITS
	FIRST SEMESTER	
2110222	INTRO2CEDT	3
2110104	COMP PROG	3
2110204	DISCRETE STRUC	3
2110328	DATA STRUCT ALGO	4
2110252	DIG COMP LOGIC	3
		16
	SECOND SEMESTER	
2110215	PROG METH I	3
2110322	DB SYS	3
2110503	Software Development Practice	3
2110504	Software Development Practice II	3
2110423	Software Engineering	3
2110426	SE LAB	1
		16
	SUMMER SEMESTER	
2110102	CP ENG PRACTICE I	3
	THIRD SEMESTER	
2110205	STAT PHYS SCI	3
2110201	COMP ENG MATH	3
2110203	COMP ENG MATH II	3
5500111	EXP ENG I	3
2110403	INTRO DATA SCI ENG	3
2110356	EMBEDDED SYS	3
		18
	FOURTH SEMESTER	
2110313	OS SYS PROG	3
2110471	COMP NETWORK I	3
2110405	AI AND ML	3
5500208	COM PRES SKIL	3
2110xxx	REQUIRED ELECTIVES	3
2110xxx	REQUIRED ELECTIVES	3
		18
	SUMMER SEMESTER	
2110212	CP ENG PRACTICE II	3
	FIFTH SEMESTER	
2110488	CAP PROJ I	2
2110506	SOFT DEF SYS I	3
2110575	IOT AND DIG SOL	3
2110413	COMP SECURITY	3
5500308	TECH WRIT ENG	3
2110xxx	REQUIRED ELECTIVES	3
2110xxx	REQUIRED ELECTIVES	3
		20
	SIXTH SEMESTER	
2110489	CAP PROJ II	3
2110xxx	REQUIRED ELECTIVES	3
2110xxx	REQUIRED ELECTIVES	3
2110xxx	REQUIRED ELECTIVES	3
xxxxxxx	FREE ELECTIVES	3
xxxxxxx	FREE ELECTIVES	3
		18
	SUMMER SEMESTER	
2100302	ENGINEERING PRACTICE III	3
	SEVENTH SEMESTER	
2110402	CP COOP	9
		9

TOTAL CREDITS FOR GRADUATION = 124

MASTER DEGREE PROGRAMS
COMPUTER SCIENCE

NAME OF THE DEGREE

: Master of Science
: M.Sc.

ADMISSION

The applicant must have the following qualification:

1. Hold a Bachelor degree in Computer Science, Computer Engineering, Software Engineering, Information Technology, Mathematics, Physics, Statistics, or other Engineering fields.
2. Have other qualifications as announced each year by Graduate School of Chulalongkorn University (if any), or have other qualifications approved by the Computer Science Program Committee.

DEGREE REQUIREMENTS

The program requires the total of 36 credits comprising

1. Required Courses: 3 credits and a non-credit seminar course
2. Required Elective Courses: 9 credits
3. General Elective Courses: 12 credits
4. Thesis: 12 credits

COURSE REQUIREMENTS

1) *Required Courses*

2110607	Research Methods in CS	3(3-0-9)
2110701	Seminar in Computer Eng. I	1(0-1-3)

Remark: 2110701 Seminar in Computer Engineering I is a non-credit course, with S/U evaluation.

2) *Required Elective Courses*

2110625	Data Science Architecture	3(3-0-9)
2110626	Enterprise and IoT Network Infrastructure	3(3-0-9)
2110636	Performance Analysis and Eval.	3(3-0-9)
2110640	Information Security	3(3-0-9)
2110654	Artificial Intelligence	3(3-0-9)
2110681	Computer Algorithm	3(3-0-9)
2110682	Embedded and Real-Time Sys.	3(3-0-9)
2110743	Machine Learning	3(3-0-9)

3) *General Elective Courses*

2110512	Computer Animation	3(3-0-9)
2110514	Sensor Technology	3(2-3-7)
2110515	Introduction to Robotics	3(3-0-9)
2110521	Software Architectures	3(3-0-9)
2110522	UNIX/Linux for Enterprise Environment	3(3-0-9)
2110523	Enterprise Application Architectures	3(3-0-9)
2110581	Bioinformatics I	3(3-0-9)
2110595	Advanced Topics in Computer Engineering V	3(3-0-6)
2110625	Data Science Architecture	3(3-0-9)
2110626	Enterprise and IoT Network Infrastructure	3(3-0-9)
2110627	Big Data Tools	3(3-0-9)
2110682	Embedded and Real-time Systems	3(3-0-9)
2110678	Mobile Computing	3(3-0-9)
2110694	Directed Studies in CS	3(3-0-9)
2110697	Special Topics in CS I	3(3-0-9)
2110698	Special Topics in CS II	3(3-0-9)
2110713	Optimization Methods	3(3-0-9)
2110731	Distributed Systems	3(3-0-9)
2110732	Parallel Computing	3(3-0-9)
2110741	Robotics	3(3-0-9)
2110742	Evolutionary Computation	3(3-0-9)
2110746	Big Data Analytics	3(3-0-9)
2110747	Social Network Analysis	3(3-0-9)
2110773	Data Mining	3(3-0-9)
2110781	Special Topics in Distributed Sys.	3(3-0-9)
2110792	Advanced Topics in AI	3(3-0-9)
2110795	Advanced Topics in Computer Network	3(3-0-9)

In addition to the list above, students can choose among the following as General Elective Courses:

1. Graduate courses of other programs of the Department (i.e. 21105xx, 21106xx, or 21107xx courses not listed as the General Elective Courses above)
2. Graduate courses of Chulalongkorn University (approval by the Computer Science Program Committee is required).

4) *Thesis*

2110811	Thesis	12 credits

STUDY PROGRAM

First Semester

2110607	Research Methods in CS	3
2110xxx	Required Electives	3
2110xxx	Electives	3
		9

Second Semester

2110xxx	Required Electives	6
2110xxx	Electives	3
		9

Third Semester

2110701	Seminar in Computer Eng. I	-
2110xxx	Electives	6

2110811	Thesis	3
		9

Fourth Semester

2110811	Thesis	9

MASTER DEGREE PROGRAM
COMPUTER ENGINEERING

NAME OF THE DEGREE

: Master of Engineering
: M.Eng.

ADMISSION

The applicant must hold a Bachelor's Degree in Computer Engineering for plan A(1) or a Bachelor's Degree in any Engineering discipline for plan A(2), meet the Graduate School requirements, and also must pass the Interview by the Computer Engineering Department.

DEGREE REQUIREMENTS

Plan A(1) program consists of three non-credit required courses and 36 credits of thesis. Plan A(2) program consists of 3 non-credit required courses, 12 credits of elective courses, and 24 credits of thesis.

COURSE REQUIREMENTS

1) Required Courses non-credit

2110606	Research Methods in Computer Engineering	3(3-0-9)
2110701	Seminar in Computer Engineering I	1(0-3-1)
2110702	Seminar in Computer Engineering II	1(0-3-1)

2) Elective Courses 12 credits

2110502	Formal Verification	3(3-0-9)
2110522	UNIX/LINUX for Enterprise Environment	3(3-0-9)
2110523	Enterprise Application Architecture	3(3-0-9)
2110541	Computer Systems Audit	3(3-0-9)
2110605	Computer Programs Structure	3(3-0-9)
2110611	Information Processing and Computer System	3(3-0-9)
2110612	System Programming	3(3-0-9)
2110614	Programming Languages and Compilation	3(3-0-9)
2110621	System Analysis and Design	3(3-0-9)
2110622	Data Management	3(3-0-9)
2110623	Software Requirements Engineering	3(3-0-9)
2110624	Software Engineering	3(3-0-9)
2110629	File Management	3(3-0-9)
2110631	Operating System	3(3-0-9)
2110632	Advanced Topics in Operating Systems	3(3-0-9)
2110634	Software Design and Development	3(3-0-9)
2110636	Performance Analysis and Evaluation	3(3-0-9)
2110637	Large-Scale Information Systems	3(3-0-9)
2110638	Object-Oriented Technology	3(3-0-9)
2110639	Computer System Security	3(3-0-9)
2110640	Information Security	3(3-0-9)
2110642	Object-Oriented Software Engineering	3(3-0-9)
2110644	Formal Software Specification	3(3-0-9)
2110645	Software Engineering Methodology	3(3-0-9)
2110646	User Interface Design	3(3-0-9)
2110651	Digital Image Processing	3(3-0-9)
2110654	Artificial Intelligence	3(3-0-9)
2110657	Computer Simulation	3(3-0-9)
2110661	Computer Network	3(3-0-9)
2110663	Worldwide Network Infrastructure	3(3-0-9)
2110664	Network Management	3(3-0-9)
2110665	Computer Communication System and Standards	3(3-0-9)
2110671	Database Management Systems	3(3-0-9)
2110672	Data Modeling Techniques	3(3-0-9)
2110673	Information Storage and Retrieval	3(3-0-9)
2110674	Information Technology Center Management	3(3-0-9)
2110678	Mobile Computing	3(3-0-9)
2110681	Computer Algorithm	3(3-0-9)
2110682	Embedded and Real-time Systems	3(3-0-9)
2110683	Concurrent Processing	3(3-0-9)
2110684	Information System Architecture	3(3-0-9)
2110685	Computer Application in Enterprises	3(3-0-9)
2110686	Enterprise Computing	3(3-0-9)
2110694	Directed Studies in Computer Science	3(3-0-9)
2110696	Advanced Topics in Computer Application	3(3-0-9)
2110697	Special Topics in Computer Science I	3(3-0-9)
2110698	Special Topics in Computer Science II	3(3-0-9)
2110711	Theory of Computation	3(3-0-9)
2110712	Analysis of Algorithms	3(3-0-9)

2110713	Optimization Methods	3(3-0-9)
2110714	Digital Systems	3(3-0-9)
2110721	Software Metrics	3(3-0-9)
2110722	Software Project Management	3(3-0-9)
2110723	Advanced Software Engineering Development	3(3-0-9)
2110724	Software Testing and Quality Assurance	3(3-0-9)
2110730	Software Quality Process and Management	3(3-0-9)
2110731	Distributed Systems	3(3-0-9)
2110732	Parallel Computing	3(3-0-9)
2110741	Robotics	3(3-0-9)
2110742	Evolutionary Computation	3(3-0-9)
2110743	Machine Learning	3(3-0-9)
2110744	Machine Vision	3(3-0-9)
2110745	Cryptography	3(3-0-9)
2110746	Big Data Analytics	3(3-0-9)
2110747	Social Network Analysis	3(3-0-9)
2110751	Computer Aided Design in Digital Systems	3(3-0-9)
2110752	Design for Testability	3(3-0-9)
2110753	Asynchronous Design	3(3-0-9)
2110771	Advanced Database Design	3(3-0-9)
2110772	Multi-Dimensional Database Systems	3(3-0-9)
2110773	Data Mining	3(3-0-9)
2110781	Special Topics in Distributed Systems	3(3-0-9)
2110791	Advanced Topics in Software Engineering	3(3-0-9)
2110792	Advanced Topics in Artificial Intelligence	3(3-0-9)
2110793	Advanced Topics in Digital Systems	3(3-0-9)
2110794	Advanced Topics in Database Systems	3(3-0-9)
2110795	Advanced Topics in Computer Network	3(3-0-9)

3) Thesis

2110814	Thesis (for plan A(2))	24	credits
2110816	Thesis (for plan A(1))	36	credits

STUDY PROGRAMS

Plan A (1)

First Semester

2110606	Researh Methods	-
2110701	Seminar Computer Eng. I	-
2110816	Thesis	9
		9

Second Semester

2110702	Seminar Computer Eng. II	-
2110816	Thesis	9
		9

Third Semester

2110702	Seminar Computer Eng. II	-
2110816	Thesis	9
		9

Fourth Semester

2110816	Thesis	9
		9

Plan A (2)

First Semester

2110606	Researh Methods	-
2110701	Seminar Computer Eng. I	-
2110 xxx	Electives	9
		9

Second Semester

2110702	Seminar Computer Eng. II	-
2110 xxx	Electives	3
2110814	Thesis	6
		9

Third Semester

2110814	Thesis	9
		9

Fourth Semester

2110814	Thesis	9
		9

MASTER DEGREE PROGRAM SOFTWARE ENGINEERING

NAME OF THE DEGREE

: Master of Science
: M.Sc.

ADMISSION

The program has 2 plans.

Plan A(2) is the plan **with thesis**. The applicant must

1. Hold a Bachelor's degree in Engineering, Statistics, Science, or equivalent.
2. Have an English test result as required by the university and Software Engineering Program.

3. Have other qualifications as announced each year by the Graduate School of Chulalongkorn University (if any), or have other qualifications approved by the Software Engineering Program Committee.

Plan B is the plan with **no thesis**, but students **must do the master project and pass the comprehensive exam**. The applicant must

1. Hold a Bachelor's degree in one of these fields.
   - Engineering
   - Statistics
   - Science
   - Education/Industrial Education with one of these sub-fields
     - Education Technology and Communication
     - Computer and Information Technology
     - Computer Technology or
     - Electronics and Computer
   - Business Administration with one of these sub-fields
     - Business Computer
     - Business Information Technology
     - Computer Information or
     - Computer Information Systems – Software Development
   - or hold other Bachelor's degree approved by the Software Engineering Program Committee.
2. Have at least 1 year of work experience in Information Technology or Computer.
3. Have an English test result as required by the university and Software Engineering Program.
4. Have other qualifications as announced each year by the Graduate School of Chulalongkorn University (if any), or have other qualifications approved by the Software Engineering Program Committee.

DEGREE REQUIREMENTS

Both Plan A(2) and Plan B require the total of 36 credits.

Plan A(2)

1. Non-credit Course (1 course)
2. Required Courses 12 credits
3. Prescribed Elective Courses 12 credits
4. Thesis 12 credits

Plan B

1. Non-credit Course (1 course)
2. Required Courses 12 credits
3. Prescribed Elective Courses 18 credits
4. Master Project 6 credits
5. Comprehensive Exam

COURSE REQUIREMENTS

Plan A(2)

1) Non-credit Course

2110608	Seminar and Research Methods in Software Engineering	3(3-0-9)

Remark: The non-credit course will be evaluated with S/U.

2) Required Courses

2110623	Software Requirements Engineering	3(3-0-9)
2110634	Software Design and Development	3(3-0-9)
2110722	Software Project Management	3(3-0-9)
2110724	Software Testing and Quality Assurance	3(3-0-9)

3) Prescribed Elective Courses

Prescribed Elective Courses are divided into two groups: Software Engineering Electives and General Electives. Student must choose four courses, and at least two of these must be in Software Engineering Electives.

---Software Engineering Electives

2110502	Formal Verification	3(3-0-9)
2110503	Software Development Practice	3(3-0-9)
2110504	User-Centered Software Design	3(3-0-9)
2110521	Software Architecture	3(3-0-9)
2110523	Enterprise Application Architecture	3(3-0-9)
2110644	Formal Software Specification	3(3-0-9)
2110645	Software Engineering Methodology	3(3-0-9)
2110646	User Interface Design	3(3-0-9)
2110721	Software Metrics	3(3-0-9)
2110723	Advanced Software Engineering Development	3(3-0-9)
2110725	Software Engineering Process and Improvement	3(3-0-9)
2110726	Software Configuration Management	3(3-0-9)
2110727	Software Evolution and Maintenance	3(3-0-9)
2110728	Special Topics in Software Engineering I	3(3-0-9)
2110729	Special Topics in Software Engineering II	3(3-0-9)
2110730	Software Quality Process and Management	3(3-0-9)
2110791	Advanced Topics in Software Engineering	3(3-0-9)

---General Electives

Any graduate-level courses of Chulalongkorn University (approval by the Software Engineering Program Committee is required for the courses offered by other departments).

4) Thesis

2110811 Thesis 12 credits

Plan B

1) Non-credit Course

2110608	Seminar and Research Methods in Software Engineering	3(3-0-9)

Remark: The non-credit course will be evaluated with S/U.

2) Required Courses

2110623	Software Requirements Engineering	3(3-0-9)
2110634	Software Design and Development	3(3-0-9)
2110722	Software Project Management	3(3-0-9)
2110724	Software Testing and Quality Assurance	3(3-0-9)

3) Prescribed Elective Courses

Prescribed Elective Courses are divided into two groups: Software Engineering Electives and General Electives. Student must choose six courses, and at least four of these must be in Software Engineering Electives.

---Software Engineering Electives

2110502	Formal Verification	3(3-0-9)
2110503	Software Development Practice	3(3-0-9)
2110504	User-Centered Software Design	3(3-0-9)
2110521	Software Architecture	3(3-0-9)
2110523	Enterprise Application Architecture	3(3-0-9)
2110644	Formal Software Specification	3(3-0-9)
2110645	Software Engineering Methodology	3(3-0-9)
2110646	User Interface Design	3(3-0-9)
2110721	Software Metrics	3(3-0-9)
2110723	Advanced Software Engineering Development	3(3-0-9)
2110725	Software Engineering Process and Improvement	3(3-0-9)
2110726	Software Configuration Management	3(3-0-9)
2110727	Software Evolution and Maintenance	3(3-0-9)
2110728	Special Topics in Software Engineering I	3(3-0-9)
2110729	Special Topics in Software Engineering II	3(3-0-9)
2110730	Software Quality Process and Management	3(3-0-9)
2110791	Advanced Topics in Software Engineering	3(3-0-9)

---General Electives

Any graduate-level courses of Chulalongkorn University (approval by the Software Engineering Program Committee is required for the courses offered by other departments).

4) Master Project

2110797	Pre-Master Project in Software Engineering	3(0-0-12)
2110798	Master Project in Software Engineering	3(0-0-12)

5) Comprehensive Exam

2110896 Comprehensive Examination

Remark: Comprehensive examination will be evaluated with S/U. The student who has passed all courses that are covered in the exam can enroll in this course.

STUDY PROGRAMS

Plan A(2)

First Semester

2110623	Software Requirements Engineering	3
2110722	Software Project Management	3
2110724	Software Testing and Quality Assurance	3
		9

Second Semester

2110608	Seminar and Research Methods in Software Engineering	-
2110634	Software Design and Development	3
2110xxx	Prescribed Electives	6
		9

Third Semester

2110xxx	Prescribed Electives	6
2110811	Thesis	3
		9

Fourth Semester

2110811	Thesis	9
		9

Plan B

First Semester

2110623	Software Requirements Engineering	3
2110722	Software Project Management	3
2110724	Software Testing and Quality Assurance	3
		9

Second Semester

2110608	Seminar and Research Methods in Software Engineering	-
2110634	Software Design and Development	3
2110xxx	Prescribed Electives	6
		9

Third Semester

2110xxx	Prescribed Electives	6
2110797	Pre-Master Project in Software Engineering	3
2110896	Comprehensive Exam	-
		9

Fourth Semester

2110xxx	Prescribed Electives	6
2110798	Master Project in Software Engineering	3
		9

PH.D. DEGREE PROGRAM

NAME OF THE DEGREE

: Doctor of Philosophy
: Ph.D.

ADMISSION

The applicant must meet the Graduate School requirement and hold one of the following qualification :

A) Bachelor's Degree in Engineering with first or second class honors and grade point of no less than 3.25
B) Master's Degree in Engineering or Science in Computer, Physics or Mathematics.

DEGREE REQUIREMENTS

There are four plans for the degree.

- Plan 1.1 (for Master's degree holder) requires non-credit seminars and 60 credits of thesis
- Plan 1.2 (for Bachelor's degree holder) requires non-credit seminars, and 72 credits of thesis
- Plan 2.1 (for Master's degree holder) requires non-credit seminars, 12 credits of elective courses and 48 credits of thesis
- Plan 2.2 (for Bachelor's degree holder) requires non-credit seminars, 24 credits of elective courses and 48 credits of thesis

COURSE REQUIREMENTS

1) Non-credit Required Courses

2110716 Seminar I
2110717 Seminar II
2110718 Seminar III
2110719 Seminar IV
2110894 Doctoral Dissertation Seminar
21108
2110897 Qualifying Examination (must pass the exam within the first four semesters)

2) Elective Courses 12 credits

2110694	Directed Studies in CS	3(3-0-9)
2110697	Special Topics in CS I	3(3-0-9)
2110698	Special Topics in CS II	3(3-0-9)
2110721	Software Metrics	3(3-0-9)
2110722	Software Project Management	3(3-0-9)
2110723	Advanced SE Development	3(3-0-9)
2110724	Software Testing and Quality Assurance	3(3-0-9)
2110730	Software Quality and Process Management	3(3-0-9)
2110731	Distributed Systems	3(3-0-9)
2110732	Parallel Computing	3(3-0-9)
2110741	Robotics	3(3-0-9)
2110742	Evolutionary Computation	3(3-0-9)
2110743	Machine Learning	3(3-0-9)
2110744	Machine Vision	3(3-0-9)
2110745	Cryptography	3(3-0-9)
2110746	Big Data Analytics	3(3-0-9)
2110747	Social Network Analysis	3(3-0-9)
2110751	Computer Aided Design in Digital Systems	3(3-0-9)
2110752	Design for Testability	3(3-0-9)

2110753	Asynchronous Design	3(3-0-9)
2110771	Advanced Database Design	3(3-0-9)
2110772	Multi-Dimensional Database Systems	3(3-0-9)
2110773	Data Mining	3(3-0-9)
2110781	Special Topics in Distributed Systems	3(3-0-9)
2110791	Advanced Topics in Software Engineering	3(3-0-9)
2110792	Advanced Topics in Artificial Intelligence	3(3-0-9)
2110793	Advanced Topics in Digital Systems	3(3-0-9)
2110794	Advanced Topics in Database Systems	3(3-0-9)
2110795	Advanced Topics in Computer Network	3(3-0-9)

3) Dissertation

2110828	Dissertation (for plan 2.1 and 2.2)	48 credits
2110829	Dissertation (for plan 1.1)	60 credits
2110830	Dissertation (for plan 1.2)	72 credits

STUDY PROGRAMS

Plan 1.1

First Semester

2110716	Seminar I	-
2110829	Dissertation	10

Second Semester

2110717	Seminar II	-
2110829	Dissertation	10

Third Semester

2110718	Seminar III	-
2110829	Dissertation	10

Fourth Semester

2110719	Seminar IV	-
2110829	Dissertation	10

Fifth Semester

2110894	Doctoral Dissertation Seminar	-
2110829	Dissertation	10

Sixth Semester

2110894	Doctoral Dissertation Seminar	-
2110829	Dissertation	10

Plan 1.2

First Semester

2110716	Seminar I	-
2110830	Dissertation	6

Second Semester

2110717	Seminar II	-
2110830	Dissertation	6

Third Semester

2110718	Seminar III	-
2110830	Dissertation	6

Fourth Semester

2110719	Seminar IV	-
2110830	Dissertation	6

Fifth Semester

2110894	Doctoral Dissertation Seminar	-
2110830	Dissertation	8

Sixth Semester

2110894	Doctoral Dissertation Seminar	-
2110830	Dissertation	8

Seventh Semester

2110894	Doctoral Dissertation Seminar	-
2110830	Dissertation	8

Eighth Semester

2110894	Doctoral Dissertation Seminar	-
2110830	Dissertation	8

Ninth Semester

2110894	Doctoral Dissertation Seminar	-
2110830	Dissertation	8

Tenth Semester

2110894	Doctoral Dissertation Seminar	-
2110830	Dissertation	8

Plan 2.1

First Semester

2110716	Seminar I	-
2110xxx	Electives	6
2110828	Dissertation	3

Second Semester

2110717	Seminar II	-
2110xxx	Electives	6
2110828	Dissertation	3

Third Semester

2110718	Seminar III	-
2110828	Dissertation	9

Fourth Semester

2110719	Seminar IV	-
2110828	Dissertation	9

Fifth Semester

2110894	Doctoral Dissertation Seminar	-
2110828	Dissertation	12

Sixth Semester

2110894	Doctoral Dissertation Seminar	-
2110828	Dissertation	12

Plan 2.2

First Semester

2110716	Seminar I	-
2110xxx	Electives	9

Second Semester

2110717	Seminar II	-
2110xxx	Electives	9

Third Semester

2110718	Seminar III	-
2110xxx	Electives	6
2110828	Dissertation	3

Fourth Semester

2110719	Seminar IV	-
2110828	Dissertation	9

Fifth Semester

2110894	Doctoral Dissertation Seminar	-
2110828	Dissertation	6

Sixth Semester

2110894	Doctoral Dissertation Seminar	-
2110828	Dissertation	6

Seventh Semester

2110894	Doctoral Dissertation Seminar	-
2110828	Dissertation	6

Eighth Semester

2110894	Doctoral Dissertation Seminar	-
2110828	Dissertation	6

Ninth Semester

2110894	Doctoral Dissertation Seminar	-
2110828	Dissertation	6

Tenth Semester

2110894	Doctoral Dissertation Seminar	-
2110828	Dissertation	6

COURSE DESCRIPTIONS IN COMPUTER ENGINEERING (B.ENG.)

2110101 Computer Programming 3(3-0-6)

Computer concepts, computer system components, hardware and software interaction, electronic information and data processing concepts; programming: data types, operators, statements, control structures; programming tools; programming styles and conventions; debugging; program design and development with applications to engineering problems using a high level language.

2110102 Computer Engineering Practice 3(0-18-0)

Engineering practice or experience is a tool for student to have a chance to practice and apply the knowledge in classroom. To be familiar with work in engineering field..as well as develop interpersonal and networking skill before actual working after graduation. Engineering practice is in related areas under supervision of experience experienced engineers in private sectors or government agencies.

2110104 Computer Programming 3(3-0-6)

Computer system components and interactions; programming: data types, operators, expressions, statements, control structures, aggregate data: programming tools; programming style and conventions; debugging: program design and development with applications to engineering problems using a high level programming language and numerical libraries.

2110191 Innovative Thinking 3(3-0-6)

Condition : Free Elective

Definition of innovative thinking ; Types of innovation ; Innovator Role Model; Innovative thinking process; Creative mistakes; Innovation development.

2110200 Discrete Structures 3(3-0-6)

Sets, relations, functions, theorem and proof; combinatorics; counting, principle of inclusion exclusion, recurrent relations, generating functions; graphs and trees; introduction to number theory.

2110201 Computer Engineering Mathematics 3(3-0-6)

Linear algebra, vector, matrix, inverse matrix, solution to system of linear equations, factorization, vector space, subspace, rank, dimension, basis, orthogonality, projection, determinant, determinant computation, eigenvalue, eigenvector, singular value decomposition, computer programming for linear algebra.

2110205 Statistics for Computer Engineering 3(3-0-6)

The scope and uses of statistics in computer engineering; elementary principles of probability theory; random variables and some probability distributions; introduction to statistical inference; introduction to analysis of variance; regression and correlation; statistical quality control.

2110211 Introduction to Data Structures 3(3-0-6)

Condition : Prerequisite 2110101

Linear allocation: array, stack, queue, dequeues; linked allocation: singly linked lists, and doubly linked lists; string processing and pattern matching; trees: binary tree, traversal, representation, B-tree and AVL-tree; internal searching and sorting: binary, radixes, shell, quicksort and merge sort; heap storage, hash coding and table handling.

2110212 Computer Engineering Practice 2 3(0-18-0)

Engineering practice or experience is a tool for student to have a chance to practice and apply the knowledge in classroom. To be familiar with work in engineering field..as well as develop interpersonal and networking skill before actual working after graduation. Engineering practice is in related areas under supervision of experience experienced engineers in private sectors or government agencies.

2110213 Information Systems Organization **3(3-0-6)**

Hardware systems: personal computer, network, Internet, internet protocol, domain name, cable, hub, switch, router, modem, Internet server, corporate server, real-time server, embedded system; application systems: multi-tier system, web server, markup language, application server, database server, query language, multi-vendor database access interface; transaction systems: process abstraction, inter-process communication, synchronization, deadlock, transaction atomicity, checkpoint and rollback, concurrency control.

2110215 Programming Methodology I **3(2-3-4)**

Condition : Prerequisite 2110101

Programming methodology: object-oriented programming, event-driven programming, concurrent programming; error and exception handling; application programming interface (API); programming tools; programming styles and practice.

2110221 Computer Engineering Essentials **3(3-0-6)**

Overview of computer engineering, information system and information technology; hardware and software; logic circuit and processor; algorithm and program; database; computer network and internet, artificial intelligence and robot; embedded system; data center; security; computer ethics; intellectual property; computer industry.

2110222 Introduction to Computer Engineering and Digital Technology **3(3-0-6)**

Programming methodology: object-oriented programming, event-driven programming, concurrent programming; error and exception handling; application programming interface (API); programming tools; programming styles and practice.

2110250 Computer Organization **3(3-0-6)**

Computer systems organization, hardware components in a computer system, basic computer principles, instruction unit, instruction execution cycle, instruction set architecture, assembly language principles.

2110251 Digital Computer Logic **3(3-0-6)**

Number systems; logic gates and logic expressions; Boolean algebra: Karnaugh map and tabulation method; combination logic circuit and applications: adder, subtractor, multiple outputs circuit, decoder, encoder, multiplexer and demultiplexer; gate implementation: tristate; speed and delay in logic circuits; sequential circuits and design; flip-flop, and counter; register.

2110253 Computer Electronics and Interfacing **3(3-0-6)**

Principles of design; design of DC and AC circuits using diodes, bipolar junction transistors, field-effect transistors and use of transistors in digital circuits, physical design of simple gates, flip-flops, and memory circuits, interfacing logic families and standard buses.

2110254 Digital Design and Verification **3(3-0-6)**

Condition: Prerequisite 2110251 or 2110254

Processor design at instruction set level and register transfer level; hardware description language (HDL); functional verification of HDL models; microprocessors; control unit; memory unit; adders; I/O device interfaces.

2110263 Digital Computer Logic Laboratory I **1(0- 2- 1)**

Hands-on experience in using digital electronics by way of logic gates and integrated circuits; practical construction, testing, and implementation of combinational and sequential logic circuits.

2110265 Digital Design and Verification Laboratory I **1(0-2-1)**

Condition : Prerequisite 2110251

Writing hardware description language (HDL) to implement digital designs, adder, arithmetic logic unit, control unit, memory modules, system integration, writing test benches to verify the design.

2110271 Programming Tools **3(2-2-5)**

Source-code tools; executable-code tools; user-interface tools; code management tools; deployment tools; documentation tools; testing tools; integrated development environments.

2110291 Individual Study in Computer Engineering I **1(0-0-3)**

Independent study and investigation, theoretically and practically, in computer engineering topics according to each student's interest under the supervision and guidance of the instructor.

2110292 Individual Study in Computer Engineering II **1(0-0-3)**

Independent study and investigation, theoretically and practically, in computer engineering topics according to each student's interest under the supervision and guidance of the instructor.

2110302 Computer Engineering Practice III **3(0-18-0)**

Engineering practice or experience is a tool for student to have a chance to practice and apply. the knowledge in classroom. To be familiar with work in engineering field. as well as develop interpersonal.and networking skill before actual working after graduation. Engineering practice is in

related areas under supervision of experience experienced engineers in private sectors or government agencies.

2110313 Operating Systems and System Programming 3(3-0-6)
Condition : Prerequisite 2110211, 2110213 or 2110221

OS services: functions, organisation, process, concurrent programming, synchronisation, critical section, semaphore, monitor, deadlock, processor management, memory management, device management, file management, resource protection, and networking; service interfaces: system call, application programming interface (API); service development; tools and utilities: system management tools, development tools, and operation tools.

2110316 Programming Languages Principles 3(3-0-6)
Condition : Prerequisite 2110211

Language definition: grammar, syntax, and semantics; conventional paradigm: data type, control structure, block structure, and recursion; interpretive languages; runtime environment and virtual computer; unconventional paradigm: functional, logic, and markup languages; object-orientation and software components: class, instance, method, message passing, inheritance, method binding, polymorphism, framework, and component-based programming; basic compiling techniques: scanner, parser, code generation, and tools.

2110317 Fundamental of Distributed Systems 3(3-0-6)
Condition : Prerequisite 2110313

Interprocess communication and remote procedure call; Logical clock and ordering; centralised transaction and concurrency control; distributed transaction; two-phase commit protocol; distributed concurrency control; deadlock and distributed deadlock; load distribution; fault tolerance: fault model, recovery; replication: view and vector clock; distributed transaction under failure conditions; security; distributed services.

2110318 Distributed Systems Essentials 1(1-0-2)
Condition : Prerequisite 2110313 or Consent of faculty

Characteristics and system models: client/server, proxy, peer-to-peer; message passing: marshaling, request-reply protocol; distributed objects and remote invocation; time, clock, and ordering; group communication: basic, reliable, and ordered multicast; transaction and concurrency control; distributed transaction: two-phase commit, recovery; advanced topics: consensus, replication, Web services.

2110327 Algorithm Design 3(3-0-6)
Condition : Prerequisite 2110200, 2110211

Algorithm design techniques: divide and conquer, dynamic programming, greedy algorithms, state-space search; asymptotic analysis of algorithms; introduction to computational complexity; algorithm designs for NP-hard problems; backtracking, branch and bound, approximation algorithms.

2110332 System Analysis and Design 3(3-0-6)
Condition : Prerequisite 2110211

Data processing systems and systems life cycle; analysis methodology: tools, cost analysis, problem definition, proposal and feasibility study; design methodology: tools, database approach, systems design, file and form design, program design, documentation; implementation methodology: coding, testing and software maintenance.

2110333 Event-Driven Programming 3(2-2-5)
Condition : Prerequisite 2110101 or *Consent of Faculty*

Events, event queues, event focus, event handlers, event loop, callbacks, delegation; GUI and distributed environments; event-driven I/Os; windowing system; GUI programming; event-driven program interactions.

2110334 Network Programming 3(2-2-5)
Condition : Prerequisite 2110210 and 2110213 Consent of Faculty

Networking concepts; internet standards; sockets programming; web programming; client-server programming.

2110352 Computer System Architectures 3(3-0-6)
Condition : Prerequisite 2110250 or 2110253

Performance metrics; central processing unit; hardwired and microprogram of control units; instruction level parallelism : pipeline, superscalar; memory system: cache memory, virtual memory, disk array; development and future of architecture.

2110355 Formal Languages and Automata Theory 3(3-0-6)

Studies concepts of grammars, automata, languages, computability and complexity; the relationship between automata and various classes of languages; Turing machine and equivalent models of computation, the Chomsky hierarchy, context-free grammar, push-down automata, etc.; pumping lemmas and variants, closure properties and decision properties; parsing algorithms.

2110361 Hardware Synthesis Laboratory 2(0-4-2)
Condition : Prerequisite 2110264

Synthesis of digital systems on FPGA technology, use of hardware description language to model digital systems and implement the design on a programmable device, design decomposition, testing and debugging the design.

2110363 Hardware Synthesis Laboratoryl 1(0-2-1)
Condition : Prerequisite 2110265

Synthesis of digital systems on FPGA technology, use of hardware description language to model digital systems, testing and debugging the design.

2110388 Database Programming 4(2-4-6)
Condition : Prerequisite 2110210 and 2110213, Consent of Faculty
Structured query language (SQL), database connectivities; database programming tools and components; concurrency control; transactions processing; programming for database-backed site.

2110391 Individual Study in Computer Engineering III 1(0-0-3)
Independent study and investigation, theoretically and practically, in computer engineering topics according to each student's interest under the supervision and guidance of the instructor.

2110392 Individual Study in Computer Engineering IV 1(0-0-3)
Independent study and investigation, theoretically and practically, in computer engineering topics according to each student's interest under the supervision and guidance of the instructor.

2110398 Software Development Pre – Project 1(0-2-1)
Study and specifying topic, scope, methodologies of problem solving and expected benefit of various areas of software development project under project advisor's supervision. Project proposal is examined by a department committee. Written progress reports must be submitted and presented periodically.

2110399 Software Development Project 3(0-6-3)
Continuing of the approved project from Software Development Pre-Project course must be carried out under project advisor's supervision. Written progress report must be submitted periodically. A written final report is required and an oral examination must be taken with a department project committee at the end of the project.

2110401 Computer Engineering Professional Ethics 3(3-0-6)
Ethical theory; privacy; intellectual properties: patents, copyrights; computer crimes; professional codes of ethics; social issues; case studies.

2110412 Parallel Computer Architecture 3(3-0-6)
Condition : Prerequisite 2110211
Parallel architectures; parallel computation models; parallel algorithms; parallel programming and languages.

2110413 Computer Security 3(3-0-6)
Computer security principle; symmetric key cryptography; public key cryptography; message digest; authentication: access control; enterprise security; network security.

2110414 Large Scale Computing Systems 3(3-0-6)
High-performance and large-scale computing infrastructure: cluster, peer-to-peer, Grid, Cloud; virtualization; software architecture and middleware; HPC applications and algorithms; HPC software development.

2110420 Compiler Construction 3(3-0-6)
Grammar, syntax, and semantics; lexical analysis; parsing methods; symbol table construction; intermediate representation; code generation; basic and advanced code optimization techniques.

2110421 Theory of Programming Languages 3(3-0-6)
Data and control abstractions; binding; type checking; advanced control constructs, backtracking and nondeterminism; formal methods for program description, formal syntax and formal semantics; methods for proving programs correctness.

2110422 Database Management Systems Design 3(3-0-6)
Condition : Prerequisite 2110200, 2110211
Database concepts: goals, data independence, relationships, logical and physical organizations, schema and subschema; data models: hierarchical, network, and relational models; data normalization: first, second, and third normal forms of data relations; canonical schema, data independence; data description languages; query facilities: relational algebra, relational calculus, data structures for establishing relations, query functions, design and translation strategies; file organization, file security; data integrity and reliability.

2110423 Software Engineering 3(3-0-6)
Design tools and techniques; top-down design, modular design, software tools, debugging and test data; software reliability, theory and concepts, errors, faults and estimation, reliability models, availability models; management techniques, cost estimation, software maintenance.

2110424 Software Process Improvement 3(3-0-6)
Condition : Consent of Faculty
Software process improvement premise; software process modeling; foundation and infrastructure of software process improvement; approach for transitioning to process improvement program; quality assurance components in software project life cycle; software engineering process group; software process and product measurement.

2110426 Software Engineering Lab 1(0-2-1)
Condition : Consent of Faculty
Introduction to software engineering modeling tools; software project management tools; risk analysis practices; requirement analysis activities and tools; modeling practices; agile development activities and tools; user interface design tools; software architecture designs and tools; coding standards and guidelines; software

security and privacy practices; test case design practices and software testing tools; continuous integration/continuous delivery practices and tools; software product delivery and acceptance; software quality assurance practices.

2110428 Introduction to Data Mining 3(3-0-6)

Fundamental concepts of data mining; data mining methodologies, decision trees, classification, association, clustering; data mining algorithms.

2110429 Information Retrieval Systems 3(3-0-6)

Condition : Prerequisite 2110211

Information structures; dictionary systems; statistical systems; vector matching and searching strategies; input specifications and systems organization; output systems; evaluation; automatic question answering.

2110430 Time Series Mining and Knowledge Discovery 3(3-0-6)

Time series mining: classification, clustering (shape- based/ model based) , associationrules, summarization visualization, anomaly detection, motif discovery; similarity measurement: dynamic time warping; distance measure; data preprocessing; time series indexing; time series representation and dimensionality reduction.

2110431 Introduction to Digital Imaging 3(3-0-6)

Overview of theory of digital image processing and analysis: definition of terms, basic principles of human visual perception, image representation, preprocessing, image enhancement, image segmentation, feature extraction and analysis, image compression; survey of applications.

2110432 Automatic Speech Recognition 3(3-0-6)

Condition : Consent of Faculty

Overview of speech and language technology; human speech production models; spectrogram; speech sounds in languages and spectrogram reading; speech representation; template matching using dynamic time warping; acoustic modeling; frame-based speech recognition using Hidden Markov models; language modeling; examples of other approaches to automatic speech recognition.

2110433 Computer Vision 3(3-0-6)

Image formation; feature detection; color; texture; region segmentation and representation; object recognition; dynamic vision; 3D vision; vision applications.

2110435 Introduction to Robotics 3(3-0-6)

An overview of robotics technology; introduction to the configulation space concept, rigid transformation and manipulator kinematics; sensing and control; robot programming; robot motion planning and application; robot manipulation.

2110441 Software Design and Development 3(3-0-6)

Design techniques : models of structured programming, code reading and correctness, stepwise refinement and reorganization, top-down design and development, structured design, strength, and coupling measures; organization and management: milestones and estimation, chief programmer teams, program libraries, walk through, and documentation; team project: organization, management and development of large scale software.

2110442 Object-Oriented Analysis and Programming 3(3-0-6)

Object-oriented design and object-oriented software construction; design and construct : classes, methods, messages, instances, inheritance, static and dynamic blinding, replacement and refinement and polymorphism analyze : frameworks and design patterns, and object-oriented software engineering.

2110443 Human-Computer Interaction 3(3-0-6)

Condition : Prerequisite 2110101

HCI design, implementation and evaluation; graphical user interface programming; prototyping tools and toolkits; window-based systems; usability engineering.

2110444 Introduction to Formal Verification 3(3-0-6)

Condition : Prerequisite 2110200

Fundamental concepts of mathematical logic; formal specification language definition : syntax, semantics; formal specification language: Z, Object Z, CafeOBJ; mathematical models of software and hardware; formal verification methods.

2110445 Enterprise information Systems 3(3-0-6)

Condition : Consent of Faculty

Enterprise information systems; information technology infrastructure and integration; impact of information systems on organizations; information technology and business strategies; e-business and e-commerce; ethical and social issues related to technology; technology decisions; business value of information systems.

2110451 Digital Computer Hardware Design 3(3-0-6)

The principles of design of modern digital computers; especially in the simple and advanced microprogrammed control unit; ALU design, carry look-ahead and multiplication and division algorithms.

2110455 Testing Digital Circuits 3(3-0-6)

Testing techniques for digital logic circuits; fault modelling; test generation; test evaluation; testabillity analysis; design for greater testabillity; automatic test equipment; IDDQ testing; writing simulation programs, current research issues on testing.

2110471 Computer Networks I 3(2-3-4)

Condition : Prerequisite 2110221

History and Overview of Computer Networks, Network Architecture and Protocol, LAN and WAN, Client-Server and Peer-to-Peer Computing, Data Security and Integrity, Wireless and Mobile Computing.

2110473 Fault Tolerant Computing 3(3-0-6)

Fault model; test generation of combinational and sequential circuits: Boolean difference, path sensitization and algorithm; digital simulation technique; design of self checking circuit; error detection and correction codes redundancy techniques; diagnosis of digital system and design of simplified testing.

2110475 VLSI Design 3(3-0-6)

Integrated circuit technology; design and implementation of very large scale integrated circuits including design methodology: design using stick diagram; the use of CAD tools including layout generators, simulators, and plot utilities; I/O pads; study of some digital subsystem, digital architecture and design styles; Fabrication processes; criterion for foundries; case study of some custom design integrated circuits.

2110476 Artificial Intelligence I 3(3-0-6)

Philosophy of mind, knowledge and reasoning, agent-based systems, planning perception, robotics: sensing, navigation & control, introduction to evolutionary computation.

2110477 Artificial Intelligence II 3(3-0-6)

Definition of Artificial Intelligence problem solving by search, knowledge representation, natural language processing, Prolog programming, machine learning, neural networks.

2110478 Computer and Communication 3(3-0-6)

Introduction: computer and communication technology; Communication and network model: Shannon and Weaver model, ISO-OSI model, LAN, and Inter/Intranet; System component: modem, multiplexer, interface, and repeater/bridge/router/switch; Resource management and error control; Data security: natural disaster and vandalism.

2110479 Computer Graphics 3(3-0-6)

The fundamentals of computer imagery; modeling ; curve, surface, geometric primitves 2D and 3D geometric transformations, rendening: clipping and windowing, scene, algorithms for visible surface determination, introduction to local and global shading models, color, and real-time rendering methods; presentation of projects in computer graphics engineering.

2110481 Wireless Computer Networks 3(3-0-6)

Condition : Prerequisite 2110478

Digital transmission; queueing theory, mobile IP internetworking, IPv6, DHCP, proxy service.

2110482 High Technology Entrepreneurchip 3(3-0-6)

This is a course focused on the student participating in the building business plan for new venture that create or use a new technology to create significant new value.

2110490 Computer Engineering Pre-Project 1(0-2-1)

Determination of topics or problems; scope, methodologies of problem solving and expected benefit from various areas of computer engineering projects under the supervision of a project advisor; examination of project proposal; periodical writing of progress reports and report presentation.

2110491 Topics in Systems and Languages 3(3-0-6)

Condition : Prerequisite 2110421

Current interest and new developments in the areas of software systems, theory of programming languages and translations.

2110492 Topics in Operations Systems 3(3-0-6)

Condition : Prerequisite 2110411

Topics of current interest and new developments in the areas of operating systems, modeling, performance analysis, utility systems.

2110493 Topic in Database Management Systems 3(3-0-6)

Condition : Prerequisite 2110422

Topics of current interest and new developments in the areas of database management systems, information systems and data dictionary.

2110495 Advanced Topics in Computer Engineering I 3(3-0-6)

Condition : Senior Standing or Consent of instructor

Topics of current interest and new developments in various fields of computer engineering.

2110496 Advanced Topics in Computer Engineering II 3(3-0-6)

Condition : Senior Standing or Consent of instructor

Topics of current interest and new developments in various fields of computer engineering.

2110497 Special Problems in Computer Engineering I 3(2-3-4)

Condition : Senior Standing or Consent of instructor

A study of investigation of special problems assigned by the instructor with the consent of the head of department. The work must be completed within one semester. A written report, a copy of which is to be kept by

the department, is required and an oral examination must be taken.

2110498 Special Problems in Computer Engineering II **3(2-3-4)**

Condition : Senior Standing or Consent of instructor

A study of investigation of special problems assigned by the instructor with the consent of the head of department. The work must be completed within one semester. A written report, a copy of which is to be kept by the department, is required and an oral examination must be taken.

2110499 Computer Engineering Project **3(0-6-3)**

Condition : Prerequisite 2110490

Continuing of approved project from course 2110490 must be carried out under project advisor's supervision. Written progress reports must be submitted periodically. A written final report is required and an oral examination must be taken with a department project committee at the end of project.

COURSE DESCRIPTIONS IN COMPUTER ENGINEERING (M.ENG., M.SC., PH.D.)

2110501 Automata Computability and Formal Languages **3(3-0-9)**

Finite states concepts: regular expressions, closure properties,sequencial machines and finite state transdicers. state minimization; formal grammars: chomsky hierarchy grammars, pushdown acceptors and linear bounded automata, closure properties and algorithms on grammars; computability and Turing machines as acceptor and transducer, universal machine, computable and noncomputable functions, and halting problem.

2110502 Formal Verification **3(3-0-9)**

Mathematical logic and temporal logic; formal models: identifying problem domain and building the formal models of concurrent system and/or asynchronous system; verification of the formal models: model checking; verification modeling language and tools: Petri Nets, signal transition graph, Promela and SPIN.

2110503 Software Development Practice **3(3-0-9)**

Condition : Consent of Faculty

Case study of software development; requirement analysis; software quality; software constraints; software architecture design decision; practical software construction; test execution; deployment to production; maintenance activities; related technologies and tools for contemporary software development.

2110504 User-Centered Software Design **3(3-0-9)**

Concepts of software design for the human; user experience; design life cycle and process; usage research: data elicitation, data analysis, data modeling; user experience design requirements; user experience design: ecology, interaction, emotional impact; prototype design; user experience evaluation: empirical evaluation, analytic evaluation; user-centered design in agile software engineering; user experience design guidelines.

2110505 Distributed Systems **3(3-0-9)**

Definition; interprocess communication; logical clock; concurrency control: two-phase locking, optimistic, timestamp ordering; distributed transaction, atomic commit protocol; deadlock: detection, prevention, avoidance, distributed detection; scheduling; reliability; fault tolerance, replication, recovery; security; distributed services: name, file, distributed management; standards and cases.

2110511 Game Programming **3(3-0-9)**

Theory of game design; graphics programming; computer graphics model; data structure for game programming; online game.

2110512 Computer Animation **3(3-0-9)**

Techniques and algorithms in computer-generated animation; vector algebra; numerical techniques; 2D and 3D animation programming; motion specification : shape interpolation algorithms and models for rule-and constraint-based motion generations.

2110513 Assistive Technology **3(3-0-9)**

People with disabilities and types of disabilities; assistive technologies for various types of disabilities; local and international rules and regulations related to disabilities; issues in assistive technology; state of assistive technology products and research; universal design.

2110514 Realtime Computer Graphics and Physics Simulation **3(3-0-9)**

Color theory; human visual perception; vector mathematics; shading and lighting; material model; projection; camera; ray tracing; programmable shading; texture; shadow; introduction to physics simulation; particle system; constraints and rigid body simulation; position based dynamics; grid based fluid simulation; curve; mesh representation; mesh subdivision; mesh simplification.

2110521 Software Architecture **3(3-0-9)**

Principles of software architectures; practical methods in software architectures using scenario-based analysis, heuristic, and formal approaches; architectural styles; architectural description language; software architectural analysis and design; software architectures specification tools; software architecture-based testing; use of software architectures in the software development process.

2110522 UNIX/Linux for Enterprise Environment 3(3-0-9)

Historical perspectives; branches and distributions; main characteristitics and components; subsystems and supports; advancements; server: performance considerations, monitoring, and tuning; desktop: distros, usability, and compatibility; administration and installation practices.

2110523 Enterprise Application Architecture 3(3-0-9)

Foundation and concepts of enterprise architecture; analysis and design of enterprise applications: UML profile specification, design quality metrics; patterns of enterprise application architecture: structure, constraints and limitation of the patterns; enterprise application integration techniques and implementation: presentation, data, application level integration approach; best practice; enterprise architecture modelling standards and tools.

2110524 Cloud Computing Technology 3(3-0-9)

Definition and benefits of cloud computing; cloud migration; infrastructure-as-a-service; platform-as-a-service; storage-as-a-service; auto-scaling and service availability; virtualization technologies and software-defined networks for cloud; cloud security; blockchain and innovative Internet-based distributed services.

2110542 Data Warehouse System 3(3-0-9)

Data warehouse system; data warehouse design; extract, transform and load process; data cube; online analytical processing; business intelligence.

2110561 Computational Fabrication 3(3-0-9)

Computer-aided design and manufacturing; additive manufacturing technology (3D Printing); additive manufacturing software; solid modeling; procedural modeling; 2D printing methods; dithering and error diffusion; physically-based simulation; kinematics and finite element method; material models; 3D scanning methods; geometry processing for 3D scanning; overview of other fabrication techniques and latest research in computational fabrication.

2110562 Sensor Technology 3(3-0-9)

Sensor mechanism; sensory devices; image sensor; depth sensor; pinhole camera model; color model; depth sensor model; camera calibration; camera intrinsic/extrinsic parameter; Bayes' theorem; Bayes' filter; Kalman filter; RANSAC algorithm.

2110571 Neural Network 3(3-0-9)

Artificial neuron; perceptron; decision surface; geographic of neuron; hidden node usage; single perceptron training; connection of neural networks; backpropagation neural network; support vector machine; convolution neural network; associative memory; neural network tools.

2110572 Natural Language Processing Systems 3(3-0-9)

Natural language processing pipeline; tokenization; language model; word representation; part-of-speech tagging; parsing; text classification; machine translation; question answering; dialogue systems.

2110573 Pattern Recognition 3(3-0-9)

K-mean clustering; regression analysis; maximum likelihood estimation; maximum a posteriori; naïve Bayes; Gaussian mixture models; expectation maximization; dimensionality reduction; support vector machines; deep neural networks; reinforcement learning.

2110574 Artificial Intelligence for Engineers 3(3-0-9)

Introduction to artificial intelligence; artificial intelligence for optimization; machine learning process; linear and logistic regression; naïve Bayes classification; decision tree learning; unsupervised learning and clustering; artificial neural network; deep learning.

2110579 Computer Graphics Systems 3(3-0-9)

Architectural aspects of modern GPUs, programming on GPU: high level languages for GPU programming, GPU applications for graphics and general purposes : geometry modelling, physical simulation, scientific computing and games.

2110581 Bioinformatics I 3(3-0-9)

Introduction to molecular biology for bioinformatics; central dogma; relationships between DNA, RNA and protein; genome sequencing; omics technology; algorithms, mathematics and statistics methods for omics data computation and analytics; public databases in bioinformatics; big data in biomedicine; bioinformatics applications especially in biomedicine.

2110606 Research Methods in Computer Engineering 3(3-0-9)

Research methods in Computer Engineering; Research techniques and tools; Project and time management; Technical paper writing; Oral presentation; Current research topics.

2110607 Research Methods in Computer Science 3(3-0-9)

Research methods in Computer Science; research techniques and tools in Computer Science; project and time management; academic writing; oral presentation; code of conduct for researchers; current Computer Science research topics.

2110608 Seminar and Research Methods in Software Engineering 3(3-0-9)

Research methods in Software Engineering; research techniques and tools; project and time management;

technical paper writing; oral presentation; current research topics; paper reviews; discussions on thesis and master project; tutorials from lecturers and external speakers.

2110623 Software Requirements Engineering **3(3-0-9)**

Methods, tools, notations, and validation techniques for the elicitation, analysis and specification of software requirements; investigating the project or applying approaches to software requirements engineering.

2110624 Software Engineering **3(3-0-9)**

Fundamental areas of software engineering: life cycle, paradigms, metrics, and tools; management techniques; cost estimation; software maintenance methodologies; incremental programming; very high level languages.

2110626 Enterprise and IoT Network Infrastructure **3(3-0-9)**

Enterprise Network Architecture, Design Considerations, Ubiquitous Computing, Mobile IP, Wireless and Mobile Networks, Vehicular Networks, Indoor Localization System, RINA Concept, MPLS, Infrastructure for Data Collection and Analytics.

2110632 Advanced Topics in Operating Systems **3(3-0-9)**

Advanced and current topics in Operating Systems.

2110634 Software Design and Development **3(3-0-9)**

Basic concepts of design; design quality; design principles; architectural design; architectural styles; detailed design; integrated development environment.

2110636 Performance Analysis and Evaluation **3(3-0-9)**

Performance metrics; performance measurements; benchmarking; workload characterization; summarizing measured data; introduction to queuing theory; single queue analysis; introduction to simulation; analysis of simulation results.

2110637 Large-Scale Information Systems **3(3-0-9)**

System framework; middleware; service-oriented architecture; large-scale services; scalable data services; cloud computing; cluster architecture and system; management distributed algorithms; map-reduce architecture; volunteer computing.

2110638 Object-Oriented Technology **3(3-0-9)**

Object orientation concepts and software development; object-oriented programming language implementation; software development frameworks; design patterns; design heuristics; design flaws; aspect-oriented programming; case studies; current topics in object-oriented technology.

2110639 Computer System Security **3(3-0-9)**

Security system planning and administration; access control; data encryption; computer crime protection; disaster recovery planning; security models; including Orange book, and RACF

2110640 Information Security **3(3-0-9)**

Information security models: confidentiality; integrity; authentication software security; network security; privacy; security management security; related laws and regulations.

2110642 Object-Oriented Software Engineering **3(3-0-9)**

An overview of object-oriented technology concepts on objects, classes, inheritance, polymorphism, and relationship between classes; software development process, software configuration management, software quality assurance, object-oriented project planning and management, object-oriented analysis and design methodologies, object-oriented programming and object-oriented software testing and maintenance, use of CASE tools.

2110644 Formal Software Specification **3(3-0-9)**

Mathematical Logic: Set, Relation, Function, Predicate Calculus, Algebraic system; Formal software specification language: Z, CafeOBJ; Identifying problem domain; Design and software modeling; Formal software specification method; Consistency verification of formal specification and its proof; Utilization of formal software specification in software process.

2110645 Software Engineering Methodology **3(3-0-9)**

Software engineering process concepts; context for personal software process; planning and measurement concepts; software size measurement; general size estimating methods; resource and schedule estimation; process measurement; design and code reviews; software quality management.

2110646 User Interface Design **3(3-0-9)**

Foundations of user-interface; human-centered software evaluation; software development; graphic user-interface design; graphic user-interface programming; multimedia systems.

2110651 Digital Image Processing **3(3-0-9)**

Visual perception, digitization and coding of images, converting pictures to discrete(digital) forms; image enhancement; image restoration including improving degraded low-contrast, blurred, or noisy pictures; image

compression : data compression used in image processing; image segmentation referred to as first step in image analysis.

2110654 Artificial Intelligence 3(3-0-9)

Definitions and application of artificial intelligence; knowledge representation; Prolog programming; natural language processing; machine learning techniques.

2110657 Computer Simulation 3(3-0-9)

Monte Carlo simulation; discrete event simulation and implementation techniques, queueing theory; equilibrium and steady state; input/output analysis; random numbers; output measurement; simulation accuracy; trace and execution-driven simulation; computer system simulation; continuous system simulation; combining continuous and discrete-event simulation

2110663 Worldwide Network Infrastructure 3(3-0-9)

Background and history of networks and the internet; principles of network applications, protocols, services, socket programming; client/server and peer-to-peer paradigms; reliable data transfer; congestion control; the Internet Protocol (IP); routing in the internet; multimedia networking; wireless and mobile networks; large-scale and global networks; next generation networks.

2110673 Information Storage and Retrieval 3(3-0-9)

Models and methods for storage and retrieval of information; Topics include information retrieval techniques, text analysis and automatic indexing, document clustering, search techniques, retrieval performance measurement, and search mechanisms for retrieval from the World Wide Web.

2110678 Mobile Computing 3(3-0-9)

Principles, technologies and applications of mobile computing and wireless networks; mobile and wireless environment; protocols and architecture of mobile computing; mobile device technology; mobile computing security; application of distributed system in mobile computing; mobile middleware; mobile information and database access; mobile computing platforms; Web-based mobile application development.

2110681 Computer Algorithm 3(3-0-9)

Analysis and design of efficient algorithms; divide and conquer, recursion, dynamic programming and greedy algorithm; selection of appropriate data abstraction; analysis and correctness of algorithms; algebraic algorithms; combination problems; proving techniques for complexity analysis.

2110682 Embedded and Real-time Systems 3(3-0-9)

Microcontroller architecture (RAM, ROM, CPU), I/O, and peripheral devices, I/O interfacing, real-time operating systems, real-time constraints, scheduling theory, real-time system design methodology, case studies.

2110686 Enterprise Computing 3(3-0-9)

IT infrastructure; management; stabillity, efficiency and responsiveness; theoretical and practical aspects of systems management; discipline in data centres; development, integration, and management of IT processes; business-support functions; enterprise services; information systems services.

2110694 Directed Studies in Computer Science 3(3-0-9)

Study of current interest and new developments in various fields of computer science.

2110696 Advanced Topics in Computer Application 3(3-0-9)

Current advanced topics and technologies in computer applications.

2110697 Special Topics in Computer Science I 3(3-0-9)

Current special topics and new technologies in computer science.

2110698 Special Topics in Computer Science II 3(3-0-9)

Current special topics and new technologies in computer science.

2110701 Seminar in Computer Engineering I 1(0-3-1)

Seminar in Computer Engineering about the thesis and assignments.

2110702 Seminar in Computer Engineering II 1(0-3-1)

Seminar in Computer Engineering about the thesis and assignments.

2110711 Theory of Computation 3(3-0-9)

Computable functions decidable predicates and solvable problems; computational complexity; NP-complete problems; automata theory; formal language; lambda calculus.

2110712 Analysis of Algorithms 3(3-0-9)

Algorithm complexity and problem complexity; discrete mathematics real analysis, and combinatorics; algorithms and data structures; average-case worst-case and amortized analysis.

2110713 Optimization Methods 3(3-0-9)

Dynamic optimization; mathematical programming; least square methods; gradient methods; Newton's method; linear programming; nonlinear programming; discrete optimizations.

2110714 Digital Systems 3(3-0-9)

Digital system architecture; logic elements, processor, compilers, operating systems; digital abstraction, synthesis of digital systems; performance measures; interpretation; micro architecture; memory architecture; processes; multiplexing; synchronization; interrupts; real time systems.

2110716 Seminar I 1(1-0-3)

Seminar in the assigned topics on current experiment and / or research on computer engineering.

2110717 Seminar II 1(1-0-3)

Seminar on current experiment and / or research on computer engineering concerning theses.

2110718 Seminar III 1(1-0-3)

Seminar on current experiment and / or research on computer engineering concerning theses.

2110719 Seminar IV 1(1-0-3)

Seminar on current experiment and / or research on computer engineering concerning theses.

2110721 Software Metrics 3(3-0-9)

Theoretical foundations of software metrics; data collection; experimental design and analysis; software metric validation; measuring the software development and maintenance process; measuring software systems; support for metrics; statistical tools; applications of software measurement.

2110722 Software Project Management 3(3-0-9)

Concepts of project and project management; project management in software and IT contexts; ethics in project management; process groups; knowledge areas: project integration management, scope management, schedule management, cost management, resource management, quality management, risk management, communication management, procurement management, and stakeholder management.

2110723 Advanced Software Engineering Development 3(3-0-9)

Software development process improvement; a series of individual programming and process projects; project planning measurement size estimation task scheduling and defect clarification.

2110724 Software Testing and Quality Assurance 3(3-0-9)

Technical and managerial views of software testing and Software Quality Assurance (SQA) quality concepts; black and white box testing techniques; test coverage; test planning; levels of testing; the formation of a testing organization; testing-in-the-large; documentation for testing; inspections and walkthroughs.

2110725 Software Engineering Process and Improvement 3(3-0-9)

Condition : Consent of Faculty

Process definition; software engineering process model; process implementation and change; process quality assessment; process and product measurement; software engineering process standards.

2110726 Software Configuration Management 3(3-0-9)

Condition : Consent of Faculty

Software configuration management (SCM) process; SCM planning; configuration management plan; SCM measures; software configuration identification; software change request process; software configuration status reporting; software configuration auditing; software release management and delivery.

2110727 Software Evolution and Maintenance 3(3-0-9)

Fundamentals of software evolution and maintenance; taxonomy of software evolution and maintenance; software evolution and maintenance models; software reengineering; legacy systems; change impact analysis; software refactoring; program comprehension; software reuse and domain engineering.

2110728 Special Topics in Software Engineering I 3(3-0-9)

Condition : Consent of Faculty

Current advanced topics and new technologies in software engineering.

2110729 Special Topics in Software Engineering II 3(3-0-9)

Condition : Consent of Faculty

Current advanced topics and new technologies in software engineering.

2110730 Software Quality and Process Management 3(3-0-9)

Software quality basics; quality tools; software life cycle processes and process assets establishment; process management premise; process improvement models; improvement paradigms; quality management in process improvement context; configuration management; measurement information model.

2110731 Distributed Systems 3(3-0-9)

Characterization and models of distributed systems; remote communication between system components; distributed applications; transactional applications; concurrency control of transactions; coordination between system components: global system state, time synchronization, access to shared resources, ordering of exchanged messages, agreement; fault tolerance; data replication; system recovery; current distributed systems and related issues; current research topics.

2110732 Parallel Computing 3(3-0-9)

Architectures in parallel computing : shared/distributed memory, SIMD/MIMD architecture, interconnection networks, granularity of the machines, dataflow and systolic arrays computers; parallel processing : pipelining and parallelism, software for parallel computers.

2110741 Robotics 3(3-0-9)

A broad view of robotics : robot control, sensors and interfacing, robot intelligence and programming; a broad spectrum of disciplines : mechanical, electrical, industrial, and computer engineering; current topics : planning, subsumption architecture, reactive systems.

2110742 Evolutionary Computation 3(3-0-9)

Computer algorithms gleaned from the model of biology; algorithms inspired by organic evolution : genetic algorithms, classifier systems, genetic programming and evolution strategies; theoretical basis of these algorithms.

2110743 Machine Learning 3(3-0-9)

Computing with logic; using logic set theory, number theory, algebras graph theory, automata; language of first order logic, model theory and logic programming; problems of inductive inference in the framework of first-order predicate calculus and the probability calculus; introduction of computational learning theory.

2110744 Machine Vision 3(3-0-9)

Low-level vision and higher-level techniques : binary machine vision, morphology, neighborhood operators, labeling, texture, region segmentation, feature extraction, motion, image matching, model matching and knowledge-based vision systems.

2110745 Cryptography 3(3-0-9)

Introduction; symmetric encryption; block ciphers; pseudorandom permutations and pseudorandom functions; one-way functions; pseudorandom generators; hash functions; message authentication; authenticated encryption; asymmetric encryption; digital signatures; authenticated key exchange; interactive proofs and zero knowledge.

2110746 Big Data Analytics 3(3-0-9)

Introduction to Big Data Analytics, Hadoop, MapReduce, Spark, Programming Languages for Big Data Analytics, Search and Indexing, Recommendation System, Regression, Classification, Clustering and Feature Selection.

2110747 Social Network Analysis 3(3-0-9)

Social networks definition; types of social networks; Social Network Representation by Computational Models; Random Network Models; Network Centrality; Clusters in Social Networks; Small World Models; Data Retrieval from Social Networks Data Analysis and Classification from Social Networks; Application examples, such as an analysis for enterprises.

2110751 Computer Aided Design in Digital Systems 3(3-0-9)

Layout editing; schematic datacapture; simulation; design rule checking; automatic placement and routing; logic synthesis for combination and sequential circuits; logic synthesis for architectural design; formal method for specifications.

2110752 Design for Testability 3(3-0-9)

Methods of design for testability; digital chip design for automatic testing equipment; ad hoc rules and structured method called scan design; fault analysis; controllability; observability; Scan-In Scan-Out (SISO) principle; Level Sensitive Scan Design (LSSD); built-in testing and other current techniques.

2110753 Asynchronous Design 3(3-0-9)

Design of digital systems not using global clock; limitation to synchronous processor; hazard analysis; Fundamental of asynchronous logic design; delay assumption; signaling protocol; asynchronous communication; Petri net; signal transition graph; completion detection; data and control paths implementations.

2110771 Advanced Database Design 3(3-0-9)

Fundamental of database design : data modeling, relational theory, query language, dependency theory; query optimization, computing with logic and universal relation.

2110772 Multi-Dimensional Database Systems 3(3-0-9)

Modern multi-dimensional database systems : spatial databases, temporal databases, multimedia databases; algorithms and data structures : R-tree, R^+ tree, R^* tree, quad-tree, spatial and temporal reasoning, disk clustering and declustering.

2110773 Data Mining 3(3-0-9)

Overview of data mining; process of knowledge discovery in large databases; applications of data mining to real-world problems; data preprocessing; data warehousing and OLAP; data mining methods: association, classification, clustering.

2110779 Advanced Topics in Computer Graphics 3(3-0-9)

In-depth study of selected current and interesting topics in computer graphics; hardware architecture, graphics systems, picture/image generation, graphics utilities, computational geometry and object modeling, methodology and techniques, three-dimensional graphics and realism and current applications.

2110781 Special Topics in Distributed Systems 3(3-0-9)

Current topics, related researches, and technology trends in distributed systems.

2110791 Advanced Topics in Software Engineering 3(3-0-9)

State of the art and current interest in software engineering.

2110792 Advanced Topics in Artificial Intelligence 3(3-0-9)

In-depth study of the current and interesting topics in artificial intelligence : problem solving, search, heuristic methods, machine learning, knowledge representation, natural language processing, computer vision, expert systems, theorem proving and current applications.

2110793 Advanced Topics in Digital Systems 3(3-0-9)

State of the art and current interest in digital systems.

2110794 Advanced Topics in Database Systems 3(3-0-9)

State of the art and current interest in database systems.

2110795 Advanced Topics in Computer Network 3(3-0-9)

State of the art and current interest in computer network.

2110797 Pre-Master Project in Software Engineering 3(0-0-12)

Condition : Consent of Faculty

Integration of software engineering principles to prepare for software engineering project to get the output which is the project proposal.

2110798 Master Project in Software Engineering 3(0-0-12)

Condition : Prerequisite 2110797

Integration of software engineering principles for software engineering project.

2110811 Thesis 12 Credits

2110814 Thesis 24 Credits

2110816 Thesis 36 Credits

2110828 Dissertation 48 Credits

2110829 Dissertation 60 Credits

2110830 Dissertation 72 Credits

2110894 Doctoral Dissertation Seminar 0(0-0-0)

2110896 Comprehensive Examination 0(0-0-0)

2110897 Qualifying Examination 0(0-0-0)

DEPARTMENT OF NUCLEAR ENGINEERING

The Department of Nuclear Engineering (formerly Department of Nuclear Technology) was established in 1972 with the main purpose of training the students with the career in nuclear energy. The department offers programs leading to degrees in Doctor of Philosophy (Ph.D.) in Nuclear Engineering, Master of Engineering (M.Eng.), Master of Science (M.Sc.) in Nuclear Technology and Bachelor of Engineering in Nuclear and Radiological Engineering. The curricula are multidisciplinary and are structured to cover the diversified principles of nuclear technology and nuclear engineering, ranging from the fundamental science and mathematics to the specialized engineering applications. The areas of specialization include nuclear power engineering, environmental and the industrial applications of radiation and nuclear technology, nuclear instrumentation, nuclear security, accelerator technology, radiation processing, radiation protection and nuclear materials. In addition, the bachelor's and the master's programs provide both theoretical and practical knowledge for those who would like to apply for the Radiation Safety Officer (RSO) license. The graduates of the programs find works in government institutions such as Office of Atoms for Peace (OAP) and Thailand Institute of Nuclear Technology (TINT); in public and private universities; in other state or public organizations such as Electricity Generating Authority of Thailand (EGAT) and Department of Medical Science; and in various industrial and medical sectors.

At present, the use of nuclear energy in industry is increasing. Thus, there is a growing need for personnel in specialized field involving safety control, research, and development that leads to the proper, efficient, and safe use of radioisotopes. This includes the development of techniques and instruments for in-house usage. Furthermore, the preparation of personnel with a solid background in nuclear engineering is also crucial to the future decision regarding the implementation of the nuclear energy in power generation, if it is to be implemented

HEAD :

Phongphaeth	Pengvanich,	Ph.D. (Michigan)

ASSOCIATE PROFESSORS :

Sunchai	Nilsuwankosit,	Ph.D. (Wisconsin)
Doonyapong	Wongsawaeng,	Ph.D. (Berkeley)
Somboon	Rassame,	Ph.D. (Purdue)
Phannee	Saengkaew,	Dr.rer.nat. (Magdeburg)

ASSISTANT PROFESSORS :

Phongphaeth	Pengvanich,	Ph.D. (Michigan)
Chadet	Yenchai,	M.Sc. (Chula)

LECTURERS :

Rawiwan	Kritsananuwat,	Ph.D. (Tokyo Metropolitan)
Kamontip	Ploykrachang,	Dr.Eng (Tokyo)
Manasavee	Lohvithee,	Ph.D (Bath)
Decho	Thong-Aram,	M.Eng. (Chula)

NAME OF THE DEGREE

: Doctor of Philosophy
: Ph.D.

ADMISSION

The applicant must submit an application under one of the following Admission Types.

Type 1.1: Ph.D. with Nuclear Background

The applicant must have a Master Degree in Nuclear Engineering or Nuclear Technology; meet the requirements of the Graduate School; have a minimum grade point average of 3.50 (out of 4); and have at least one good-quality international publication (conference or journal).

Type 1.2: Master continuing to Ph.D. with Nuclear Background

The applicant must have a Bachelor Degree in Nuclear Engineering from Chulalongkorn University; meet the requirements of the Graduate School; obtain at least an honor-level grade; and have at least one international publication (conference or journal).

Type 2.1: Ph.D. with Non-Nuclear Background

The applicant must have a Master Degree in Science or Engineering (non-nuclear); meet the requirements of the Graduate School; and have a minimum grade point average of 3.50.

Type 2.2: Master continuing to Ph.D. with Non-Nuclear Background

The applicant must have a Master Degree in Engineering (non-nuclear) from Chulalongkorn University; meet the requirements of the Graduate School; and obtain at least an honor-level grade.

FIELDS OF STUDY

The student must concentrate on one of the following fields of study:

- Nuclear Engineering
- Nuclear Security and Safeguards

DEGREE REQUIREMENTS

The student entering under

- Admission Type 1.1 must pass 49 credits of dissertation course;
- Admission Type 1.2 must pass 74 credits of dissertation course;
- Admission Type 2.1 must pass 13 credits of the specific required courses (see COURSE REQUIREMENTS) and pass 36 credits of dissertation course;
- Admission Type 2.2 must pass 13 credits of the specific required courses (see COURSE REQUIREMENTS), pass 9 credits of the specific elective courses, pass 3 credits of the general elective courses, and pass 49 credits of dissertation course.

Every student must also

- pass total of 6 credits of the general required courses (see COURSE REQUIREMENTS);
- pass a qualification examination;
- present an acceptable dissertation and pass an oral examination; publish at least 2 research journals, one of journal which must be an international journal ;
- present the dissertation work in a national or international symposium; and meet publication requirements of the Graduate School.

Due to the background of the student, some introductory courses may also be required (see COURSE REQUIREMENTS)..

COURSE REQUIREMENTS

Courses are divided into prerequisite, general required, specific required, general elective, specific elective, and thesis courses. Course requirements may vary depending on the field of study and the study plan.

0) Introductory Courses

Student with insufficient background knowledge of mathematics and/ or nuclear engineering must take two following courses.

2111600	Nuclear Engineering I *	3(3-0-9)
2111631	Applied Mathematics in Nuclear Technology *	3(3-0-9)

* Non- credit course, the student is given S/ U (Satisfactory/Unsatisfactory) instead of the letter grade.

Student with Admission Type 1.1 or 1.2 with insufficient background knowledge of nuclear reactor engineering and nuclear power engineering must take

2111642	Nuclear Reactor Engineering	3(3-0-9)
2111643	Nuclear Power Engineering	3(3-0-9)

Student with Admission Type 1. 1 or 1. 2 with insufficient practicing knowledge of nuclear/ radiation experiments must take one of the following courses

2111603	Radiation Detection and Measurements Laboratory *	1(0-3-7)
2111604	Radiation Detectors and Nuclear Instruments Laboratory *	1(0-3-7)
2111659	Methods and Instrumentation for Nuclear Security and Safeguards Laboratory *	1(0-3-7)

*Non-credit course, the student is given S/U (Satisfactory/Unsatisfactory) instead of the letter grade.

Student may be exempted from taking the course upon receiving the approval from the Program Board. A proof of priori knowledge on the subject is required.

1) General Required Courses:

All of the following courses are required for all Admission Types (1.1, 1.2, 2.1, and 2.2) for the total of 6 credits.

2111801	Seminar in Nuclear Engineering I*	2(2-0-6)
2111802	Seminar in Nuclear Engineering II*	2(2-0-6)
2111803	Seminar in Nuclear Engineering III*	2(2-0-6)
2111897	Qualifying Examination**	S/U

* Student must take these courses in each consecutive semester.

* * Non- credit course, the student is given S/ U (Satisfactory/Unsatisfactory) instead of the letter grade.

Student who don't register in subject seminar in any semester. Must take this course on every semester.

2111894	Doctoral Dissertation Seminar*	S/U

* Non-credit course, the student is given S/U

1) *Specific Required Courses:*

The following courses are required for Admission Types 2.1 and 2.2 for the total of 13 credits.

2.1) *Nuclear Engineering Field of Study: All of the following courses are required for the total of 10 credits.*

2111604	Radiation Detectors and Nuclear Instruments Laboratory	1(0-3-7)
2111613	Radiation Safety and Shielding	3(3-0-9)
2111643	Nuclear Power Engineering	3(3-0-9)
2111663	Radiation Detectors and Nuclear	3(3-0-9)

2.2) *Nuclear Security and Safeguards Field of Study: All of the following courses are required for the total of 10 credits.*

2111610	Nuclear Security	3(3-0-9)
2111651	Weapon Mass Destruction Nonproliferation	3(3-0-9)
2111658	Methods and Instrumentation for Nuclear Security and Safeguards	3(3-0-9)
2111659	Methods and Instrumentation for Nuclear Security and Safeguards Laboratory	1(0-3-7)

2.3) *Elective Required Courses in Nuclear Engineering and Nuclear Security and Safeguards (3 credits)*

2111642	Nuclear Reactor Engineering	3(3-0-9)
2111650	Introduction to Plasma Physics and Nuclear Fusion	3(3-0-9)

3) Specific Elective Courses minimum 12 credits

3.1) *Nuclear Engineering Field of Study: Choose from the following courses; minimum of 9 credits are required.*

2111603	Radiation Detection and Measurements Laboratory	1(0-3-7)
2111607	Environmental Radiation Measurements	3(3-0-9)
2111608	Practical Radiation Detection and Measurements	3(3-0-9)
2111609	Radiation Dosimetry	3(3-0-9)
2111616	Environmental Impact of Nuclear Power Plant	3(3-0-9)
2111621	Radiation Chemistry and Processing	3(3-0-9)
2111626	Industrial Radiation and Radioisotope Applications	3(2-3-7)
2111627	Material Analysis by Nuclear Techniques	3(3-0-9)
2111628	Radioisotope Production and Utilization	3(3-0-9)
2111629	Nuclear Chemical Engineering	3(3-0-9)
2111632	Numerical Calculation for Nuclear Engineering	3(3-0-9)
2111640	Nuclear Reactor Control	3(3-0-9)
2111646	Radioactive Waste Management	3(3-0-9)
2111647	Nuclear Fuels and Nuclear Fuel Cycles	3(3-0-9)
2111648	Nuclear Power Plant Systems and Operation	3(2-3-7)
2111650	Introduction to Plasma Physics and Nuclear Fusion	3(3-0-9)
2111655	Computer Application in Nuclear Technology	3(3-0-9)
2111660	Industrial Radiation Imaging	3(3-0-9)
2111661	Experimental Nuclear Engineering	3(2-3-7)
2111662	Nuclear Electronics	3(3-0-9)
2111664	Digital Computer Interfacing for Nuclear Instrument	3(3-0-9)
2111666	Radiation Machines	3(3-0-9)
2111678	Nuclear Materials Engineering	3(3-0-9)
2111683	Current Topics in Nuclear Engineering	3(3-0-9)
2111687	Special Topics in Nuclear Engineering	3(3-0-9)

3.2) *Nuclear Security and Safeguards Field of Study: Choose from the following courses; minimum of 9 credits are required.*

2111652	Strategic Trade Control	3(3-0-9)
2111653	Nuclear Safeguards	3(3-0-9)
2111654	Nuclear Fuel Cycle and Environmental Impacts	3(3-0-9)
2111656	Physical Protection of Nuclear Materials and Facilities I	3(3-0-9)
2111657	Advanced Detection Technologies for Radioactive and Nuclear Materials	3(3-0-9)

4) General Elective Course

Both fields of study: Student must take 3 credits of the courses available in the Master of Engineering in Nuclear Engineering Program.

5) Dissertation

Number of required credits depends on student's admission type.

For Admission Types 1.1 and 2.2 : 49 credits of the following courses

2111831 Dissertation

(Student may register for this course multiple times. The number of credits for each registration depends upon the agreement between the student and his/her thesis advisor.)

For Admission Type 2.1 : 36 credits of the following course

2111826 Dissertation

(Student may register for this course multiple times. The number of credits for each registration depends upon the agreement between the student and his/her thesis advisor.)

For Admission Type 1.2: 74 credits of the following courses

2111832 Dissertation

(Student may register for this course multiple

times. The number of credits for each registration depends upon the agreement between the student and his/her thesis advisor.)

NAME OF THE DEGREE

: Master of Engineering
: M.Eng.

ADMISSION

The applicant must have a Bachelor Degree in engineering or a Bachelor Degree in an equivalent/related field, must meet the requirements of the Graduate School and also must pass the entrance examination administered by the department.

DEGREE REQUIREMENTS

A student must pass a minimum of 15 credits of the required courses and another 12 credits from elective courses, a total of 27 credits.

A student must present an acceptable thesis and pass an oral examination in the field of Nuclear Technology for a quantity of 12 credits.

A student who has fulfilled the requirements of the program with a passing grade no less than 3.00 within a period of study of no more than 8 regular semesters will be awarded the Degree of Master of Engineering in Nuclear Technology.

FIELDS OF STUDY

The student must concentrate on one of the following fields of study:

- Nuclear Engineering
- Nuclear Security and Safeguards

STUDY PLAN

In each field of study, two study plans are possible:

A-1 Full thesis plan

A-2 Coursework and thesis plan

DEGREE REQUIREMENTS

For A-1 plan, the student must

- pass 2 credits of the general required courses (see COURSE REQUIREMENTS);
- pass a minimum of 37 credits of the thesis course;
- present an acceptable thesis and pass an oral examination;
- meet the publication requirements of the Graduate School; and
- obtain "Satisfactory (S)" grade in all courses within the allowed period of study (no less than 4 and no more than 8 regular semesters).

For A-2 plan, the student must

- pass 2 credits of the general required courses (see COURSE REQUIREMENTS);
- pass a minimum of 27 credits of the required and the elective courses (see COURSE REQUIREMENTS);
- pass the total of 12 credits of the thesis course;
- present an acceptable thesis and pass an oral examination;
- meet the publication requirements of the Graduate School; and
- obtain a passing grade point average (GPA) of no less than 3.00 within the allowed period of study (no less than 4 and no more than 8 regular semesters).

COURSE REQUIREMENTS

Courses are divided into prerequisite, general required, specific required, general elective, specific elective, and thesis courses. Course requirements may vary depending on the field of study and the study plan.

A-1 Plan

0) Prerequisite Courses

Student with insufficient background knowledge of nuclear engineering must take the following course

2111600 Nuclear Engineering I * 3(3-0-9)

*Non-credit course, the student is given S/U (Satisfactory/Unsatisfactory) instead of the letter grade.

Student may be exempted from taking the course upon receiving the approval from the Program Board. A proof of priori knowledge on the subject is required.

1) General Required Courses

Both fields of study: The following courses are required for the total of 2 credits.

2111701 Seminar in Nuclear Technology I * 1(1-0-3)
2111702 Seminar in Nuclear Technology II * 1(1-0-3)

2) Thesis Course

Both fields of study: 37 credits of the following course are required.

2111812 Thesis
(Student may register for this course multiple times. The number of credits for each registration depends upon the agreement between the student and his/her thesis advisor. S(atisfactory)/U(nsatisfactory) is given instead of letter grades.)

A-2 Plan

0) Prerequisite Courses

Student with insufficient background knowledge of nuclear engineering must take

2111600 Nuclear Engineering I * 3(3-0-9)
*Non-credit course, the student is given S/U (Satisfactory/Unsatisfactory) instead of the letter grade.

Student may be exempted from taking the course upon receiving the approval from the Program Board. A proof of priori knowledge on the subject is required.

1) General Required Courses

Both fields of study: The following courses are required for the total of 2 credits.

2111701 Seminar in Nuclear Technology I 1(1-0-3)
2111702 Seminar in Nuclear Technology II 1(1-0-3)

2) Specific Required Courses

2.1) *Nuclear Engineering Field of Study: All of the following courses are required for the total of 13 credits.*

2111604 Radiation Detectors and Nuclear Instruments Laboratory 1(0-3-7)
2111613 Radiation Safety and Shielding 3(3-0-9)
2111643 Nuclear Power Engineering 3(3-0-9)
2111663 Radiation Detectors and Nuclear Instruments 3(3-0-9)

2.2) *Nuclear Security and Safeguards Field of Study: All of the following courses are required for the total of 13 credits.*

2111610 Nuclear Security 3(3-0-9)
2111651 Weapon Mass Destruction Nonproliferation 3(3-0-9)
2111658 Methods and Instrumentation for Nuclear Security and Safeguards 3(3-0-9)

2111659 Methods and Instrumentation for Nuclear Security and Safeguards Laboratory 1(0-3-7)

2.3) *Elective Required Courses in Nuclear Engineering and Nuclear Security and Safeguards (3 credits)*
2111642 Nuclear Reactor Engineering 3(3-0-9)
2111650 Introduction to Plasma Physics and Nuclear Fusion 3(3-0-9)

3) Specific Elective Courses minimum 12 credits

3.1) *Nuclear Engineering Field of Study : Choose from the following courses; minimum of 9 credits are required.*

2111603 Radiation Detection and Measurements Laboratory 1(0-3-7)
2111607 Environmental Radiation Measurements 3(3-0-9)
2111608 Practical Radiation Detection and Measurements 3(3-0-9)
2111609 Radiation Dosimetry 3(3-0-9)
2111616 Environmental Impact of Nuclear Power Plant 3(3-0-9)
2111621 Radiation Chemistry and Processing 3(3-0-9)
2111626 Industrial Radiation and Radioisotope Applications 3(2-3-7)
2111627 Material Analysis by Nuclear Techniques 3(3-0-9)
2111628 Radioisotope Production and Utilization 3(3-0-9)
2111629 Nuclear Chemical Engineering 3(3-0-9)
2111632 Numerical Calculation for Nuclear Engineering 3(3-0-9)
2111640 Nuclear Reactor Control 3(3-0-9)
2111646 Radioactive Waste Management 3(3-0-9)
2111647 Nuclear Fuels and Nuclear Fuel Cycles 3(3-0-9)
2111648 Nuclear Power Plant Systems and Operation 3(2-3-7)
2111650 Introduction to Plasma Physics and Nuclear Fusion 3(3-0-9)
2111655 Computer Application in Nuclear Technology 3(3-0-9)
2111660 Industrial Radiation Imaging 3(3-0-9)
2111661 Experimental Nuclear Engineering 3(2-3-7)
2111662 Nuclear Electronics 3(3-0-9)
2111664 Digital Computer Interfacing for Nuclear Instrument 3(3-0-9)
2111666 Radiation Machines 3(3-0-9)
2111678 Nuclear Materials Engineering 3(3-0-9)
2111683 Current Topics in Nuclear Engineering 3(3-0-9)
2111687 Special Topics in Nuclear Engineering 3(3-0-9)

3.2) *Nuclear Security and Safeguards Field of Study: Choose from the following courses; minimum of 9 credits are required.*

2111652 Strategic Trade Control 3(3-0-9)
2111653 Nuclear Safeguards 3(3-0-9)
2111654 Nuclear Fuel Cycle and Environmental Impacts 3(3-0-9)
2111656 Physical Protection of Nuclear Materials and Facilities I 3(3-0-9)
2111657 Advanced Detection Technologies for Radioactive and Nuclear Materials 3(3-0-9)

4) General Elective Course

Both fields of study: Student must take 3 credits of the courses available in the Master of Engineering in Nuclear Engineering Program.

5) Thesis

For A1 plan

2111811 Thesis 12 credits

For A2 plan

2111817 Thesis 37 credits

NAME OF THE DEGREE

: Master of Science

: M.Sc.

ADMISSION

The degree of Master of Science in Nuclear Technology is offered under the general regulations of the Graduate School. The program is intended for those students who plan a career or research related to nuclear technology. The courses cover basic nuclear science & technology, radiation protection & safety, radiation measurement, applications of radiation and radioisotope, nuclear materials and radiation chemistry & processing. Moreover, the courses include theoretical and practical knowledge equivalent to those with the competency of a radiation safety officer (RSO) at the intermediate level, according to the law. Since November 2013, the program has included courses related to nuclear security and safeguards.

To be eligible for admission to the program an applicant must hold a Bachelor degree in science, applied science, technology or engineering or a Bachelor Degree in an equivalent/related field, must meet the requirements of the Graduate School and also must pass the entrance examination administered by the department.

DEGREE REQUIREMENTS

The program consists of 38 credits of courses, 14 credits of required courses and 12 credits of elective courses. To graduate, a student must present an acceptable thesis and pass an oral examination for a quantity of 12 credits.

A student who has fulfilled the requirements of the program with the cumulative GPA not less than 3.00 with a period of study of no more than 8 regular semesters will be awarded a Degree of Master of Science in Nuclear Technology with concentration in Nuclear Technology or in Nuclear Security and Safeguards.

FIELDS OF STUDY

The student must concentrate on one of the following fields of study:

- Nuclear Technology
- Nuclear Security and Safeguards

COURSE REQUIREMENTS

Courses are divided into general required, specific required, general elective, and thesis.
Course requirements may vary depending on the field of study and the study plan.

1) General required courses:

Both fields of study: The following courses are required for the total of 2 credits.

2111703	Research Methodology and Project Management*	1(1-0-3)
2111704	Seminar in Nuclear Technology*	1(1-0-3)

* Non- credit course, the student is given S/U (Satisfactory/Unsatisfactory) instead of the letter grade.

2) Specific required courses:

2.1) Nuclear Technology field of study: All of the following course are required for the total of 14 credits.

2111603	Radiation Detection and Measurements Laboratory	1(0-3-7)
2111608	Practical Radiation Detection and Measurements	3(3-0-9)
2111612	Radiation Protection	3(3-0-9)
2111688	Nuclear Science and Engineering	3(3-0-9)
2111690	Radiation Waste Management & Emergency Preparedness and Response	3(3-0-9)
2111697	Radiation Decontamination and Emergency Response Laboratory	1(0-3-7)

2.2) Nuclear Security and safeguards field of study: All of the following course are required for the total of 13 credits.

2111610	Nuclear Security	3(3-0-9)
2111651	Weapon Mass Destruction Nonproliferation	3(3-0-9)
2111653	Nuclear Safeguards	3(3-0-9)
2111658	Method and Instrumentation for Nuclear Security and Safeguards	3(3-0-9)
2111659	Methods and Instrumentation for Nuclear Security and Safeguards Laboratory	3(3-0-9)
2111697	Radiation Decontamination and Emergency Response Laboratory	1(0-3-7)

3) Specific elective courses:

3.1) Nuclear Technology Field of Study: Choose from the following courses; minimum of 9 credits are required.

Measurement and Applications

2111607	Environmental Radiation Measurements	3(3-0-9)
2111609	Radiation Dosimetry	3(3-0-9)
2111613	Radiation Safety and Shielding	3(3-0-9)
2111626	Industrial Radiation and Radioisotope Applications	3(3-2-7)
2111627	Material Analysis by Nuclear Techniques	3(3-0-9)
2111646	Radioactive Waste Management	3(3-0-9)
2111655	Computer Application in Nuclear Technology	3(3-0-9)
2111660	Industrial Radiation Imaging	3(3-0-9)
2111689	Radiation Shielding Design and Inspection of Radiation Safety	3(3-0-9)
2111691	Nuclear Forensics Science	3(3-0-9)
2111692	Application of Isotopes in Hydrology and Climate Change Studies	3(3-0-9)
2111693	Nuclear Technology in Medical Applications	3(3-0-9)

Nuclear Instruments

2111604	Radiation Detectors and Nuclear Instruments Laboratory	3(3-0-9)
2111662	Nuclear Electronics	3(3-0-9)
2111663	Radiation Detections and Nuclear Instruments	3(3-0-9)
2111664	Digital Computer Interfacing for Nuclear Instruments	3(3-0-9)
2111694	Basic Electronics for Nuclear Technologist	3(3-0-9)
2111695	Development of Materials for Radiation Detection	3(3-0-9)

Nuclear Material and Radiation Chemistry

2111621	Radiation Chemistry and Processing	3(3-0-9)
2111628	Radioisotope Production and Utilization	3(3-0-9)
2111629	Nuclear Chemical Engineering	3(3-0-9)
2111678	Nuclear Materials Engineering	3(3-0-9)

Nuclear Power Technology

2111616	Environmental Impact of Nuclear Power Plant	3(3-0-9)
2111632	Numerical Calculation for Nuclear Engineering	3(3-0-9)
2111640	Nuclear Reactor Control	3(3-0-9)
2111642	Nuclear Reactor Engineering	3(3-0-9)
2111643	Nuclear Power Engineering	3(3-0-9)
2111647	Nuclear Fuels and Nuclear Fuel Cycles	3(3-0-9)
2111648	Nuclear Power Plant System and Operation	3(3-0-9)
2111650	Introduction to Plasma Physics and Nuclear Fusion	3(3-0-9)
2111696	Introduction to Nuclear Safety, Security, Safeguards and related Laws	3(3-0-9)

3.2) *Nuclear Security and Safeguards Field of Study: Choose from the following courses; minimum of 9 credits are required.*

2111652	Strategic Trade Control	3(3-0-9)
2111654	Nuclear Fuel Cycle and Environmental Impacts	3(3-0-9)
2111656	Physical Protection of Nuclear Materials and Facilities I	3(3-0-9)
2111657	Advanced Detection Technologies for Radioactive and Nuclear Materials	3(3-0-9)

4) General Elective Course

Both fields of study: Student must take 3 credits of the courses available in the Master of Science in Nuclear Technology Program or choose from the following courses;

2111684	Current Topics in Nuclear Technology	3(3-0-9)
2111686	Special Topics in Nuclear Technology	3(3-0-9)

5) Thesis

2111811	Thesis	12 credits

NAME OF DEGREE

: Bachelor of Engineering
: B.Eng.

ADMISSION

Since 2016, the Bachelor Degree program in Nuclear and Radiological Engineering has been established and offered to the students with the background in science and mathematics. The program is intended for those students who plan their careers in the industry, research and services involving the nuclear and radiological engineering. The courses cover basic nuclear science & technology, radiation protection, radiation measurement and instrumentation, applications of radiation and radioisotope, nuclear materials, and radiation chemistry and processing. The program also includes courses related to nuclear security and safeguards.

To be eligible for admission to the program, an applicant must hold a secondary school certificate or an equivalent document. The applicant must also pass the selection process administered by Chulalongkorn University and the authority.

DEGREE REQUIREMENTS

To graduate from the program, a student must collect at least 138 course credits as described in the following section.

A student who has fulfilled the requirements of the program with the cumulative GPA of no less than 2.00 with a period of study not more than 8 education years will be awarded a Bachelor Degree in Nuclear and Radiological Engineering.

FIELD OF STUDY

The program is concentrated on the following field of study:

- Nuclear and Radiological Engineering

COURSE REQUIREMENTS

Courses are divided into 30 credits of general education courses, 21 credits of fundamental mathematics and science courses, 81 credits of program specific courses, and no less than 6 credits of free elective courses.

NUCLEAR AND RADIOLOGICAL ENGINEERING CURRICULUM
FIRST YEAR CURRICULUM

BUT REPLACE 210xxxx ENGINERING DRAWING BY xxxxxxx GENERAL EDUATION

COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER	
21112xx	APP MATH NUC ENG	3
21112xx	FUN NUC DRAW	1
2103213	ENG MECHANICS I	3
2103295	BASIC THERMO	3
2111200	ESS NUC ENG	3
2111204	HEA PHY RAD	3
2111205	INT NUC MAT	3
		19
	FORTH SEMESTER	
2104253	ENG STAT I	3
2111206	NUC PLA TEC	3
2102391	ELEC ENG I	3
2102392	ELEC ENG LAB I	1
2111210	TRANSP PHE NUC ENG	3 OR
2103351	FLUID MECHANICS I	
2111304	PRI NUC INS	3
2111305	NUC INS LAB	1
2111308	ELE CIR NUC	3
		20
	FIFTH SEMESTER	
2111301	ENV ASP NUC	3
2111202	BAS NUC DET	3
2111203	NUC RAD LAB	1
2111208	NUC REAC ANALYSIS	3 OR
2111410	PLA PHY APP	
210xxxx	AI & BIG DATA	3
xxxxxxx	GENERAL EDUCATION	3
		16

COURSE NO.	SUBJECT	CREDITS
	SIXTH EMESTER	
2111306	IND RAD MAT	3
2111307	IND RAD LAB	1
2111309	NUC REA LAB	1
2111401	SEM NUC ENG	0
2111xxx	APPROVED ELECTIVE	3
210xxxx	AI & BIG DATA	3
xxxxxxx	GENERAL EDUCATION	3
		14
	SUMMER SEMESTER	
2100301	ENGINEERING PRACTICE	2
	SEVENTH SEMESTER	
2104203	ENG MANAGEMENT	3
2111402	PRO NUC ENG I	1
2111xxx	APPROVED ELECTIVES	3
xxxxxxx	GENERAL EDUCATION	3
xxxxxxx	GENERAL EDUCATION	3
xxxxxxx	FREE ELECTIVE	3
		16
	EIGHTH SEMESTER	
2111403	PRO NUC ENG II	3 OR
2100499	SENIOR PROJECT	
210xxxx	21TH CENTURY SKILLS	3
2111xxx	APPROVED ELECTIVES	3
xxxxxxx	GENERAL EDUCATION	3
xxxxxxx	FREE ELECTIVE	3
		15

TOTAL CREDITS FOR GRADUATION = 138

COURSE DESCRIPTIONS IN NUCLEAR AND RADIOLOGICAL ENGINEERING (B.ENG.)

2111200 Essence of Nuclear Engineering 3(3-0-6)

Atomic physics and nuclear physics; interaction between radiation and matters; neutron calculations; types of nuclear reactors; generation of nuclear reactors; applications of nuclear technology and radioisotopes; research reactor; Thailand nuclear power program; other topics of interest in nuclear engineering.

2111202 Basic Principle of Nuclear Radiation Detection and Measurement 3(3-0-6)

Radiation sources; nuclear radiation properties; interaction of radiation with matter, statistics of radiation counting; characteristics of various nuclear radiation detectors; relative and absolute measurements.

2111203 Nuclear Radiation Detection and Measurement Laboratory 3(3-0-6)

Laboratory works on nuclear radiation properties; interaction of radiation with matter; characterization of various nuclear radiation detectors; statistical errors of radiation counting; relative and absolute measurements; nuclear radiation spectroscopy.

2111204 Health Physics and Radiation Protection 3(3-0-6)

Basic concepts of radiation; interactions with tissue; biological effects of radiation; radiation detection and dosimetry; dose limits& regulatory issues; protection from external radiation; internal radiation hazard; surface contamination and decontamination; calculation of internal and external body radiation exposure dose; calculation of gamma and x-ray shielding; clinical applications.

2111205 Introduction to Nuclear Materials 3(3-0-6)

Nuclear fuel cycle; uranium resources in Thailand; uranium extraction from seawater; materials used in nuclear power plants; crystal structures of metals; point defect in metals; diffusion in solids; non-permanent and permanent deformation; dislocation theory; creep; grain and grain growth; generation of fission gas and release; effect of radiation on structure and properties of materials.

2111206 Nuclear Power Plant Technology 3(3-0-6)

Introduction to nuclear power plant technologies, pressurized water reactor, boiling water reactor, other advanced reactor types, Thermodynamics of nuclear power plants, rankine cycle, thermal design of nuclear reactors, reactor heat generation, single phase heat transfer, two phase heat transferrin nuclear reactor.

2111208 Nuclear Reactor Analysis 3(3-0-6)

Production and characteristics of neutrons; the fission process; neutron diffusion theory; slowing-down theory; Fermi theory of the bare thermal reactor; one- and multi-group diffusion methods; basic principles of nuclear reactor kinetics.

2111210 Transport Phenomena in Nuclear Engineering 3(3-0-6)

Introduction and fundamental concepts: fluid as a continuum, velocity field, nature of forces in fluid; fluid statics: fluid in rigid- body motion; Reynolds' transport theorem; governing equations for fluid motion in integral form: conservation of mass, linear momentum, angular momentum, and energy; introduction to kinematics of fluid motion: Eulerian and Lagrangian description of fluid motion, substantial derivative, translation, rotation, vorticity and circulation, deformation; introduction to governing equations for fluid motion in differential form: conservation of mass, stress in fluid motion, resultant force due to stress, the Navier- Stokes equation; introduction to inviscid flow: Euler's equation, Bernoulli's equation; dimensional analysis and similarity; introduction to internal viscous flow: fully- developed laminar flow, flow in pipes and ducts, flow measurements; introduction to external viscous flow: boundary layer flow, flow about immersed bodies, drag force, and lift force.

2111211* Applied Mathematics for Nuclear Engineer 3 (3-0-6)

Ordinary differential equations; linear differential equations with constant coefficients; Laplace transform, vector analysis; finite differences; gamma and beta functions; Fourier series and Fourier integrals; partial differential equations; Bessel and Legendre polynomial functions.

2111212* Fundamental Nuclear Engineering Drawing 1 (1-0-2)

Drawing standards (paper sizes and folding, scales, lines and lettering, title block and parts list), presentation drawings (dimetric projection, isomeric projection and orthographic projection), engineering drawings (sketches, hand drafts and detail drawings) and assembly drawings.

2111301 Environmental Aspects of Nuclear Engineering 3(3-0-6)

Environmental Aspects of Nuclear Engineering al impact of nuclear power plants; Impact of nuclear fuel cycle; radionuclides released from nuclear power plants; atmospheric diffusion; marine diffusion; dispersion simulation using computer codes; types of radioactive waste; radioactive waste transport; radioactive waste management; spent fuel transport; spent fuel management.

2111303 Industrial Control Electronics 3(3-0-6)

Principle of industrial control systems; transducer devices e.g. temperature, pressure, humidity, strain/stress; signal conditioning; industrial equipment; analog and digital control system; data transmission/receiving with computer.

2111304 Principle of Nuclear Instrument 3(3-0-6)

Properties of radiation; interaction of radiation with matter; radiation detectors; standard NIM and CAMAC instrumentation system; principle of nuclear instruments e.g. low voltage power supply, high voltage power supply,

pre-amplifier, main-amplifier, rate meter, single channel analyzer, counter and timer, multi-channel analyzer radiation detection system setting.

2111305 Nuclear Instrument Laboratory 1(0-3-0)

Operation of nuclear instrumentation laboratory e.g. low voltage power supply, high voltage power supply, pre-amplifier, main-amplifier, rate meter, single channel analyzer, counter and timer, radiation detection system setting.

2111306 Industrial Uses of Radiation and Radioactive Material 3(3-0-6)

Basic principle of nuclear techniques used for industrial application; radiation sources and equipment used for industrial application; industrial radiography and computed tomography; nuclear techniques used for industrial gauging; nuclear analytical techniques for on-line elemental analysis in industry; radioisotope tracers used in industrial processes; basic principle of radiation processing for industrial application.

2111307 Industrial Uses of Radiation and Radioactive Material Laboratory 1(0-3-0)

Laboratory works on nuclear techniques used for industrial application; industrial radiography and computed tomography; nuclear techniques used for industrial gauging; nuclear analytical techniques for on-line elemental analysis in industry; radioisotope tracers used in industrial processes.

2111308 Electronic Circuits for Nuclear Instruments 3(3-0-6)

Study the principles, behavior and characteristic of the passive/active electronic devices; electrical signal and waveform; designing and calculation of electronic circuits, including the power supply circuit, feedback, amplifier, Oscillator, Filters, logic. application of radiation measurement devices and in other areas; electronic circuits simulation on computer.

2111309 Nuclear Reactor Laboratory 1(0-3-0)

Condition: Prerequisite 2111208

Approaching of critically, control rod calibration, measurement of thermal neutron flux, measurement of fast neutron flux, profiling of axial flux, calibration of thermal power.

2111310 Nuclear Reactor Safety 3(3-0-6)

Condition: Prerequisite 2111206

Safety systems and functions of current and advanced reactor technologies, design basis accidents, severe accidents, safety analysis report, probabilistic safety analysis, technology of accident analysis, computer simulation of accidents, role of safety culture, current regulatory issues, significant nuclear accidents.

2111311 Radiation Machines I 3(3-0-6)

Particle Sources; Charge Particle Motion in Static Fields; Linear Transverse Motion; Acceleration and Longitudinal Motion; Beam Distribution; Guiding and Focusing; Accelerator; Laser; Cyclotron; Synchrotron; Other Auxiliary Components.

2111312 Nuclear Safety, Security, and Safeguards 3(3-0-6)

Condition: Prerequisite 2111201

Nuclear Safety; Nuclear Security; Nuclear Safeguards; Objectives; Interrelationship between Safety, Security, and Safeguards; National and International Policies; Related Law & Regulations; Related Regimes; Important Elements; Case Studies.

2111401 Seminar in Basic Nuclear Engineering 1(1-0-3)

Condition: Senior Standing or Consent of Faculty

Instructors provide research topics in nuclear technology to students; each student requires selecting a tentative project with a written report and making an oral presentation and discussion of relevance items of selected topic.

2111402 Project in Nuclear Engineering I 1(0-3-1)

Condition: Senior Standing or Consent of Faculty

Perform a preliminary nuclear engineering project in a team manner such that the processes comply with prescribed design processes including report documenting and presenting the project in a professional way.

2111403 Project in Nuclear Engineering II 1(0-3-1)

Condition: Prerequisite 2111402

Perform and complete a nuclear engineering project in a team manner such that the processes comply with prescribed design processes including report documenting and presenting the project in a professional way.

2111404 Microcontroller Programming and Interfacing 3(3-0-6)

Architecture and principle of microprocessor, microcontrollers, and peripheral devices;programming for control applications; interfacing methods and techniques with real world.

2111405 Vacuum Technology for Scientific Instrument 3(3-0-6)

Gas properties; relevant physical concept of vacuum system; vacuum gauge; vacuum pump; control valve; vacuum system design; cleaning techniques; applications of vacuum technology for scientific instruments and devices; leak detection techniques and maintenance.

2111406 Principle of Scientific Instrument 3(3-0-6)

Theory and principle of scientific instrument e.g. spectrophotometer, x-ray spectroscopy and radiography, electron microscopy; maintenance method for scientific instrument.

2111407 Basic scientific instrument maintenance 3(3-0-6)

Condition: Prerequisite 2111308

Using fault finding tools for investigation fault of device and electronic signal; scientific instrument structure and components study; fault diagnosis of Scientific Instruments; circuit analysis; replacement parts and accessories correctly; test the validity of the operation after maintenance.

2111408 Ionizing Radiation Calibration and Dosimetry 3(3-0-6)

Radiation terminology and units; basic principle of radiation dosimetry for various kinds of ionizing radiation; low and high level radiation dosimetry; various types of radiation dosimeter; radiation calibration systems; radiation calibration techniques.

2111410 Plasma Physics and Applications 3(3-0-6)

Basic characteristics of plasma; motions of charge particles under electric and magnetic fields; Maxwell's equations; plasma as fluid; plasma oscillation; different types of waves in plasma; diffusion process in plasma; methods of plasma generation; plasma measurements; nuclear fusion and current technology; plasma applications in industry.

2111411 Nuclear Techniques for Material Analysis 3(3-0-6)

Theoretical principle; methodology; instrumentation and characteristics of nuclear analytical techniques e.g. thermal and fast neutron activation techniques, prompt gamma radiation measurement techniques, measurement of gamma radiation from inelastic neutron collision, charged particles induced x-ray and gamma-ray analytical techniques, x-ray fluorescence techniques, electron and X-ray microanalysis, x-ray diffraction, track-etch techniques.

2111412 Nuclear Technology in Medicine 3(3-0-6)

Condition : Prerequisite 2111201

Radiopharmaceuticals as radioactive tracers in medical imaging, functional studies, and therapy for many diseases e.g. cardiovascular disease, digestive system, lung, skeleton, blood and nervous system etc., Positron emission tomography (PET), Radiotherapy; teletherapy and brachytherapy, Radioimmunoassay for measuring concentrations of antigens, Medical Radiography; computed tomography (CT); Magnetic resonance imaging (MRI)or magnetic resonance tomography (MRT),PET, Single-photon emission computed tomography (SPECT), mammography; dental radiology, Neutron therapy, Heavy-ion therapy.

2111416 Nuclear Techniques for Measurement and Inspection in Industrial Process 3(3-0-6)

Condition : Prerequisite 2111304

Radiation gauging for measurement of thickness, level, moisture and density; detection of corrosion and blockage; distillation column and packed column scan; industrial radiography and tomography; elemental analysis techniques; radiotracer techniques.

2111417 Nuclear Techniques for elemental Analysis 3(3-0-6)

Condition : Prerequisite 2111304

Principles of nuclear analytical techniques; advantages and limitations; x-ray fluorescence analysis technique; nuclear activation analysis techniques; prompt gamma-ray neutron activation analysis techniques; charged particle activation analysis techniques.

2111421 Thermal Hydraulics 3(3-0-6)

Condition : Prerequisite 2111206

Two-phase flow, conservation equations, flow patterns, void fraction modeling, pressure drop modelling, steam separation, flow instabilities, critical flow, bubble nucleation, pool boiling, subcooled and saturated flow boiling, boiling crises, transient analysis (single channel), loop analysis, condensation.

2111422 Nuclear Power Plant Simulation 3(3-0-6)

Condition : Prerequisite 2111206

Operational characteristics of nuclear power plants with the simulation computer programs, reactivity control systems, safety systems, and response to transients and accident situations.

2111423 Heat Transfer Process in Nuclear Power Plant 3(3-0-6)

Condition: Prerequisite 2111206

Heat production from a nuclear reactor, nuclear reactor cooling system, boiling and condensation, two-phase fluid, thermal energy-mechanical energy conversion, thermal cycle, efficiency improvement for heat transfer process, accident involving thermal system in a nuclear power plant and the emergency cooling system.

2111424 Radiation Transport 3(3-0-6)

Definitions and Assumptions regarding the radiation, interaction with the radiation, radiation transport theory, Pn approximation, Sn approximation, numerical calculation for radiation transport, monte-carlo technique.

2111425 Basic Nuclear Reactor Engineering 3(3-0-6)

Applying the nuclear reactor theory for the design and the operation of the nuclear theory, evaluation of the nuclear reactor's importance, safety by design for the nuclear reactor and the thermal system, the management on the operation of a nuclear reactor and the economics of the nuclear reactor's operation.

2111431 Nuclear Weapons and Nuclear Accidents 3(3-0-6)

History of nuclear weapon development; how nuclear weapons work; materials for construction of nuclear weapons; impact of nuclear weapons; current topics on nuclear weapons; Three Mile Island accident, Chernobyl accident and Fukushima accident; impacts on human and the environment; roles of International Atomic Energy Agency; potential of utilizing nuclear explosion for peaceful purposes.

2111432 Corrosion in Nuclear Power Systems 3(3-0-6)

Condition : Prerequisite 2111205

Structural metals in nuclear power plants; properties and fabrication of Zircaloy; aqueous corrosion of reactor components; structural integrity of reactor components under combined mechanical loading, neutron irradiation, and chemical environment.

2111434 Radiation processing and its applications **3(3-0-6)**

Condition : Prerequisite 2111201

Radiation sources; chemical and physical effects of radiation; radiation effects to water, gases, monomers and polymers; polymer modification by radiation; radiation sterilization; development of material structures by radiation; radiation degradation of materials; food irradiation; radiation application in Agro-industry.

2111435 Radiation Detection Materials Development **3(3-0-6)**

Reviews of radiation measurement and detection, types of radiation detectors and their characterizations, development of radiation detection materials; crystal synthesis by chemical processes; the methods of bulk-crystal growths e.g. Bridgman-Stockbarger technique and Czochralski technique; thin-film growth by chemical and physical deposition e.g. epitaxial technique and sputter technique.

2111443 Nuclear Waste Disposal **3(3-0-6)**

Radioactivity; radiation effects on living things; dose limit; various characteristics of radioactive waste management; disposal technology of nuclear waste.

2111444 Social Sciences for Nuclear Engineering **3(3-0-6)**

Economics, Project Management, Law and International obligations, Psychology, Communication with Public, Public Acceptance, education in Nuclear Engineering.

2111497* Seminar in Basic Nuclear Engineering **1 (0-1-2)**

Instructors provide research topics in nuclear technology to students; each student requires selecting a tentative project with a written report and making an oral presentation and discussion of relevance items of selected topic.

2111498* Nuclear Engineering Pre-Project **1 (0-2-1)**

Condition : Prerequisite 2111497

Perform a preliminary nuclear engineering project in a team manner such that the processes comply with prescribed design processes including report documenting and presenting the project in a professional way

2111499* Nuclear Engineering Project **3 (0-6-3)**

Condition : Prerequisite 2111498

Perform and complete a nuclear engineering project in a team manner such that the processes comply with prescribed design processes including report documenting and presenting the project in a professional way

COURSE DESCRIPTIONS IN NUCLEAR ENGINEERING AND NUCLEAR TECHNOLOGY ENGINEERING
(Ph.D, M.Eng, AND M.Sc)

2111600 Nuclear Engineering I 3(3-0-9)

Atomic physics and nuclear physics; interaction between radiation and matters; neutron diffusion; types of nuclear reactors; generation of nuclear reactors; nuclear fuel cycle; applications of nuclear technology and radioisotopes; nuclear weapons; Thailand nuclear power program.

2111603* Radiation Detection and Measurements Laboratory 1(0-3-7)

Laboratory work on radiation measurements; statistical errors of radiation counting; characterization of radiation detectors; relative and absolute measurements; energy loss and penetration of charged particle through matter; interactions of photons with matter; interactions of neutrons with matter.

2111604 *Radiation Detectors and Nuclear instruments laboratory 1(0-3-7)

Laboratory works on electronics circuit of radiation detectors, nuclear pulse shaper and discriminator circuits; inspection and calibration of Nuclear Instrument Module, pulse amplifier, single channel analyzer, multichannel analyzer, time to amplitude converter and some special nuclear instruments; experiment on parameters that affect energy resolution of the spectroscopy system and pulse pile-up rejection.

2111607 Environmental Radiation Measurements 3(3-0-9)

Natural sources of radiation and man-made sources of radionuclides; instrumentation for radiation detection and measurement; measurement techniques and procedures for environmental samples; sampling and sample preparation for analyses in laboratory; statistical treatment of radioactivity measurements; laboratory and field radiation measurements.

2111608 Practical Radiation Detection and Measurements 3(3-0-9)

Nuclear radiation basics; sources of nuclear radiation; types of radioactive decay; statistical errors of radiation counting; interactions of nuclear radiation with matter; characteristics and utilization of various nuclear radiation detectors; relative and absolute measurements; gamma and X-ray spectroscopy; charged-particle spectroscopy; neutron detection and spectroscopy.

2111609 Radiation Dosimetry 3(3-0-9)

Basic principle of radiation dosimetry for various kinds of radiation: charged particle radiation, gamma radiation and neutron; low and high level radiation dosimetry; various types of radiation dosimeter.

2111610 Nuclear Security 3(3-0-9)

Nuclear security; overview of related legal framework; interrelationships between nuclear safety, security and safeguards; nuclear and radiation threat by non-State actors; counterterrorism; chemical biological, radiological and nuclear security of nuclear and nuclear (CBRN) Weapons; basic elements of nuclear security; planning nuclear materials and other radioactive materials outside regulatory control; information security; security culture.

2111612 Radiation Protection 3(3-0-9)

Basic concepts of radiation; biological effects of radiation on human body; dose limits; protection from external radiation; Internal radiation hazard; surface contamination and decontamination; radiation dosimetry; calculation of internal and external radiation exposure dose; calculation of gamma and x-ray shielding.

2111613 Radiation Safety and Shielding 3(3-0-9)

Definitions and basic concepts of radiation safety; biological effects of radiation: protection, dose limits; regulation concerning radioactive materials; transportation of radioactive materials; accidents and emergency procedure; gamma radiation and x-ray shielding; radiation shielding from nuclear reactor.

2111616 Environmental Impact of Nuclear Power Plant 3(3-0-9)

Radionuclides released from nuclear power plant, dispersion in the atmosphere; dispersion in aquatic environment; radiation dose calculation; food chain; reactor siting; accident risk analysis; emergency management.

2111621 Radiation Chemistry and Processing 3(3-0-9)

Radiation sources; chemical and physical effects of radiation; radiation effects to water, gases, monomers and polymers; polymer modification by radiation; radiation sterilization; food irradiation; radiation degradation of materials.

2111626 Industrial Radiation and Radioisotope Applications 3(2-3-7)

Industrial radiography and computed tomography; radiation sources and nuclear instrumentation used for industrial application; nuclear techniques used for industrial gauging; nuclear analytical techniques for on-line elemental analysis in industry; radioisotope tracers in industrial processes; basic principle of radiation processing; experiments on industrial radiation and radioisotope applications.

2111627 Material Analysis with Nuclear Techniques 3(3-0-9)

Condition: Prerequisite 2111608 or 2111663

Theoretical principle; methodology; instrumentation and characteristics of nuclear analytical techniques e.gl thermal and fast neutron activation techniques, prompt gamma radiation measurement techniques, measurement of gamma radiation from inelastic neutron collision, charged particles induced x-ray and gamma-ray analytical techniques, x-ray fluorescence techniques, electron and X-ray microanalysis, x-ray diffraction, track-etch techniques.

2111628 Radioisotope Production and Utilization 3(3-0-9)

Radioisotope production; nuclear reactor-produced radioisotopes; special techniques to produce radioisotope; radioisotopes derived from generators; accelerator produced isotopes, labelled compounds; dispensing and quality control; radioisotope utilization.

2111629 Nuclear Chemical Engineering 3(3-0-9)

Production of fissiles and nuclear reactor materials; isotope separation; property of spent nuclear fuel; separation of remaining and newly producing fissiles from spent nuclear fuel.

2111631 Applied Mathematics in Nuclear Technolog 3(3-0-9)

Ordinary differential equations; linear differential equations with constant coefficients; Laplace transform, vector analysis; finite differences; gamma and beta functions; Fourier series and integral.

2111632 Numerical Calculation for Nuclear Engineering 3(3-0-9)

Numerical technique for differential, integration and finding; matric manipulation; data interpolaion; finite difference; simulation with Monte Carlo technique.

2111640 Nuclear Reactor Control 3(3-0-9)

Condition: Prerequisite 2111642

Phylosophy of nuclear reactor and plant control; elementary physics of reactor control; nuclear reactor kinetics; nuclear reactor control radiation instruments; nuclear reactor control mechanisms; nuclear reactor control problems; computer simulation of nuclear reactor power.

2111642 Nuclear Reactor Engineering 3(3-0-9)

Advance theory on neutron analysis; neutron transport theory, Pn and Sn calculation, importance calculation, neutron library implementation

2111643 Nuclear Power Engineering 3(3-0-9)

Condition: Prerequisite consent of faculty

Power reactor systems; vapor power cycle; reactor heat generation; reactor heat transport, single phase flow, two- phase flow; reactor core thermal analysis; practices using PC-based simulators of nuclear power plants for operations under normal and abnormal conditions.

2111646 Radioactive Waste Management 3(3-0-9)

Nature of radioactive wastes; origin of low- high radioactive wastes; characteristics, forms and quantity of radioactive wastes; storage and transportation; waste management technologies; radioactive waste management plans in various countries.

2111647 Nuclear Fuels and Nuclear Fuel Cycles 3(3-0-9)

Condition: Prerequisite 2111642

Characteristics of fuel- element materials; design of fuel- elements; fuel- element fabrication; fuel cycles in nuclear reactors; properties of irradiated fuel; spent fuel reprocessing; economics of nuclear power.

2111648 Nuclear Power Plant Systems and Operation 3(2-3-7)

Condition: Prerequisite consent of faculty

Functions, equipment and operation of the main systems of a nuclear power plant; how each system is controlled, principles of overall unit operation and control, reactor safety and protection for the public; experiments used PC-based simulators of nuclear power plants for operations under normal and abnormal conditions.

2111650 Introduction to Plasma Physics and Nuclear Fusion 3(3-0-9)

Basic characteristics of plasma, methods of plasma generation; nuclear fusion process, problems and current status of fusion technology; single-particle motions, effects of electric and magnetic field on plasma motion; Maxwell's equations, fluid equation of motion; plasma oscillation, different types of waves in plasma; diffusion process in plasma, plasma resistivity; hydrodynamic equilibrium, various types of instability in plasma.

2111651 Weapon Mass Destruction Nonproliferation 3(3-0-9)

Issues concerning the proliferation of nuclear, chemical, and biological weapons; introduction to nuclear and radiological terrorism; international nuclear nonproliferation framework; weapon technologies of mass destruction; nuclear proliferation issues in South Asia.

2111652* Strategic Trade Controls 3(3-0-9)

National and international contexts of export control; threats of nuclear proliferation to the state and business sectors, international export control framework; instruments for export control; catch-all concepts; intangible technology transfers, dual-use controls; end-use method.

2111653* Nuclear Safeguards 3(3-0-9)

Safeguarding nuclear material and facilities; monitoring principles and technologies; safeguards issues; international framework of nuclear material safeguard; nuclear proliferation threat; radiological threat; detecting nuclear and other radioactive materials; roles of intelligence; A. Q. Khan's network; counter proliferation of nuclear weapons; nuclear material safeguard in various countries.

2111654 Nuclear Fuel Cycle and Environmental Impacts 3(3-0-9)

Technology of nuclear fuel cycle; technologies used in manufacturing, safety handling, and disposing of nuclear materials and by-products; social environmental, and health impacts of materials used in each major step in the fuel cycle; potential of nuclear proliferation.

2111655 Computer Application in Nuclear Technology 3(3-0-9)

Calculation of gamma-ray shielding calculation of primary and secondary x-ray shielding; radioactivity calculation; radiation imaging; application of data acquisition for computed tomography reconstruction.

2111656 Physical protection of Nuclear Materials and Facilities I 3(3-0-9)

Principles of physical protection of nuclear materials and facilities: detection, delay, response; threat identification and analysis; vital area analysis; international physical safeguard framework; internal threats.

2111657 Advanced Detection Technologies for Radioactive and Nuclear Materials 3(3-0-9)

Condition: Prerequisite 2111608 or 2111658 or 2111663

Detection and identification of the types of nuclear materials; chemical and radiological characteristics of nuclear materials from raw materials to various finished products; detection technologies; nuclear forensics.

2111658 Method and Instrumentation for Nuclear Security and Safeguards 3(3-0-9)

Counting statistics; radiation detection; gamma detection; neutron detection; detection of charged particles; gamma spectroscopy; activation analysis; destructive analysis; non-destructive analysis; quantitative nuclear material measurements; survey devices; use of detectors at port.

2111659 Method and Instrumentation for Nuclear Security and Safeguards Laboratory 1(0-3-7)

Use of gamma, neutron, and charged particle detection systems; gamma spectroscopy method; activation analysis; quantitative nuclear material measurements; uses of various survey and detection devices at port.

2111660 Industrial Radiation Imaging 3(3-0-9)

Condition: Prerequisite consent of faculty

Principles of industrial radiography and tomography; advantages and disadvantages; x-ray and gamma-ray radiography; neutron radiography; x-ray and gamma-ray computed tomography; neutron computed tomography; radiation imaging equipment.

2111661 Experimental Nuclear Engineering 3(2-3-7)

Condition: Prerequisite 2111663 or 2111642

Nondestructive testing methods; industrial radiography using x-rays and gamma-rays and neutrons; equipment for x-ray and gamma-ray radiography; x-ray and neutron computed tomography.

2111662 Nuclear Electronics Engineering 3(3-0-9)

Condition: Prerequisite consent of faculty

Outline of nuclear electronics; nuclear measuring systems; shaping of signals for spectroscopy; radiation detection circuit; high voltage bias power supply; pulse amplifier; pulse height and shape discriminators; timing circuit; single channel and multichannel analyzer; digital counter and ratemeter; energy resolution in spectroscopy systems.

2111663* Radiation Detectors and Nuclear Instruments 3(3-0-9)

Principle of radiation detection process; modes of detector operation; NIM and CAMAC standards for modular nuclear instrumentation; configurations of nuclear measurement systems; properties of radiation detectors; operation characteristics of various radiation detector; operation characteristics of various radiation detectors; nuclear pulse signal processing; radiation spectroscopy; nuclear instrumentation; application of counting statistics and error prediction in nuclear radiation measurement.

2111664 Digital Computer Interfacing for Nuclear Instruments 3(3-0-9)

Condition: Prerequisite: 2111608 or 2111663 or consent of faculty

Standard of nuclear instrument modules; nuclear instrumental system; electronic signal conditioning and interfacing for nuclear instrument; standard data bus of parallel and serials type; analog and digital data conversion; uses of microcomputer and microcontroller interfacing for manipulation of nuclear instrument system.

2111666 Radiation Machines 3(3-0-9)

Principle and structure of radiation machine; mechanism of charge particles acceleration; electron and ion beams generation; electromagnetic and electrostatic lens; high vacuum technology; high voltage power supply; basic refrigeration; operation of various types of accelerator and radiation machine; industrial and research applications of radiation machines.

2111678 Nuclear Materials Engineering 3(3-0-9)

Condition: Prerequisite consent of faculty

Nuclear fuel cycle; materials and thermal aspects of nuclear reactors; crystal structures of solids; point defects; diffusion in solids; elastic behavior of solids; dislocations in solid and creep deformation; grain and grain boundaries; cavities in solids; fission product behavior in nuclear fuel; radiation damage and fast-neutron irradiation effects in metals; introduction to the High-Temperature Gas-Cooled Reactor Technology.

2111683 Current Topics in Nuclear Engineering 3(3-0-9)

Current topics in nuclear engineering field are selected, summarized and discussed by the students with faculty participation.

2111684 Current Topics in Nuclear Technology 3(3-0-9)

Current topics in nuclear technology field are selected, summarized and discussed by the students with faculty participation.

2111686 Special Topics in Nuclear Technology 3(3-0-9)

Special topics in nuclear technology; presentations and discussions led by instructors, concluding.

2111687 Special Topics in Nuclear Technology 3(3-0-9)

Students' selection, summaries and discussion of special topics in nuclear engineering, with faculty participation.

2111697* Radiation Decontamination and Emergency Response Laboratory 1(0-3-7)

Laboratory works on Radiation Decontaminations and Emergency Preparedness and Response: Survey for the contaminated areas by using the appropriate methods,

effective chemicals and suitable equipment, Identify the radiation types and radioisotopes of contamination, Determine of radiation dose or the concentration of contaminated areas, Design and develop the radiation protection plan including the decontamination plan, Exercise on the appropriate methods and suitable equipment for Emergency Preparedness and Response, Design and develop the Emergency Preparedness and Response plan, Radiation alarm system and monitoring system.

2111701 Seminar in Nuclear Technology I S/U

Instructors provide research topics in nuclear technology to students and each student is required to summarize with written report and oral presentation.

2111702 Seminar in Nuclear Technology II S/U

Condition: Prerequisite: 2111701

Instructors provide research topics in nuclear technology to students each student required to conduct experimental research with written report and oral presentation; discussion of topics related to research works.

2111811 Thesis 12(0-0-0)

2111817 Thesis 37(0-0-0)

2111826 **Dissertation 49(0-0-0)**

2111831 **Dissertation 36(0-0-0)**

2111832 Dissertation 74(0-0-0)

DEPARTMENT OF WATER RESOURCES ENGINEERING

The Department of Water Resources Engineering was formerly one of the five divisions in the Department of Civil Engineering which had offered some basic courses in hydraulic, hydrology and water resources engineering to the undergraduate students in civil, environmental and survey engineering. The division had also offered a graduate program specialized in water resources engineering leading to the Master of Engineering Degree since 1971 and to the Doctor of Engineering Degree since 1984. At the end of 1991, the Department of Water Resources Engineering was established to reflect growing concern of Chulalongkorn University in the field of water resources development and management which nowaday, has become one of the nation 's most critical problems.

The Department offers programs leading to the Master and Doctor of Engineering degrees in Water Resources Engineering. Works are directed toward research and professional development in areas such as hydrology and hydrologic engineering; hydraulic engineering; irrigation engineering; groundwater; coastal engineering; and water resources planning and management. Students who wish to continue their study in water resources engineering should have completed the equivalent of the undergraduate majoring in civil engineering or water resources engineering, or other related fields with adequate background in civil engineering.

HEAD :

Anurak	Sriariyawat,	Ph.D. (Nottingham)

ASSOCIATE PROFESSORS :

Aksara	Putthividhya,	Ph.D. (U. of Michigan)

ASSISTANT PROFESSORS :

Busawan	Bidorn,	Ph.D. (FSU)
Anurak	Sriariyawat,	Ph.D.(Nottingham)
Supattra	Visessri,	Ph.D. (ICL)
Piyatida	Ruangrassamee,	Ph.D. (MIT)
Pongsak	Suttinon,	D.Eng (Kochi UT)

LECTURERS :

Thanawat	Tangcharusritharatorn,	Ph.D. (Kyoto U)
Pavisorn	Chuenchum,	Ph.D. (Tsinghua U)

NAME OF THE DEGREE

: Master of Engineering in Water Resources Engineering
: M.Eng.

ADMISSION

An applicant must hold a Bachelor's Degree in Civil Engineering, Irrigation Engineering, Water Resources Engineering or equivalent and also meet the requirements of the Graduate School.

DEGREE REQUIREMENTS

The candidate is required to complete at least a total of 36 credits, of which 24 credits shall be graduate course work. These 24 credits course work shall consist of 12 credits of required courses and 12 credits of approved elective credits. The grade point (GPA) must not be less than 3.00, Plus 12 credits of thesis and satisfactorily pass an oral examination.

COURSE REQUIREMENTS

1) Required Courses 12 credits

2112602	Hydroinformatics I	1(0-3-1)
2112605	Hydrology and Hydraulic Laboratory	1(0-3-1)
2112611	Engineering Fluid Mechanics	3(3-0-9)
2112614	Hydraulics of Open Channels	3(3-0-9)
2112617	Hydraulic Design	3(3-0-9)
2112698	Seminar in Water Resources Engineering	1(0-3-1)

2) ***Elective Courses***

At least 12 credits must be chosen from the following courses with the approval of the advisor and in accordance with the approved student's plan.

2112501	Computer Application in Water Resources Engineering	3(3-0-9)
2112503	Irrigation Engineering	3(3-0-9)
2112504	Water Resources Systems Design	3(3-0-9)
2112505	Water Resources Planning and Management	3(3-0-9)
2112541	Introduction to Groundwater Contamination	3(3-0-9)
2112542	Probability and Time Series Analysis for Infrastructure Data	3(3-0-9)
2112543	Water Resources and Environmental Project management	3(3-0-9)
2112601	Digital Methods in Water Resources Engineering	3(3-0-9)
2112603	Hydroinformatics II	3(3-0-9)
2112604	Advanced Topics in Hydroinformatics for Water Resources Engineering	3(3-0-9)
2112615	Erosion and Sedimentation	3(3-0-9)
2112622	River Engineering	3(3-0-9)
2112631	Hydrological Processes	3(3-0-9)
2112633	Advanced Hydrology	3(3-0-9)
2112634	Statistical Hydrology	3(3-0-9)
2112635	Stochastic Processes in Hydrology and Hydraulics	3(3-0-9)
2112636	Urban Hydrology	3(3-0-9)
2112637	Flood Plain Hydrology	3(3-0-9)
2112641	Groundwater Hydrology	3(3-0-9)
2112642	Flow Through Porous Media	3(3-0-9)
2112643	Modelling of Subsurface Flow	3(3-0-9)
2112644	Groundwater Exploration and	3(3-0-9)

	Development	
2112661	Coastal Engineering	3(3-0-9)
2112662	Port and Harbour Engineering	3(3-0-9)
2112663	Coastal Process and Protection	3(3-0-9)
2112664	Estuaries Hydraulics	3(3-0-9)
2112671	Systems Analysis for Large-Scale Systems	3(3-0-9)
2112672	Water Resources Systems Engineering	3(3-0-9)
2112673	Economics of Water Resources Systems	3(3-0-9)
2112674	Water Management	3(3-0-9)
2112675	Sustainable Water Resources Planning and Development	3(3-0-9)
2112681	Engineering for Water Disaster Mitigation	3(3-0-9)
2112691	Special Studies in Water Resources Engineering	3(3-0-9)
2112692	Advanced Topics in Water Resources Engineering	3(3-0-9)

3) ***Thesis***

2112811	Thesis	12 credits
2112816	Thesis	36 credits

NAME OF THE DEGREE

: Master of Sciences in Water Resources Management
: M.Sc.

ADMISSION

An applicant must hold a Bachelor's Degree in Engineering, Science or equivalent and also meet the requirements of the Graduate School.

DEGREE REQUIREMENTS

The candidate is required to complete at least a total of 36 credits, of which 24 credits shall be graduate course work. These 24 credits course work shall consist of 12 credits of required courses and 12 credits of approved elective credits. The grade point (GPA) must not be less than 3.00, Plus 12 credits of thesis and satisfactorily pass an oral examination.

In additional, the students, who were not graduated from B.Eng in Civil Engineering, Irrigation Engineering, Water Resources Engineering, Environmental Engineering or equivalent, have to study and pass this fundamental course (S/U) except the students obtain the permission from the program committee to waive this subject.

2112610	Fundamental Hydraulics for Water Resources Management	3(3-0-9)

COURSE REQUIREMENTS

1) Required Courses 9 credits

2112602	Hydroinformatics I	1(0-3-1)
2112631	Hydrological Processes	3(3-0-9)
2112672	Water Resources Systems Engineering	3(3-0-9)
2112696	Seminar in Water Resources Management I	1(0-3-1)
2112697	Seminar in Water Resources Management II	1(0-3-1)

2) Elective Courses

At least 15 credits must be chosen from the following courses with the approval of the advisor and in accordance with the approved student's plan.

2112501	Computer Application in Water Resources Engineering	3(3-0-9)
2112503	Irrigation Engineering	3(3-0-9)
2112504	Water Resources Systems Design	3(3-0-9)
2112505	Water Resources Planning and Management	3(3-0-9)
2112541	Introduction to Groundwater Contamination	3(3-0-9)
2112542	Probability and Time Series Analysis for Infrastructure Data	3(3-0-9)
2112543	Water Resources and Environmental Project management	3(3-0-9)
2112601	Digital Methods in Water Resources Engineering	3(3-0-9)
2112603	Hydroinformatics II	3(3-0-9)
2112604	Advanced Topics in Hydroinformatics for Water Resources Engineering	3(3-0-9)
2112605	Hydrology and Hydraulic Laboratory	1(0-3-1)
2112611	Engineering Fluid Mechanics	3(3-0-9)
2112614	Hydraulics of Open Channels	3(3-0-9)
2112615	Erosion and Sedimentation	3(3-0-9)
2112617	Hydraulic Design	3(3-0-9)
2112633	Advanced Hydrology	3(3-0-9)
2112634	Statistical Hydrology	3(3-0-9)
2112635	Stochastic Processes in Hydrology and Hydraulics	3(3-0-9)
2112636	Urban Hydrology	3(3-0-9)
2112637	Flood Plain Hydrology	3(3-0-9)
2112641	Groundwater Hydrology	3(3-0-9)
2112642	Flow Through Porous Media	3(3-0-9)
2112643	Modelling of Subsurface Flow	3(3-0-9)
2112644	Groundwater Exploration and Development	3(3-0-9)
2112661	Coastal Engineering	3(3-0-9)
2112671	Systems Analysis for Large-Scale Systems	3(3-0-9)
2112673	Economics of Water Resources Systems	3(3-0-9)
2112674	Water Management	3(3-0-9)
2112675	Sustainable Water Resources Planning and Development	3(3-0-9)
2112681	Engineering for Water Disaster Mitigation	3(3-0-9)
2112693	Special Studies in Water Resources Management	3(3-0-9)
2112694	Advanced Topics in Water Resources Management	3(3-0-9)

3) Thesis

2112811	Thesis	12 credits
2112816	Thesis	36 credits

NAME OF THE DEGREE

: Doctor of Engineering in Water Resources Engineering
: D.Eng.

ADMISSION

An applicant must hold a Master Degree in Civil/Water Resources Engineering or equivalent with GPA above 3.25, passes an English examination and also meet the requirements of the Graduate School.

DEGREE REQUIREMENTS

An acceptable dissertation of not less than 48 credits, together with 12 credits in the primary area plus 2 credits in seminar (S/U), is required for the Doctoral Degree.

A student who has fulfilled the requirements of the program and satisfactorily pass an oral examination, will be awarded the Degree of Doctor of Engineering.

COURSE REQUIREMENTS

1) Required Courses (S/U) 2 credits

2112798	Seminar in Water Resources Engineering II	1(0-3-1)
2112799	Seminar in Water Resources Engineering III	1(0-3-1)
2112894	Doctoral Dissertation Seminar	S/U
2112897	Qualifying Examination	S/U

2) Elective Courses 12 credits

2112601	Digital Methods in Water Resources Engineering	3(3-0-9)
2112602	Hydroinformatics I	1(0-3-1)
2112603	Hydroinformatics II	3(3-0-9)
2112604	Advanced Topics in Hydroinformatics For Water Resources Engineering	3(3-0-9)
2112605	Hydrology and Hydraulic Laboratory	1(0-3-1)
2112611	Engineering Fluid Mechanics	3(3-0-9)
2112614	Hydraulics of Open Channels	3(3-0-9)
2112615	Erosion and Sedimentation	3(3-0-9)
2112617	Hydraulic Design	3(3-0-9)
2112622	River Engineering	3(3-0-9)
2112631	Hydrological Processes	3(3-0-9)
2112633	Advanced Hydrology	3(3-0-9)
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2112643	Modelling of Subsurface Flow	3(3-0-9)
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2112673	Economics of Water Resources Systems	3(3-0-9)
2112674	Water Management	3(3-0-9)
2112675	Sustainable Water Resources Planning and Development	3(3-0-9)
2112681	Engineering for Water Disaster Mitigation	3(3-0-9)
2112691	Special Studies in Water Resources Engineering	3(3-0-9)
2112692	Advanced Topics in Water Resources Engineering	3(3-0-9)

3) Dissertation

2112828	Dissertation	48 credits
2112829	Dissertation	60 credits
2112830	Dissertation	72 credits

NAME OF THE DEGREE

: Doctor of Philosophy in Water Resources Management
: Ph.D.

ADMISSION

An applicant must hold a Master Degree in Water Resources Management or equivalent with GPA above 3.25, passes an English examination and also meet the requirements of the Graduate School.

DEGREE REQUIREMENTS

An acceptable dissertation of not less than 48 credits, together with 12 credits in the primary area plus 2 credits in seminar (S/U), is required for the Doctoral Degree.

A student who has fulfilled the requirements of the program and satisfactorily pass an oral examination, will be awarded the Degree of Doctor of Philosophy.

COURSE REQUIREMENTS

1) Required Courses (S/U) 2 credits

2112796	Seminar in Water Resources Management III	1(0-3-1)
2112797	Seminar in Water Resources Management VI	1(0-3-1)
2112894	Doctoral Dissertation Seminar	S/U

2112897	Qualifying Examination	S/U

2) Elective Courses 12 credits

2112601	Digital Methods in Water Resources Engineering	3(3-0-9)
2112602	Hydroinformatics I	1(0-3-1)
2112603	Hydroinformatics II	3(3-0-9)
2112604	Advanced Topics in Hydroinformatics For Water Resources Engineering	3(3-0-9)
2112611	Engineering Fluid Mechanics	3(3-0-9)
2112614	Hydraulics of Open Channels	3(3-0-9)
2112615	Erosion and Sedimentation	3(3-0-9)
2112617	Hydraulic Design	3(3-0-9)
2112622	River Engineering	3(3-0-9)
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2112681	Engineering for Water Disaster Mitigation	3(3-0-9)
2112693	Special Studies in Water Resources Management	3(3-0-9)
2112694	Advanced Topics in Water Resources Management	3(3-0-9)

3) Dissertation

2112828	Dissertation	48 credits
2112829	Dissertation	60 credits
2112830	Dissertation	72 credits

COURSE DESCRIPTIONS IN WATER RESOURCES ENGINEERING

2112210 Water/Soc 3(3-0-6)

Importance of Water Resources; Context and roles of water resources in society, environment, and community; water cycle, surface water, precipitation, surface runoff, stream flow, erosion surface, water quality, salftwater/intrusion, groundwater, groundwater storage, groundwater abstraction, land subsidence groundwater quality groundwater contamination, remediation for contaminated groundwater, water supply water supply production proun, water distribution system, village water supply system, wastewater, paramenters, treatment technologies, water resources situation in the society, flood drought climate change and impacts, transboundary water resources problems, flood and drought mitigation measures, structural measures, dam/reservoir, rainfall harvesting water drainage system, water reuse program, non-structural measures, forecasting and warning system, conjunctive use of surface and groundwater; laws and regulations

2112341 Hydrology 2(2-0-4)

Hydrologic cycles; precipitation; infiltration; rainfall – runoff and river gauging**;** hydrographs; reservoirs; evaporation; evapotranspiration; flood forecasting; flood routing; groundwater; measurement of hydrologic and meteorological parameters.

2112342 Principles of Hydrology 3(3-0-6)

Hydrologic cycles; precipitation; infiltration; runoff rainfall and river gaging; hydrographs; reservoirs; evaporation; evapotranspiration; flood forecasting; flood routing; groundwater; measurement of hydrologic and meteorological parameters; application in water resources projects; demonstration of infiltration, runoff hydrographs; and groundwater flow.

2112343 Hydrology for Surveying Engineering 3(3-0-6)

Hydrologic cycle and processes; precipitation; streamflow and hydrograph analyses; infiltration soil water and groundwater movement; measurement of hydrogic and hydro-meteorological parameters; rainfall-runoff relationship; statistical and probabilitistic analyses of hydrogic data; introduction to water management; hydrological applications of GIS/Hydro-informatics..

2112344 Hydraulic Laboratory I 1(0-3-0)

Condition : Prerequisite 2112346

Experimental measurement of fluid pressure; principles of fluid flow through orifices and weirs ; momentum forces; measurement of flow in pipe, flow in open channel and unsteady flow.

2112346 Hydraulics I 3(3-0-6)

Condition : Prerequisite 2103213

Properties of fluid statics; dynamics and kinematics of fluid flow; energy equations in steady flow; momentum and dynamic forces in fluid flow; similitude and dimensional analysis; flow of fluid in pipes; open channel flow; fluid flow measurement; unsteady flow.

2112440 Hydraulic Engineering 3(3-0-6)

Condition : Prerequisite 2112346

Open channel flow; flow in pressure conduits; water hammer; reservoirs; sediment transport in streams; reservoir sedimentation; dams; spillways; gates; tunnels; penstocks; turbines; hydraulic models; design of channels; groundwater and hydraulics of well; surface drainage.

2112501 Computer Application in Water Resources Engineering 3(3-0-9)

Application of computer in solving water resources problems; program development or application of available packages to solve assigned water resources problems.

2112503 Irrigation Engineering 3(3-0-9)

Land grading and field layout; irrigation water requirements; water application techniques; water conveyance, control and acquisition.

2112504 Water Resources Systems Design 3(3-0-9)

Condition : Prerequisite 2112346

Introduction to water resources engineering; application of hydraulic and hydrology to related water system projects; reservoirs; pipe system and pump; design of water distributed system and urban drainage design.

2112505 Water Resources Planning and Management 3(3-0-9)

Condition : Prerequisite 2112341 or 2112342 OR 2112343

Water resources and rainfall characteristics in Thailand; principles of water resources planning and management; water resources system modeling; role in planning and management; problem-based water resources management; concepts in probability and statistic modeling in hydrological waters; river basin models for water resources planning and management; climate change and hydrological uncertain issues.

2112541 Introduction to Groundwater Contamination 3(3-0-9)

Fundamentals of subsurface flow and transport; Relation of groundwater flow to geologic structure; mam-made contamination and their impacts of subsurface environment; Behavior of chemicals in subsurface environment; Management of contaminated groundwater; Movement of contaminants through groundwater and their eventual fate; Fate of Contaminants in saturated and unsaturated groundwater aquifers.

2112542 Probability and Time Series Analysisfor Infrastructure Data 3(3-0-9)

Probabilistic concepts and quantitative methods that are useful for water resources and infrastructure data analysis; random variables and their properties; hypothesis testing; analysis of trends; Fourier transformation; characterization of data in the time domain; characterization of data in the frequency domain; correlation among variables; simulation of random variables; linear regression and time series models; Theory and use of MATLAB programming language to import raw data construct simulation models analyze data and present the results.

2112543 Water resources and environmental project management 3(3-0-9)

Condition : Consent of Faculty

The importance of water resources and environment in infrastructural development, water quantity and water quality aspects in infrastructural development, the projects principles of infrastructure planning in developing countries, appropriate and sustainable technologies for water and sanitation projects, technical, socio-cultural, public health, and economic factors important to planning and design of water and sanitation systems that unique in the city critical factors that are often unique to a major water resources and environmental project : the uncertainty lappen in water resources and environmental cleanup projects and process of environmental laws.

2112601 Digital Methods in Water Resources Engineering 3(3-0-9)

Condition : Prerequisite 2112501 or Consent of Faculty

Digital computer methods in solving problems in water resources engineering; selected problems in the areas of hydrology, groundwater, hydraulics, coastal engineering and water resources systems simulation and management.

2112602 Hydroinformatics I 3(3-0-9)

Introduction to information and communication technologies (ICTs) in water resources; integration of hydraulics, hydrology and environmental engineering; assimilation of measured data; concept of the geographic information system; GIS applications in water resources engineering; social dimension of the problems of water management; decision support tools.

2112603 Hydroinformatics II 3(3-0-9)

Drainage basin form and process; geomorphologic approach; physically-based catchment modeling; development of numerical schemes; modeling and forecasting of hydrological systems; database management system; risk analysis and mitigation; decision making process; applications of information and communication technologies (ICTs) to water and related resources management.

2112604 Advanced Topic in Hydroinformatics for Water Resources Engineering 3(3-0-9)

Condition : Prerequisite 2112603 or Consent of Faculty

Analysis, design, installation and operation of combined measuring and numerical-modeling schemes; dynamic and mobile river systems; introduction to flood- and other early warning systems; introduction to real-time water management systems; contemporary issues in hydroinformatics.

2112605 Hydrology and Hydraulic Labolatory 1(0-3-1)

Experimental verification of advanced principles of hydrology and hydraulics; usage of various hydrological and hydraulic measurement devices; preparation for field laboratory/field measurement.

2112610 Fundamental Hydraulics for Water Resources Management 3(3-0-9)

Properties of fluid statics; dynamics and kinematics of fluid flow; energy equations in steady flow; momentum and dynamic forces in fluid flow; flow of fluid in pipes; open channel flow; fluid flow measurement; reservoirs; dams; spillways; gates; pumps and turbines.

2112611 Engineering Fluid Mechanics 3(3-0-9)

Advanced topics in theoretical fluid mechanics and hydrodynamics including mechanics of ideal fluids and viscous fluids; incompressible and compressible flow; one-two-and three-dimenssional flows.

2112614 Hydraulics of Open Channels 3(3-0-9)

Continuity, energy and momentum principles applied to steady and unsteady flow in open channels, channel controls, transitions, flood routing, and models.

2112615 Erosion and Sedimentation 3(3-0-9)

Condition : Prerequisite 2112614

Form of erosion and methods of control; sediment properties and their measurement; initiation of sediment movement; transportation and deposition of sediment by flowing water; bed load and suspended load movement; sediment discharge formulas; river behavior and control.

2112617 Hydraulic Design 3(3-0-9)

Condition : Prerequisite 2112614

Analysis of flow behavior through various types of hydraulic structures such as spillway, stilling basin, energy dissipator, gates, outlet works, open channel, pressure conduit, transitions and flow measurement structure. Consideration and procedures for hydraulic design.

2112622 River Engineering 3(3-0-9)

River geomorphology; sediment transport and river behavior; stabilization and rectification of rivers; inland navigation and canalization; impacts of river engineering works; physical hydraulic models of rivers.

2112631 Hydrological Processes 3(3-0-9)

The hydrologic cycle; atmospheric moisture; precipitation; streamflow; infiltration; evaporation and evapotranspiration; groundwater and well hydraulics; hydrograph analysis; analysis and synthesis of hydrological processes; water quality; mathematical models and simulation in hydrology.

2112633 Advanced Hydrology 3(3-0-9)

Condition : Prerequisite 2112631 or Consent of Faculty

Transport phenomena in hydrology and meteorology; flood routing and overlandflow theory; linear and nonlinear analysis of rainfall-runoff system; conceptual and digital models for hydrologic processes.

2112634 Statistical Hydrology 3(3-0-9)

Condition : Prerequisite 2112631 or Consent of Faculty

Basic statistical characteristics of hydrological data; probability and distributions; parameters estimation techniques; linear and non-linear equations and coefficients estimation; maximum probable values.

2112635 Stochastic Processes in Hydrology and Hydraulics 3(3-0-9)

Condition : Prerequisite 2112631 or Consent of Faculty

Basic characteristics of time series; time series analysis and synthesis; prediction and forecasting.

2112636 Urban Hydrology 3(3-0-9)

Condition : Prerequisite 2112631 or Consent of Faculty

Effects of urban on hydrological processes; urban drainage system and flood protection design; mathematical modelling and simulation for design and management.

2112637 Flood Plain Hydrology 3(3-0-9)

Condition : Prerequisite 2112631 or Consent of Faculty

Nature and origin of flood; rainfall-runoff analysis; flood routing; flood surface profile analysis; flood plain modelling and simulation; flood forecasting and flood protection measures.

2112641 Groundwater Hydrology 3(3-0-9)

Condition : Prerequisite 2112631 or Consent of Faculty

Occurrence of groundwater; basic principles of flow through porous media; hydrology of aquifers; well hydraulics; numerical and analog models for aquifer analysis; discussion on special topics such as salt-water intrusion, water quality, artificial recharge, land subsidence and groundwater basin management.

2112642 Flow Through Porous Media 3(3-0-9)

Condition : Prerequisite 2112641 or Consent of Faculty

Kinematics and dynamics of fluids in saturated porous and fractured media; introduction to free surface, unsaturated, and multiphase flows.

2112643 Modelling of Subsurface Flow 3(3-0-9)

Condition : Prerequisite 2112641 or Consent of Faculty

Finite difference and finite element methods for subsurface fluid flow and mass or energy transport simulation; applications to aquifers, unsaturated soils, seepage through earth dams.

2112644 Groundwater Exploration and Development 3(3-0-9)

Condition : Prerequisite 2112641 or Consent of Faculty

Review of geologic and hydrologic formation of groundwater; techniques and interpretation of field survey; data collection and analysis; water quality; groundwater exploration and construction of well; large-scale development of groundwater; simulation model of wellfields; determination of groundwater yield; analysis and management of groundwater basin; case studies.

2112661 Coastal Engineering 3(3-0-9)

Condition : Prerequisite 2112611 or Consent of Faculty

An introductory course to coastal engineering; basic wave theories; wave mechanics-refraction, diffraction, reflection and breaking; wave generation and forecasting; wave forces on structures; longshore current and sediment

transport; field survey; coastal process and protection; design of coastal structure; hydraulic model.

2112662 Port and Harbour Engineering 3(3-0-9)
Condition : Prerequisite 2112661 or Consent of Faculty

Review of wave mechanics and wave forecasting; functions of ports and harbors; various types of coastal structures for ports and harbours; analysis and design of structures; planning of ports and harbours; economics and environmental consideration, case studies.

2112663 Coastal Process and Protection 3(3-0-9)
Condition : Prerequisite 2112661 or Consent of Faculty

Review of wave mechanics and generation process; wave forecasting; coastal process; mechanics of sediment transport; coastal protection works; beach and land reclamation; economics and environmental consideration; case studies.

2112664 Estuaries Hydraulics 3(3-0-9)
Condition : Prerequisite 2112661 or Consent of Faculty

Estuary phenomena and its problems in hydraulic aspect; tidal phenomena; tidal dynamics; tidal computation; density current; water pollution; mixing and dispersion process; and withdrawal of water from estuaries zone.

2112671 Systems Analysis for Large-Scale Systems 3(3-0-9)

An introduction to system concept and methodologies; nature of large-scale public projects; socio-economic evaluation; identification of objectives and alternatives; systems modelling; optimization techniques; simulation; applications to the design and management of large-scale projects.

2112672 Water Resources Systems Engineering 3(3-0-9)

Application of system analysis in water resources planning, design and operation; simulation modelling; deterministic and stochastic approaches; reservoir design and operation; optimization for multipurpose water resources system; design and management of urban water resources; river basins and groundwater aquifers. Determination of optimal operating rules and planning strategies. Current and proposed methods for feasibility studies of water resources development projects.

2112673 Economics of Water Resources Systems 3(3-0-9)

Discounting techniques for public works planning; socio-economic evaluation in water resources development and pollution control; benefit-cost analysis; allocation of joint-costs in multipurpose development; design and risk analysis; applications to planning and management of flood control, drainage, water supply, hydropower, irrigation, water quality control, recreation and navigation.

2112674 Water Management 3(3-0-9)

Water requirements for agriculture, industries, communities and environmental; economic, social and political criteria in water resources allocations; water resources allocation techniques and optional allocations.

2112675 Sustainable Water Resources Planning and Development 3(3-0-9)

Principles of sustainable development, applications of sustainable development principles to planning and development of water resources to achieve water security, assessment of carrying capacity of watershed quantitatively and qualitatively, planning and development procedures of transboundary river basin in Mekong River Basin, sustainable hydropower development, water-food-energy nexus, and risk assessment of floods and droughts.

2112681 Engineering for Water Disaster Mittiagtion 3(3-0-9)

Introduction to water disaster resilience, causes and mitigation of flood disaster, basic concept of designing flood mitigation and beach erosion protection, risk in hydrologic, hydraulic and coastal engineering, field trip to water disaster prone areas.

2112691 Special Studies in Water Resources Engineering 3(3-0-9)

Special problems in water resources engineering with emphasis on research work and independent study.

2112692 Advanced Topics in Water Resources Engineering 3(3-0-9)

A special course offering the advanced topics on the current research and development in water resources engineering. (offered under special circumstance)

2112693 Special Studies in Water Resources Management 3(3-0-9)

Special problems in water resources management with emphasis on research work and independent study.

2112694 Advanced Topics in Water Resources Management 3(3-0-9)

Advanced topics on the current research and development in water resources management

2112696 Seminar in Water Resources Management I 1(0-3-1)

Research for water resources management; preparation of research proposal; data analysis; result discussion; presentation of reports.

2112697 Seminar in Water Resources Management II 1(0-3-1)

Discussion of special topics related to advanced water resources management linking with other related disciplines; analysis of data and conclusion; academic writing and presentation in conference and journal publication.

2112698 Seminar in Water Resources Engineering 1(0-3-1)

Discussion of special topics related to advanced water resources engineering; analysis of data and conclusion; presentation of reports.

2112796 Seminar in Water Resources Management III 1(0-3-1)

Research for water resources management; preparation of research proposal; data analysis; result discussion; presentation of reports.

2112797 Seminar in Water Resources Management VI **1(0-3-1)**

Discussion of special topics related to advanced water resources management linking with other related disciplines; analysis of data and conclusion; academic writing and presentation in conference and journal publication.

2112798 Seminar in Water Resources Engineering II **1(0-3-1)**

Discussion of special topics related to advanced research works in water resources engineering; analysis of data and conclusions; presentation of reports.

2112799 Seminar in Water Resources Engineering III **1(0-3-1)**

Condition : Prerequisite 2112798 or Consent of Faculty

Discussion of special topics related to advanced research works in water resources engineering; analysis of data and conclusions presentation of reports.

2112811 Thesis **12(0-0-0)**

2112816 Thesis **36(0-0-0)**

2112828 Dissertation **48(0-0-0)**

2112829 Dissertation **60(0-0-0)**

2112830 Dissertation **72(0-0-0)**

2112894 Doctoral Dissertation Seminar **0(0-0-0)** *(S/U)*

2112897 Qualifying Examination **0(0-0-0)** *(S/U)*

International School of Engineering (ISE)

VISION

ISE aims for Internationalization of Engineering under the determination of Chulalongkorn University in educating students with Knowledge and Morality and the promotion of Thai culture

MISSION

Teaching Engineering in English for both undergraduate and postgraduate students
Promote and support research for academic excellence
Support academic **services** for both domestic and international organizations
Promote moral and Thai culture
Support services after graduation for both career and higher education

ISE VALUES

A unit under the Faculty of Engineering which has an excellence in academic, research and services in Engineering
Readiness in human resources and forefront in teaching and learning
Domestic and international collaboration with universities and Industries

ISE Executive Board

Chairman

Dean

Supot Teachavorasinskun, Assoc.Prof.Dr.

Member

Associate Dean

Kasem Choocharukul, Assoc.Prof.Dr.
Tawatchai Charinpanitkul, Assoc.Prof.Dr.
Paisan Kittisupakornj, Prof.Dr.
Anongnat Somwangthanaroj, Assoc.Prof.Dr.
Manop Wongsaisuwan, Asst.Prof.Dr.
Sanphet Chunithipaisan, Asst.Prof.Dr.
Atiwong Suchato, Assoc.Prof.Dr.

Assistant Dean

Chotirat Ratanamahatana, Assoc.Prof.Dr.
Channarong Banmongkol, Asst.Prof.Dr.
Sawekchai Tangaramvon, Assoc.Prof.Dr.
Falan Srisuriyachai, Assoc.Prof.Dr
Phannee Saengkaew, Assoc.Prof.Dr.
Natt Leelawat , Assoc.Prof.Dr.
Supattra Visessri, Asst.Prof.Dr.
Surat Kwanmuang, Asst.Prof.Dr.

Other Administrative Position

On-anong Larpparisudthi, Asst.Prof.Dr.
Sanguan Purahong
Kanyanat Chuikaw
Wipapan Pinkaew

Head of Department

Head of the Department of Mechanical Engineering
Angkee Sripakagorn, Assoc.Prof.Dr.
Head of the Department of Electrical Engineering
Naebboon Hoonchareon, Assoct.Prof.Dr.
Head of the Department of Computer Engineering
Attawith Sudsang, Asst.Prof.Dr.
Head of the Department of Industrial Engineering
Paveena Chaovalitwongse, Assoc.Prof.Dr.
Head of the Department of Chemical Engineering
Soorathep Kheawhom, Assoc.Prof.Dr.

Director

Witaya Wannasuphoprasit, Assoc.Prof.Dr.

Associate Director

Tawan Paphapote, Asst.Prof.
Artiwan Shotipruk, Prof.Dr.
David Banjerdpongchai, Prof.Dr.
Pimporn Ponpesh, Asst.Prof..Dr.

Undergraduate curricula

International School of Engineering (ISE) was formed to serve as a channel for the Faculty of Engineering, Chulalongkorn University to keep abreast with the world's challenges. Four diverse but complementary fields of study are offered at undergraduate level:

Nano Engineering (NANO)
Automotive Design and Manufacturing Engineering (ADME)
Aerospace Engineering (AERO)
Information and Communication Engineering (ICE)
Robotics and Artificial Intelligence Engineering (Robotics AI)

Academic calendar for Undergraduate curricula

International semester system follows the international program time table set by Chulalongkorn University:

First semester: Fall (August – December)
Second semester: Spring (January – May)
Optional: Summer (June – July)

Contact:

International School of Engineering (ISE)
Building no.2, Room 107
Faculty of Engineering
Chulalongkorn University
Phayathai Road, Pathumwan
Bangkok 10330
Tel. 02-218 6422-3
Fax. 02-218 6424
http://www.ise.eng.chula.ac.th
Email: ise@eng.chula.ac.th

NANO ENGINEERING CURRICULUM
(INTERNATIONAL PROGRAM)

Nanotechnology can be applied in almost all industries and can increase a country's competitiveness. In some industries, nanotechnology is a means for survival. Despite the eminent threat of being left behind, many firms or nations cannot harvest the full potential of nanotechnology due to its multidisciplinary nature and the heavy investment involved in research and development. Our nano-engineering program is such an investment and is truly multidisciplinary in that it ingrains in students the basics (physics, chemistry and biology) and the applied (electrical, optical, biomedical and materials engineering). Most of the current science and engineering degrees are highly fragmented, with little collaboration among departments, resulting in scientists who are too theoretical-minded or engineers who are weak in the sciences. The increased knowledge base and skills required to compete mean that the engineers have to have stronger fundamentals in the sciences and the scientists have to have more hands-on experience. The nano-engineering program is thus formulated to bridge the capability gap of the two.

The nano-engineering program aims to produce undergraduates who are knowledgeable in the fundamental building blocks of nanotechnology through the two majors including Bio-Engineering major and Advanced Material Engineering major. Both majors will provide a strong background in chemical, electrical, optical, biomedical, and material areas in which developments on the nanoscale are becoming a major force for technological improvement. Upon graduation, students will be a unique and important contributor to the human resource pool. They will be capable of developing many manufacturing and service industries and taking them to the next level. The students will possess problem-solving and analytical skills typical of engineers and at the same time have a deep understanding of sciences and materials, especially ones with size scale in the nano-meter range. These will be necessary for providing industries with solutions that are novel and better than existing ones.

The nano-engineering program aims to meet the industries' needs for engineers that are conversant in the various aspects of nanotechnology. Those who graduate from the program can be counted on by virtually all those that are involved in high value-added manufacturing and by most service providers in hi-tech industries to help them gain a sustainable competitive advantage. The graduates from this program can be relied upon for their strong scientific knowledge, practical engineering skills and effective management skills required to lead organizations into the ever increasing competitive world.
Each student is required to accumulate a minimum of 147 credits to graduate for Bachelor of Engineering Program in Nano-Engineering (International Program) which also includes 2 credits of industrial training and 4 credits of senior project.

Nano Engineering curriculum has offered two majors in Advanced Materials Nano-Engineering and Bio-Nano Engineering. By which, all students have to make a decision on their field in the third semester.

Each student is required to accumulate a minimum of 147 credits to graduate for Bachelor of Engineering Program in Nano-Engineering (International Program) which also includes 2 credits of industrial training and 4 credits of senior project.

Curriculum board

Asst. Prof. Charusluk Viphavakit	Ph.D.	Chair
Prof. Artiwan Shotipruk	Ph.D.	Committee
Jirapon Khamwannah	Ph.D.	Committee
Chee Keong Ngaw	Ph.D.	Committee
Apipon Methachittipan	Ph.D.	Committee
Porpin Pungetmongkol	Ph.D.	Secretary

Lecture

Boonchuay Supmonchai	Ph.D.
Apipon Methachittipan	Ph.D.
Boonchuay Supmonchai	Ph.D.
Assoc. Prof. Chanchana Tangwongsan	Ph.D.
Asst. Prof. Charusluk Viphavakit	Ph.D.
Chatchai Srinitiwarawong	Ph.D.
Asst. Prof. Chate Patanothai	Ph.D.
Chedtha Puncreobutr	Ph.D.
Chee Keong Ngaw	Ph.D.
Chotiros Surapholchai	Ph.D.
Assoc. Prof. Duangdao Wichadakul	Ph.D.
Asst. Prof. Nipaka Sukpirom	Ph.D.
Nithi Saenarjhan	Ph.D.
Nontivich Tandavanitj	Ph.D.
Assoc. Prof. Nopdanai Ajavakorn	Ph.D.
Asst. Prof. Numpon Insin	Ph.D.
Asst. Prof. Oran Kittithreerapronchai	Ph.D.
Prof. Paitoon Rashatasakhon	Ph.D.
Assoc. Prof. Patama Visuttipitukul	Ph.D.
Asst. Prof. Patchanita Thamyongkit	Ph.D.
Asst. Prof. Peerapat Thongnuek	Ph.D.
Pinunta Rojratsirikul	Ph.D.
Pitaakphong Rattanagraikanakorn	Ph.D.
Asst. Prof. Pongdate Montagantirud	Ph.D.
Porpin Pungetmongkol	Ph.D.
Richard Lemarie	
Asst. Prof. Rojrit Rojanathanes	Ph.D.
Rujira Wanotayan	Ph.D.
Saran Keeratihattayakorn	Ph.D.
Assoc. Prof. Sarawut Rimdusit	Ph.D.
Sirichai Leelachao	Ph.D.
Asst. Prof. Somsak Pianwanit	Ph.D.
Assoc. Prof. Sorada Kanokpanont	Ph.D.
Assoc. Prof. Sujin Khomrutai	Ph.D.
Assoc. Prof. Supaart Sirikantaramas	Ph.D.
Assoc. Prof. Tachai Luangvaranunt	Ph.D.
Asst. Prof. Tawan Paphapote	
Assoc. Prof. Varawut Tangpasuthadol	Ph.D.

Curriculum

Total number of credits requirement	147	credits
General Education	30	credits
Core Courses	111	credits
Basic Mathematics and Sciences	29	credits
Compulsory for Nano Engineering	49	credits
Compulsory for Major		
A. Bioengineering	18	credits
B. Advanced Material Engineering	21	credits
Approved Electives		
A. Bioengineering	15	credits
B. Advanced Material Engineering	12	credits
Free Electives	6	credits

1. General Education **30 credits**

Social Science	3	credits
Humanity	3	credits
Interdisciplinary	3	credits
Science and Mathematics	3	credits

General Education (Special) 6 credits

2140111	Exploring Engineering World	3(3-0-6)
2141100	Introduction to Nanotechnology	3(3-0-6)

Foreign Language 12 credits

5501112	Communicative English I	3(3-0-6)
5501123	Communicative English II	3(3-0-6)
5501214	Communication and Presentation Skills	3(3-0-6)
5501225	Technical Writing	3(3-0-6)

2. Core Course **111 credits**

Basic Mathematics and Sciences 29 credits

2182201	Mathematics for Nano-Engineering	3(3-0-6)
2301107	Calculus I	3(3-0-6)
2301108	Calculus II	3(3-0-6)
2302103	General Chemistry Laboratory	1(0-3-0)
2302105	Chemistry for Engineers	3(3-0-6)
2302106	Basic Organic Chemistry	3(3-0-6)
2302203	Organic Chemistry Laboratory	1(0-3-0)
2303111	Biology for Engineers	3(3-0-6)
2303112	Biology Laboratory for Engineers	1(0-3-0)
2304153	Physics for Engineers	3(3-0-6)
2304154	Physics and Electronics for Engineers	3(3-0-6)
2304193	Physics Laboratory for Engineers	1(0-3-0)
2304194	Physics and Electronics Laboratory for Engineers	1(0-3-0)

Compulsory for Nano Engineering 49 credits

2140301	Industrial Training	2(0-6-0)
2141290	Statistic and Research Methodology for Nano Engineers	3(3-0-6)
2141302	Nanofabrication Technology	3(3-0-6)
2141485	Nano Capstone	3(0-6-3)
2141490	Nano Seminar	1(1-0-2)
2141498	Nano-Engineering Pre-Project	1(0-2-1)
2141499	Nano-Engineering Project	3(0-6-3)
2182210	Electrical Circuit	3(3-0-6)
2182213	Electric Circuit Laboratory	1(0-3-0)
2182312	Signal Processing and Instrumentation	3(3-0-6)
2183101	Engineering Graphics	3(2-3-4)
2183211	Engineering Mechanics	4(4-0-8)
2184303	Engineering Management	3(3-0-6)
2185222	Physical Chemistry for Nano-Engineering	3(3-0-6)
2185333	Transport Phenomena	3(3-0-6)
2189202	Fundamental of Materials Science and Engineering	3(3-0-6)
2189341	Materials Characterization	3(3-0-6)
2190101	Computer Programming	3(3-0-6)
2190151	Computer Programming Laboratory	1(0-3-0)

Major

A. Bioengineering *18 credits*

2141355	Introduction to Bioengineering	3(3-0-6)
2141357	Cells Biology and Human Body	3(3-0-6)
2189356	Materials for Biomedical Applications	3(3-0-6)
2302207	Basic Inorganic Chemistry	2(2-0-4)
2185373	Reaction Engineering	3(3-0-6)
2310380	Biochemistry for Bioengineers	3(3-0-6)
2310381	Biochemistry Laboratory for Bioengineers	1(0-3-0)

B. Advanced Material Engineering *21 credits*

2141305	Nanostructures and Crystalline Defects	3(3-0-6)
2185302	Thermodynamics in Materials Engineering	3(3-0-6)
2185379	Polymer Engineering	3(3-0-6)
2189322	Phase Transformations and Kinetics	3(3-0-6)
2189370	Physical Metallurgy	3(3-0-6)
2189411	Mechanical behavior of materials	3(3-0-6)
2189450	Materials Design and Selection	3(3-0-6)

Approved Electives

A. Bioengineering *15 credits*

Select 18 Credits in the following list

2141347	Introduction to Pharmaceutical Nanotechnology	3(3-0-6)
2141407	Nanomaterial Toxicology	3(3-0-6)
2141459	Biointerface Engineering	3(3-0-6)
2141457*	Introduction to Biomedical Imaging	3(3-0-6)
2141458	Introduction to Assistive and Rehabilitation Technology	3(3-0-6)
2141556	Applied Genetic Engineering	3(3-0-6)
2141557	Engineering Systems for Regenerative Medicine	3(3-0-6)
2141561*	Advance Topic in Bioengineering 1	1(1-0-2)
2141562*	Advance Topic in Bioengineering 2	2(2-0-4)
2141563*	Special Topic in Bioengineering 1	3(3-0-6)
2141564*	Special Topic in Bioengineering 2	3(3-0-6)
2141565*	Special Topic in Bioengineering 3	3(3-0-6)
2182450	Biomedical Instrumentation	3(3-0-6)
2183412	Micro and Nano-Electro	3(3-0-6)

	Mechanical Systems	
2183452	Biomechanics	3(3-0-6)
2185379	Polymer Engineering	3(3-0-6)

B. Advanced Material Engineering *12 credits*

Select 15 Credits in the following list

2141405	Surfaces and Thin Films	3(3-0-6)
2141459	Biointerface Engineering	3(3-0-6)
2141501*	Advance Topic in Advanced Material engineering I	1(1-0-2)
2141502*	Advance Topic in Advanced Material engineering II	2(2-0-4)
2141503*	Special Topic in Advanced Material engineering I	3(3-0-6)
2141504*	Special Topic in Advanced Material engineering II	3(3-0-6)
2141505*	Special Topic in Advanced Material engineering III	3(3-0-6)
2183412	Micro and Nano-Electro Mechanical Systems	3(3-0-6)
2185373	Reaction Engineering	3(3-0-6)
2302389	Intermediate Inorganic Chemistry	3(3-0-6)
2189356	Materials for Biomedical Applications	3(3-0-6)
2189415	Materials for Energy	3(3-0-6)
2189417	Composite materials	3(3-0-6)
2189570	Electronic Materials	3(3-0-6)

3. Free Electives **6 credits**

Select 6 credits from any courses offered in English by any International Programs in Chulalongkorn University.

NANO ENGINEERING CURRICULUM
(INTERNATIONAL PROGRAM)

A. BIOENGINEERING

OURSE NO.	SUBJECT	CREDITS
	FIRST SEMESTER	
2190101	Computer Programming	3
2190151	Computer Programming Laboratory	1
2301107	Calculus I	3
2140111	Exploring Engineering World	3
2304153	Physics for Engineers	3
2304193	Physics Laboratory for Engineers	1
5501112	Communicative English I	3
		17
	SECOND SEMESTER	
2141100	Introduction to Nanotechnology	3
2183101	Engineering Graphics	3
2302105	Chemistry for Engineers	3
2302103	General Chemistry Laboratory	1
2301108	Calculus II	3
2304154	Physics and Electronics for Engineers	3
2304194	Physics and Electronics Lab for Eng	1
5501123	Communicative English II	3
		20
	THIRD SEMESTER	
2182201	Mathematics for Nano-Engineering	3
2182210	Electrical Circuit	3
2183211	Engineering Mechanics	4
2189202	Fundamental of Materials Sci and Eng	3
2302106	Basic Organic Chemistry	3
2302303	Organic Chemistry Laboratory	1
5501214	Communication and Presentation Skills	3
		20
	FOURTH SEMESTER	
2141290	Statist and Research Methodology for Nano-Eng	3
2182213	Electrical Circuit Laboratory	1
2303111	Biology for Engineers	3
2303112	Biology Laboratory for Engineers	1
2185222	Physical Chemistry for Nano – Eng	3
2302207	Basic Inoraganic Chemistry	2
5501225	Technical Writing	3
xxxxxxx	General Education	3
		19

COURSE NO.	SUBJECT	CREDITS
	FIFTH SEMESTER	
2189341	Materials Characterization	3
2182312	Signal processing and instrumentation	3
2141355	Introduction to Bioengineering	3
2185373	Reaction Engineering	3
2310380	Biochemistry for Bioengineers	3
2310381	Biochemistry Lab for Bioengineers	1
xxxxxxx	General Education	3
		19
	SIXTH SEMESTER	
2141302	Nanofabrication Technology	3
2185333	Transport Phenomena	3
2141357	Cells Biology and Human Body	3
2189356	Material for Biomedical Applications	3
xxxxxxx	Approved Electives	3
xxxxxxx	General Education	3
		18
	SUMMER SEMESTER	
2140301	Industrial Training	2
		2
	SEVENTH SEMESTER	
2141498	Nano - Engineering Pre-Project	1
2141485	Nano Capstone	3
xxxxxxx	Approved Electives	3
xxxxxxx	Approved Electives	3
xxxxxxx	Approved Electives	3
xxxxxxx	Free Elective	3
		16
	EIGTHTH SEMESTER	
2141490	Nano Seminar	1
2141499	Nano Engineering Project	3
2184303	Engineering Management	3
xxxxxxx	Approved Electives	3
xxxxxxx	Free Elective	3
xxxxxxx	General Education	3
		16
TOTAL CREDITS FOR GRADUATION		**147**

NANO ENGINEERING CURRICULUM
(INTERNATIONAL PROGRAM)

B. ADVANCED MATERIAL ENGINEERING

OURSE NO.	SUBJECT	CREDITS
	FIRST SEMESTER	
2190101	Computer Programming	3
2190151	Computer Programming Laboratory	1
2301107	Calculus I	3
2140111	Exploring Engineering World	3
2304153	Physics for Engineers	3
2304193	Physics Laboratory for Engineers	1
5501112	Communicative English I	3
		17
	SECOND SEMESTER	
2141100	Introduction to Nanotechnology	3
2183101	Engineering Graphics	3
2302105	Chemistry for Engineers	3
2302103	General Chemistry Laboratory	1
2301108	Calculus II	3
2304154	Physics and Electronics for Engineers	3
2304194	Physics and Electronics Lab for Eng	1
5501123	Communicative English II	3
		20
	THIRD SEMESTER	
2182201	Mathematics for Nano-Engineering	3
2182210	Electrical Circuit	3
2183211	Engineering Mechanics	4
2189202	Fundamental of Materials Sci and Eng	3
2302106	Basic Organic Chemistry	3
2302303	Organic Chemistry Laboratory	1
5501214	Communication and Presentation Skills	3
		20
	FOURTH SEMESTER	
2141290	Statist and Research Methodology for Nano-Eng	3
2182213	Electrical Circuit Laboratory	1
2303111	Biology for Engineers	3
2303112	Biology Laboratory for Engineers	1
2185222	Physical Chemistry for Nano – Eng	3
5501225	Technical Writing	3
xxxxxxx	General Education	3
		17

COURSE NO.	SUBJECT	CREDITS
	FIFTH SEMESTER	
2189341	Materials Characterization	3
2182312	Signal processing and instrumentation	3
2141305	Nanostructures and Crystalline Defects	3
2185302	Thermodynamics in Materials Eng	3
2185379	Polymer Engineering	3
xxxxxxx	General Education	3
		18
	SIXTH SEMESTER	
2141302	Nanofabrication Technology	3
2185333	Transport Phenomena	3
2189322	Phase Transformations and Kinetics	3
2189370	Physical Metallurgy	3
xxxxxxx	Approved Electives	3
xxxxxxx	General Education	3
		18
	SUMMER SEMESTER	
2140301	Industrial Training	2
		2
	SEVENTH SEMESTER	
2141498	Nano - Engineering Pre-Project	1
2189411	Mechanical Behavior of Materials	3
2141485	Nano Capstone	3
xxxxxxx	Approved Electives	3
xxxxxxx	Approved Electives	3
xxxxxxx	Free Elective	3
		16
	EIGTHTH SEMESTER	
2141490	Nano Seminar	1
2141499	Nano Engineering Project	3
2189450	Materials Design and Selection	3
2184303	Engineering Management	3
xxxxxxx	Approved Electives	3
xxxxxxx	General Education	3
xxxxxxx	Free Elective	3
		19
TOTAL CREDITS FOR GRADUATION		**147**

COURSES DESCRIPTIONS IN NANO ENGINEERING (B.ENG)

General Education (Special)

2140111 Exploring Engineering World 3(3-0-6)

Engineering topics related to daily life: energy, resources, environment, manufacturing process, industry, material, automotive, infrastructure, information system and bioengineering.

2141100 Introduction to Nanotechnology 3(3-0-6)

Overview of nanotechnology: What is nanotechnology, Nanotechnology in daily life, fundamental knowledge and its applications, working at nanoscale, trends of nanoscience in industry, life and health.

Foreign Language

5501112 Communicative English I 3(3-0-6)

Practice language skills in acquiring information and knowledge from different sources and media in subjects of students' interest under selected themes; collecting information, summarizing and presenting important issues.

5501123 Communicative English II 3(3-0-6)
CONDITION: PRER 550112 Communicative English I

Practice language skills in acquiring analyzing and synthesizing information and knowledge from different sources and media on topics of students' interest under selected themes; summarizing what they have learned, and presenting opinions from group discussion.

5501214 Communication and Presentation Skills 3(3-0-6)
CONDITION: PRER 550112 Communicative English II

Practice using English for social communication and giving oral presentation on engineering-related topics.

5501225 Technical Writing 3(3-0-6)
CONDITION: PRER 5501123 Communicative English II

Practice in writing summaries composing different types and styles of writing in the field of engineering and writing reports of studies and experiments.

Core Courses

Basic Mathematics and Sciences

2182201 Mathematics for Nano-Eng 3(3-0-6)
Condition : PRER2301108 Calculus II

Systems of Linear Equations, Determinants, Vector Spaces, Subspaces, Null Space, Column Space, Row Space, Kernel and Range of a Linear Transformation, Linear Independence, Basis, Coordinate Systems, Dimension, Rank, Change of Basis, Eigenvalues, Eigenvectors, Diagonalization, First-order Differential Equation, Linear Second-order Differential Equation, Reduction of Order, Euler's Equation, Power Series Solution, Frobenius Method, Partial Differential Equation, Boundary Value Problem, Tensor and its Convention, Indicial Notation, Rank of Tensor, Kronecker Delta Tensor, Symmetric and Skew-Symmetric Tensor, Summation Convention, Tensor Operator, E-Permutation Tensor and its Relationship with Kronecker Delta Tensor, Indicial Manipulation in Vector Calculus, Gradient/ Divergence/ Curl in Tensor Formulation,Tensor Rotation, Introduction to Quantum Mechanics, Schrodinger's Equation, Particle in a Box, Hermitian, Dirac's BraKet, Eigenvalue, Eigenfunction, Expectation Values, Overview of Nanotechnology, Applications to Scanning Tunneling Microscope Image.

2301107 Calculus I 3(3-0-6)

Limits; continuity; differentiation; applications of differentiation; integration; applications of definite integral; transcendental functions; techniques of integration; improper integrals; first-order differential equations.

2301108 Calculus II 3(3-0-6)
CONDITION: PRER 2301107 Calculus I

Sequences and infinite series; convergence tests; power series; Taylor series; lines; planes, and quadric surface in three-dimensional space; calculus of vector-valued functions; line integrals; limits and continuity of functions of several variables; partial derivatives; directional derivatives and gradients; Lagrange multipliers; multiple integrals.

2302103 General Chemistry Laboratory 1(0-3-0)

Standard solution preparation; qualitative analysis; titration; electrochemistry; pH metric titration; spectroscopy; calculation and evaluation of data; calibration curve; introduction to polymer.

2302105 Chemistry for Engineers 3(3-0-6)

Structure of atoms; chemical bonding; ionic bonding, covalent bonding, valence bond theory, hybridization-interaction coordination, intermolecular forces, molecular movement; state of matter: gases, structure of solid, liquid, and solutions; chemical reactions; interaction of matters with electromagnetic radiation and electrical energy; chemical thermodynamics.

2302106 Basic Organic Chemistry 3(3-0-6)

Structure and bonding, stereochemistry, spectroscopy, hydrocarbon, halogen-containing compounds, oxygen-containing compounds, nitrogen-containing compounds, biomolecules.

2302203 Organic Chemistry Laboratory 1(0-3-0)
CONDITION: PRER 2302103 General Chemistry Laboratory

Fundamental laboratory techniques concerning the separation, purification and determination of physical constants of organic compounds; Chemical reactions of organic compounds of various functional groups; Synthesis of certain target molecules.

2303111 Biology for Engineers 3(3-0-6)

Biological principles; cell structures and functions; functions of organelles and sub-cellular structures; chemical basis of life; metabolism and cellular energy processes including regulatory mechanisms; structural organization in relation to functions of organisms; cellular physiology; maintenance the homeostasis of life; continuity of life through inheritance; cellular and molecular basis of development; molecular genetics; evolution theory and evolution of populations; biological diversity; life responses to environmental changes; biological applications in nanotechnology.

2303112 Biology Laboratory for Engineers 1(0-3-0)

Biological experiments which accord with Biology for Engineer.

2304153 Physics for Engineers 3(3-0-6)

Mechanics of particles and rigid bodies; properties of matter; fluid mechanics; heat; vibrations and waves; elements of electromagnetism; optics; modern physics.

2304154 Physics and Electronics for Engineers 3(3-0-6)

Electricity; DC circuits; AC circuits; basic electronics; solid state devices; electrical actuators.

2304193 Physics Laboratory for Engineers 1(0-3-0)

Measurement and precision; experiments on simple harmonic motion; radius of gyration; dynamics of rotation; velocity of sound; viscosity of fluids.

2304194 Physics and Electronics Laboratory for Engineers 1(0-3-0)

Resistance and electromotive force measurements; experiments on ampmeter; voltmeter; oscilloscope; AC circuit; transistor; lenses and mirrors; polarization; interference; diffraction.

Compulsory for Nanoengineering

2140301 Industrial Training 2(0-6-0)

Engineering practice in related areas under supervision of experienced engineers in private sectors or government agencies.

2141290 Statistic and Research Methodology for Nano Engineers 3(3-0-6)
CONDITION: PRER 2301108 Calculus II

Introduction to random process; Research formulation, research objectives, basic procedure for doing research; Statistical method for research; Analysis of data and its implication; Integration of statistics in engineering applications.

2141302 Nanofabrication Technology 3(3-0-6)

Structure and performance of nanomaterials; Principle of nanostructured materials synthesis, crystal growth, stabilization of nanomaterials; Nanoparticle syntheses; Syntheses of nanowire; Fabrication of thin film, Lithography; Special techniques for nanostructured materials fabrication.

2141485 Nano Capstone 3(0-6-3)

Utilization and application of knowledge in nanoengineering by using scientific research, problem analysis, design, and development to determine possible solutions, question reviews, team collaboration and communication. Apply the project to the real- world problem in the form of group projects.

2141490 Nano Seminar 1(1-0-2)

Seminar on interesting topics related to Nano-Engineering

2141498 Nano-Engineering Pre-Project 1(0-2-1)

Problem- solving framework; Guidelines for problem solving and solution from Nano-Engineering project.

2141499 Nano-Engineering Project 3(0-6-3)

Group or individual project on a subject related to Nano or Bio-Nano-Engineering.

2182210 Electrical Circuit 3(3-0-6)
CONDITION: PRER 2304154 Physics and Electronics for Engineers

DC circuit analysis; Kirchhoff's laws; Thevenin's and Norton's theorem; Semiconductor devices; op-amps; digital circuit; DC motor.

2182213 Electrical Circuit Laboratory 1(0-3-0)

Electronic instruments; Multimeter; oscilloscope; DC circuit; Voltage regulators; Filter circuit; Transistor amplifier circuit; Op-amp circuits; Digital circuits; DC motor.

2189202 Fundamental of Materials Science and Engineering 3(3-0-6)

Atomic structures and bonding in solids; Crystallography; Surfaces and interfaces; Crystal defects; Phase equilibrium diagrams; Solid solution and compounds; Polymeric materials; Amorphous materials; Material properties; Relationship between micro- and nano-structures and properties of engineering materials; Classes of engineering materials, material processing and real-world applications.

2182312 Signal Processing and Instrumentation 3(3-0-6)
CONDITION: PRER 2182210 Electrical Circuit

Basic electromechanical techniques used in modern instrumentation and control systems; Use of transducers and actuators; Signal conditioning, grounding, and shielding; Analog and digital signal processing and feedback control methods with emphasis on frequency domain techniques; Low- level measurements; Lock- in technique frequency response of continuous and discrete systems.

2183101 Engineering Graphics 3(2-3-4)

Lettering; orthographic projections; sketching and drawing; pictorial drawing; dimensioning, tolerancing and geometrical tolerancing; section; working drawing; mechanical parts drawing; introduction to CAD.

2183211 Engineering Mechanics 3(3-0-6)

Analysis of force systems and their equilibrium as applied to engineering systems; Stresses and strains; Mechanical properties of materials; Hooke's law, elastic modulus, stress in beam, shear force, bending moment diagram, torsion, buckling of columns, Mohr's circle.

2184303 Engineering Management 3(3-0-6)

Modern management principles; methods of increasing productivity; human relations; industrial safety; pollution problems; commercial laws; basics of engineering economy, finance, marketing, and project management.

2185222 Physical Chemistry for Nano-Engineering 3(3-0-6)

Basic concept of thermodynamics; Thermodynamics laws; Phase rule; Phase equilibrium; Principal of chemical kinetics; Rate of chemical reactions; Chemical equilibrium

2185333 Transport Phenomena 3(3-0-6)

Viscosity, mathematical models of momentum transports in isothermal fluid systems; Thermal conduction and convection; Mathematical models of energy transports in solids and in fluids for isothermal systems and non-isothermal systems; Diffusion in binary mixtures; Mathematical models of mass transports in isothermal mixtures without chemical reactions and with chemical reactions; Simultaneous mass and energy transports in fluid mixtures.

2189341 Materials Characterization 3(3-0-6)

Optical Microscopy, Scanning Probe Microscopy (SPM), Field Emission Scanning Electron Microscopy (FE SEM), Transmission Electron Microscopy (TEM) and Scanning TEM (STEM), Focused Ion Beam (FIB), Energy Dispersive X-Ray Spectroscopy (EDS), X-ray Reflectivity and Total Reflection X-ray Fluorescence, Auger Electron Spectroscopy (AES), Secondary Ion Mass Spectrometry (SMS), Surface Secondary Ion Mass Spectrometry Extended Profile (Surface SIMS XP), Time of Flight Secondary Ion Mass Spectrometry (TOF SIMS), Liquid Chromatography with Mass Spectroscopy (LCMS), Gas Chromatography with Mass Spectroscopy (GCMS), Fourier Transform Infrared Spectroscopy (FTIR) and X-Ray diffraction (XRD).

2190101 Computer Programming 3(3-0-6)

Introduction to computer systems; problem-solving using computers; programming style and convention, control statements, data handling and processing; subprograms; classes and objects.

2190151 Computer Programming Laboratory 1(0-3-0)

Computer programming in Engineering; reviews of computer programming concepts; hands-on experience on computer programming using contemporary engineering tools.

Compulsory for Major

A. BIOENGINEERING

2141355 Introduction to Bioengineering 3(3-0-6)

Introduction to Biological and Biomedical engineering, Engineering of life science and medical technology; Application of biomolecular systems for engineering of cells, biomechanics, biological micro-electromechanical systems (Bio-MEMS), bioinformatics, genomics, bioelectronics, biosensor, bioimaging technology, tissue engineering, drug delivery system, pharmaceutical engineering, etc; The uses of multidisciplinary engineering knowledges in chemical engineering, electrical engineering, computer engineering, mechanical engineering, metallurgical engineering, environmental, nuclear engineering, etc; Study trips.

2141357 Cells Biology and Human Body 3(3-0-6)

Biological mechanisms occurring in a cell that maintain cell activities; Physiological processes of cell in human body, such as membrane transport, neurotransmission and muscle contraction; Basic structure of major organs integrated into various systems in human body; Anatomy and physiology of human body.

2189356 Materials for Biomedical Applications 3(3-0-6)
Condition: PRER 2303111 Biology for engineers, or consent by instructor

Introduction to the interactions between cells and the surfaces of biomaterials; Surface chemistry and physics of selected metals, polymers, and ceramics; Modification of biomaterials surfaces; Biocompatibility and biodegradability; Medical implants; Acute and chronic response to implanted biomaterials; Recent development in metallic prostheses, biosensors, drug delivery system, tissue engineering and anti-microbial surface.

2302207 Basic Inorganic Chemistry 2(2-0-4)

Fundamental concepts in inorganic chemistry; Atomic structure; Chemical periodicity; Chemical bonding and molecular structures; Crystal structures; Inorganic solids; Symmetry and group theory, Molecular orbitals

2185373 Reaction Engineering 3(3-0-6)
CONDITION: PRER: 2302105 Chemistry for Engineers, or consent by instructor

Fundamental of reaction engineering; reaction rate laws, kinetics, mechanisms of homogeneous and heterogeneous reactions, catalysis reactions, biological reactions, analysis of reaction rate data, basic design of reactors.

2310380 Biochemistry for Bioengineers 3(3-0-6)

Fundamental concepts in biochemistry and molecular biology; Chemical and biological properties of biomolecules; Biochemical Reactions; Enzymes; Metabolic Pathways; Molecular genetics; Protein synthesis; Basic of genetic engineering.

2310381 Biochemistry Laboratory for Bioengineers **1(0-3-0)**

Laboratory in biochemistry and molecular biology including the use of computer programs according to Biochemistry for Bioengineers course. Biochemistry Laboratory for Bioengineers

B. ADVANCED MATERIAL ENGINEERING

2141305 Nanostructures and Crystalline Defects **3(3-0-6)**

Laws and theories governing the synthesis and the control of nanomaterial system; Free energy and kinetic principles involved in synthesis, assembly, structure and performance of nanomaterials; Crystal interfaces and structures of nanomaterial; Defects in crystals; Point defects, line defects, planar defects; Motion of dislocations; Effect of impurities on solid-state material properties.

2185302 Thermodynamics in Materials Engineering **3(3-0-6)**

CONDITION: PRER 2185222 Physical Chemistry for Nano – Engineering

Treatment of the first, second and third law of thermodynamics; Free energies as a function of temperature, pressure and chemical potential; Numerical calculation of free energies from available thermodynamic data; Phase equilibria in single- and multi-component systems; Phase diagrams; Electrochemical equilibria and surface thermodynamics; Introduction to statistical thermodynamics; Application of thermodynamics to treat general phenomena in materials engineering.

2185379 Polymer Engineering **3(3-0-6)**

Definitions and basic concepts; Crystalline and amorphous polymer; Molecular architecture; Conformation and morphology; Polymer synthesis; Transition phenomena; Mechanical properties affected by transition phenomena; Theory of rubber elasticity; Polymer rheology; Types of mechanical deformations; Basic rheological response; Viscoelastic properties of polymer; Linear viscoelastic models; Synthesis of controlled architecture polymers; Morphological characterization; Block copolymers; Polymer surfaces and interfaces; Nano-effects in polymer blends and composites; Applications of polymer nanotechnology for electronics and photonics

2189322 Phase Transformations and Kinetics **3(3-0-6)**

CONDITION: PRER 2185302* Thermodynamics in Materials Engineering

Phase equilibrium diagram; Phase transformation; Microstructure evolution; Diffusion; Rates of diffusion; Morphological instabilities; Crystal interfaces; Nucleation and growth; Effects of temperature and driving force on transformations and microstructure; Solid-state diffusion; Spinodal decomposition; Diffusionless transformations and kinetics.

2189370* Physical Metallurgy **3(3-0-6)**

CONDITION: PRER 2189202* Fundamental of Materials Science and Engineering

Physical basis that links the structure of materials with their properties; Material processing including casting, welding, thermomechanical processing; Heat treatment; Plastic deformation; strengthening and toughening mechanism in metals and ceramics; Recovery, recrystallization, grain growth; Microstructural control; Oxidation and corrosion.

2189411 Mechanical behavior of materials **3(3-0-6)**

CONDITION: PRER 2183211 Engineering Mechanics

Theory elasticity; theory of plasticity; Dislocation theory; Mechanical failure; Fractures, fatigue, creep, embrittlement; Materials testing; Tension, hardness, torsion, impact, fatigue, creep; Fracture mechanics; Mechanical behavior of composite materials.

2189450 Materials Design and Selection **3(3-0-6)**

Criteria and concept in design; Materials selection process; Production and cost functions; Materials property charts, and performance indices; Decision analysis; Case studies of materials design and selection in real-world applications.

Approved Electives

A. BIOENGINEERING

2141347 Introduction to Pharmaceutical Nanotechnology **3(3-0-6)**

Importance of nanotechnology in enhancing pharmaceutical technology; Fundamental pharmaco-kinetics for engineers; Reviews of the types and characteristics of physico-chemical properties of biomaterials produced in Thailand; Fabrication technology of nanomaterials: nanoparticles, micelles, vesicles, liposomes, microemulsions, nanocolloids, polymer multilayers, nanoporous materials and nanocapsules, as well as experimental techniques to characterize these nanomaterials; pharmaceutical technologies.

2141407 Nanomaterial Toxicology **3(3-0-6)**

Condition: PRER 2303111 Biology for engineers, or consent by instructor

Fundamentals of nanotoxicology; Exposure assessment for safe nanotechnology in environment and organisms; Biodistribution of engineered nanomaterials; Nanomaterial interactions with cell, genome and epigenome; Toxicity of nanoengineered materials in systemic organs; Use of nanomaterials in food and cosmetic products; Approach to Regulation of Nanotechnology Products; Laboratory evaluation of potential toxicity of engineered nanomaterials.

2141459 Biointerface Engineering 3(3-0-6)
Condition: PRER 2189356* Materials for Biomedical Applications, or consent by instructor

Reviews of cell- material interactions and its applications. Surface energy and thermodynamics of biological molecules; Hydrophobicity of surfaces; Properties of extracellular matrics (ECM) of various types of cells; Cell migration, growth, and differentiation; Blood compatibility of materials; Physical and chemical technics for biosurface modifications; Morphology of surfaces; Evaluation of biocompatibility of materials; Case studies related to biointerfaces engineering such as biomineralization, biosensors, anti-microbial surface etc.

2141457 Introduction to Biomedical Imaging 3(3-0-6)

Various biomedical imaging modalities (x-rays, CT, MRI, ultrasound, PET, SPECT, etc.) and their applications in medicine and biology; Basic concepts of signal processing in two and three dimensions relevant to imaging physics, image reconstruction, image processing, and visualization.

2141458 Introduction to Assistive and Rehabilitation Technology 3(3-0-6)

Problems and basic rehabilitation techniques in various areas, e. g. visual and hearing disability, orthopaedics, stroke, etc.; Human centered concept and design of assistive and rehabilitation devices and technologies; Examples, e. g. wheelchairs, prostheses, hearings aids, visual aids, and specialized computer software and hardware.

2141556 Applied Genetic Engineering 3(3-0-6)
Condition: PRER 2310380* Biochemistry for Bioengineering, or consent by instructor

Genetic coding; Mutation; Mutagenesis; Gene transfer; Genetically modified organisms (GMOs); Biomolecular engineering; Diagnostic DNA microarray; Large- Scale Protein Production; Antibody design and production for sensors/ vaccines; DNA/ RNA therapeutic delivery.

2141557 Engineering Systems for Regenerative Medicine 3(3-0-6)
Condition: PRER 2303111 Biology for engineers, or consent by instructor

Basic knowledge of regenerative medicine and tissue regeneration; Components of tissue engineering; Cells and stem cells regeneration, biological signals and molecules, scaffolds, bioreactors, controlled release systems; Analysis and evaluation of tissue regeneration; Case studies in tissue engineering (such as skin, bone, vascular, etc.), cell therapy, drug and gene delivery, medical contrast agents, anti-aging medicine etc.

2141561* Advance Topic in Bioengineering 1 1(1-0-2)

Advance topics in the field of bioengineering

2141562* Advance Topic in Bioengineering 2 2(2-0-4)

Advance topics in the field of bioengineering

2141563* Special Topic in Bioengineering I 3(3-0-6)

Interesting topics in the field of bioengineering.

2141564* Special Topic in Bioengineering II 3(3-0-6)

Interesting topics in the field of bioengineering.

2141565* Special Topic in Bioengineering III 3(3-0-6)

Interesting topics in the field of bioengineering.

2182450 Biomedical Instrumentation 3(3-0-6)

Basic concepts of biomedical electronics and instrumentation, e.g. sensors, electrodes, amplifiers, etc.; Measurement of biopotential signals, heart rate, heart sound, blood pressure, blood flow and oxygen saturation; Therapeutic devices; Electrical safety in medical environment; Trend in biomedical instrumentation.

2183412 Micro and Nano-Electro Mechanical Systems 3(3-0-6)

Overview of MEMs; Scaling of micromechanical devices; Behavior and modeling of micromechanical devices; Mechanical properties of MEMs materials; Review of microfabrication; Bulk and surface micromachining; Applications of MEMs: pressure sensors, accelerometer; Micromotors; Micropumps and microvalves; Thermal sensors and actuators; Micromirror.

2183452 Biomechanics 3(3-0-6)
Condition: PRER 2304153 Physics for engineers, or consent by instructor

Introduction to the biomechanics of human movement; Static and dynamic biomechanics; Forces and moments in human posture and movement; musculoskeletal anatomy; knowledge of joint mechanics and example of the analysis and design of artificial joints.

2185379 Polymer Engineering 3(3-0-6)

Definitions and basic concepts; Crystalline and amorphous polymer; Molecular architecture; Conformation and morphology; Polymer synthesis; Transition phenomena; Mechanical properties affected by transition phenomena; Theory of rubber elasticity; Polymer rheology; Types of mechanical deformations; Basic rheological response; Viscoelastic properties of polymer; Linear viscoelastic models; Synthesis of controlled architecture polymers; Morphological characterization; Block copolymers; Polymer surfaces and interfaces; Nano-effects in polymer blends and composites; Applications of polymer nanotechnology for electronics and photonics.

2185452 Biosystems and Biotransport 3(3-0-6)

Application of fundamental chemical engineering principles in the study of biological systems with emphasis on the current research in bioengineering, biochemical engineering and industrial applications

2185455 Bioreactor 3(2-1-6)
Condition: PRER 2185373 Reaction Engineering, or consent by instructor

Microbiological and enzymatic processes; Stoichiometry and kinetics of biotransformations; Kinetics of cell growth; Basic knowledge of bioreactor design and their cascades; Analysis of bioreactor dynamics; Batch vs. Continuous stirred tank bioreactors; Immobilized cell bioreactors extractive bioreactors; Animal cell and plant cell reactors; Examples of various types of bioreactors in foods, agricultural, environmental, pharmaceutical, and medical applications, such as stirred tank & rotating, packed bed, hollow-fiber, airlift, membrane bioreactors, etc.

2190456 Introduction to Bioinformatics 3(3-0-6)
Condition: PRER 2310380* Biochemistry for Bioengineer, or consent by instructor

Next Generation Sequencing (NGS) and -omics technologies; -omics data analysis e.g. genomics, transcriptomics, and proteomics and applications of these technologies in biomedicine e.g. translational medicine, precision/personalized medicine, and drug design.

B. ADVANCED MATERIAL ENGINEERING

2141405 Surfaces and Thin Films 3(3-0-6)

Basic knowledge of modern nanoscale thin film technology; thin film deposition and epitaxial; fundamental of thin film nucleation and growth; emerging thin film materials and applications; various method of surface coating such as thermochemical, plating, fusion and vapor phase process; surface modification and methods to improve properties of coated surface.

2141459 Biointerface Engineering 3(3-0-6)
Condition: PRER: 2189356* Materials for Biomedical Applications, or consent by instructor

Reviews of cell-material interactions and its applications. Surface energy and thermodynamics of biological molecules; Hydrophobicity of surfaces; Properties of extracellular matrics (ECM) of various types of cells; Cell migration, growth, and differentiation; Blood compatibility of materials; Physical and chemical technics for biosurface modifications; Morphology of surfaces; Evaluation of biocompatibility of materials; Case studies related to biointerfaces engineering such as biomineralization, biosensors, anti-microbial surface etc.

2141501* Advance Topic in Advanced Material engineering I 1(1-0-2)

Advance topics in the field of Advanced Material engineering

2141502* Advance Topic in Advanced Material engineering II 2(2-0-4)

Advance topics in the field of Advanced Material engineering.

2141503* Special Topic in Advanced Material engineering I 3(3-0-6)

Interesting topics in the field of Advanced Material engineering.

2141504* Special Topic in Advanced Material engineering II 3(3-0-6)

Interesting topics in the field of Advanced Material engineering.

2141505* Special Topic in Advanced Material engineering III 3(3-0-6)

Interesting topics in the field of Advanced Material engineering.

2183412 Micro and Nano-Electro Mechanical Systems 3(3-0-6)

Overview of MEMs; Scaling of micromechanical devices; Behavior and modeling of micromechanical devices; Mechanical properties of MEMs materials; Review of microfabrication; Bulk and surface micromachining; Applications of MEMs: pressure sensors, accelerometer; Micromotors; Micropumps and microvalves; Thermal sensors and actuators; Micromirror.

2185373 Reaction Engineering 3(3-0-6)
CONDITION: PRER: 2302105 Chemistry for Engineers, or consent by instructor

Fundamental of reaction engineering; reaction rate laws, kinetics, mechanisms of homogeneous and heterogeneous reactions, catalysis reactions, biological reactions, analysis of reaction rate data, basic design of reactors.

2302389 Intermediate Inorganic Chemistry 3(3-0-6)

Atomic structure and periodicity; molecular geometry and symmetry; introduction to molecular orbital theory; reaction with electron transfer; inorganic solids; structures and bonding of coordination compounds; crystal and ligand field theories; electronic spectra; organometallic chemistry; 18 electron rule; organometallic reactions; applications in industry and medicine.

2189356 Materials for Biomedical Applications 3(3-0-6)
Condition: PRER 2303111 Biology for engineers

Introduction to the interactions between cells and the surfaces of biomaterials; Surface chemistry and physics of selected metals, polymers, and ceramics; Modification of biomaterials surfaces; Biocompatibility and biodegradability; Medical implants; Acute and chronic response to implanted biomaterials; Recent development in metallic prostheses, biosensors, drug delivery system, tissue engineering and anti-microbial surface.

2189405* Ceramics and Glasses 3(3-0-6)

Family of ceramics and glasses; production of advanced ceramics, composites and glasses; bonding and atomic configurations; powder processing, forming, sintering, densification processes, slip casting, blow molding, and material selection and design of compositions based on required properties; additives in ceramics and glasses; characterization of advanced ceramics and glasses; mechanical and reliability tests; applications of advanced ceramics and glasses.

2189415 Materials for Energy 3(3-0-6)

Overview of materials and materials research in the areas of fuel cells, batteries (electrochemical energy conversion and storage), catalysts and membrane separations (fossil fuel and biomass energy conversion), nuclear fuels, supercapacitors, thermoelectrics, solar cells, solar heat and other renewable energy sources; overview of life cycle assessment and material sustainability; applications and future trends.

2189570 Electronic Materials 3(3-0-6)

Electronic, optical and magnetic properties of materials; elementary quantum physics; kinetic molecular theory and thermally activated processes; band structure; electrical conductivity of metals and semiconductors; intrinsic and extrinsic semiconductors; elementary p-n junction theory; doping; dielectric materials and insulation; superconductivity; operating principles of light emitting diodes, solar cells, thermoelectrics, and transistors.

2189581* High Performance Metals and Alloys 3(3-0-6)

Overview of physical metallurgy fundamentals to achieving high performance metals, alloys and materials; applications of metals and alloys in petroleum, automotive, electronic, medical and automation industries; light weight metals and alloys for next generation electric vehicles. Metals, alloys and advanced materials using in renewable energy sector such as wind turbine, bearings, solar cells and fuel cells. Biomedical and health applications. Understanding the production processes from conventional to novel techniques: from casting to additive manufacturing, and from machining to laser cutting, et

2190401* Computation, Modelling and Problem Solving 3(3-0-6)

Introduction to modelling and simulation in materials engineering; development and design of models for materials processes and structure-property relations; understanding and prediction of material behavior at scales from atomistic to macroscopic through modelling and simulation; topics include symmetry and structure, thermodynamics, solid state physics, mechanics, phase transformations and kinetics; methods for visualizing solutions and graphical presentation of results.

2189581 High Performance Metals and Alloys 3(3-0-6)

Overview of physical metallurgy fundamentals to achieving high performance metals, alloys and materials; applications of metals and alloys in petroleum, automotive, electronic, medical and automation industries; light weight metals and alloys for next generation electric vehicles. Metals, alloys and advanced materials using in renewable energy sector such as wind turbine, bearings, solar cells and fuel cells. Biomedical and health applications. Understanding the production processes from conventional to novel techniques: from casting to additive manufacturing, and from machining to laser cutting, etc.

2190401 Computation, Modelling and Problem Solving 3(3-0-6)

Introduction to modelling and simulation in materials engineering; development and design of models for materials processes and structure-property relations; understanding and prediction of material behavior at scales from atomistic to macroscopic through modelling and simulation; topics include symmetry and structure, thermodynamics, solid state physics, mechanics, phase transformations and kinetics; methods for visualizing solutions and graphical presentation of results.

AUTOMOTIVE DESIGN AND MANUFACTURING ENGINEERING (INTERNATIONAL PROGRAM) (B.ENG)

Automotive design and manufacturing engineering are a highly demanded profession, which is linked to the national and global boosted growth of automotive industry. Automotive design involves the development of motor vehicles with a primarily concern on design of mechanical components and the creation of the product concept. Manufacturing engineering deals with all aspects of manufacture, from production control to materials handling to automation.

Our ADME graduates, being specialized, are trained in both automotive design and manufacturing engineering. Our program trains students to have a solid background in both fields with a flexibility to choose to specialize in either topic. This advantage doubles the job opportunities for our graduates, whilst serving the local and international automotive industry with qualified and versatile engineers with a broad academic background.

Each student is required to accumulate a minimum of 144 credits to graduate for Bachelor of Engineering Program in Automotive Design and Manufacturing Engineering (International Program) which also includes 2 credits of industrial training and 3 credits of senior project.

Curriculum board

Wanchalerm Pora Ph.D. (London)

Sunhapos Chatranuwathana Ph.D. (Michigan)
Witaya Wannasuphoprasit Ph.D. (Northwestern)
Surapong Sirikulvadhana M.S. (Michigan)
Prabhath De Silva Ph.D. (USA)
Nuksit Noomwongs D.Eng. (TUAT)

Professors

Mechanical Engineering

Pramote Dechaumphai Ph.D. (Old Dominion)
Viboon Sangveraphunsiri Ph.D. (Georgia Tech)

Associate Professors
Mechanical Engineering

Asi Bunyajitradulya Ph.D. (UC Irvine)
Kuntinee Maneeratana Ph.D. (London)
Ratchatin Chanchareon D.Eng. (Chula)
Nopdanai Ajavakom Ph.D. (UC.Berkeley)
Witaya Wannasuphoprasit Ph.D. (Northwestern)
Niphon Wansophark D.Eng. (Chula)
Chanat Ratanasumawong D.Eng. (Tokyo Tech)
Thanyarat Singhanart Ph.D. (Tokyo)
Alongkorn Pimpin Ph.D. (Tokyo)
Boonchai Lertnuwat Ph.D. (Tokyo)

Electrial Engineering
Wanchalerm Pora Ph.D. (London)

Industrial Engineering
Somkiat Tangjitsitchareon D.Eng. (Kobe Japan)
Oran Kittithreerapronchai Ph.D. (Georgia)

Metallurgical and materials Engineering
Seksak Asavavisithchai Ph.D. (Nottingham)

Assistant Professors

Electrial Engineering
Suree Pumrin Ph.D. (Washington)

Mechanical Engineering
Sunhapos Chantranuwathana Ph.D. (Michigan)
Nuksit Noomwodsuputtrngs D.Eng. (TUAT)
Tawan Paphapote Ph.D.C. (USA)

Industrial Engineering
Somchai Puajindanetr Ph.D. (London)

Lecturer

Electrial Engineering
Boonchuay Supmonchai M.Eng. (Chula)

ISE Staffs
Yan Zhao Ph.D. (London)
Prabhath De Silva Ph.D. (USA)

Guest lecturer
Kaukeart Boonchukosol Poitiers (Frence)

Visiting Professor (USA)

Stanley Peter Lynch Ph.D. (UK)

Curriculum

Total number of credits requirement	138	credits
General Education	30	credits
Core Courses	102	credits
Basic Sciences	30	credits
Basic Engineering	8	credits
Digital skill: Big data & AI	6	credits
21st Century skill	6	credits
Compulsory	49	credits
Approved Electives	3	credits
Free Electives	6	credits

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1. General Education 30 credits

Social Science	3	credits
Humanity	3	credits
Science and Mathematics	3	credits
Interdisciplinary	3	credits
Foreign Language	12	credits
5501214 Communication and Presentation Skills		3(3-0-6)
5501225 Technical Writing		3(3-0-6)
XXXXXX General Education (Foreign Language)	6	credits
General Education (Special)	6	credits
2140111 Exploring Engineering World		3(3-0-6)
2183282* Introduction to Modern Automotive Engineering		3(3-0-6)

2. Core Course 102 credits

Basic Sciences	30	credits
2301107 Calculus I		3(3-0-6)
2301108 Calculus II		3(3-0-6)
2301312 Differential Equations		3(3-0-6)
2302103 General Chemistry Laboratory		1(0-3-0)
2302105 Chemistry for Engineers		3(3-0-6)
2304153 Physics for Engineers		3(3-0-6)
2304154 Physics and Electronics for Eng.		3(3-0-6)
2304193 Physics Laboratory for Eng.		1(0-3-0)
2304194 Physics and Electronics Laboratory for Engineers		1(0-3-0)
2184201 Probability and Statistics for Automotive Engineering		3(3-0-6)
2301216 Linear Algebra		3(3-0-6)
2301215 Multivariable Calculus		3(3-0-6)
Digital Skills: Bigdata & AI	6	credits
2100201* Introduction to Artificial Intelligence		3(3-0-6)
2182570* Digital System and IoT In Automotive Technology		3(3-0-6)
Interdisciplinary and 21st Century Skills	6	credits
2147104* Engineering Design Thinking		3(3-0-6)
2142344 Management for Automotive Industry		3(3-0-6)
Basic Engineering	8	credits
2183103* Fundamentals of Engineering Graphics		2(1-3-2)
2183212 Statics		3(3-0-6)
2189101 Engineering Materials		3(3-0-6)
Compulsory Courses	49	credits
2140301 Industrial Training		2(0-6-0)
2142413* Manufacturing Process for Automotive Engineering		2(2-0-4)
2182214* Fundamentals of Electrical Circuits		2(2-0-4)
2182215* Fundamentals of Electrical Machines		2(2-0-4)
2182216* Electrical Engineering Laboratory		1(0-3-0)
2183221 Thermodynamics		3(3-0-6)
2183213 Mechanics of Material		3(3-0-6)
2183323 Fundamentals of Fluid Mechanics and Heat Transfer		3(3-0-6)
2183261 Mechanical Engineering Laboratory		2(1-3-2)
2190101 Computer Programming		3(3-0-6)
2190151 Computer Programming Laboratory		1(0-3-0)
2183231 Dynamics		3(3-0-6)
2183325* System Modeling and Vibrations		2(2-0-4)
2183332 CAD/CAM/CAE		3(2-3-4)
2142424 Vehicle Dynamics		3(3-0-6)
2183351 Mechanical Engineering Design		3(3-0-6)
2184344* XEV Propulsion System		3(3-0-6)
2183427* Modern Vehicle System Design		3(3-0-6)
2182431* System Dynamics and Controls		2(2-0-4)
2142499 Automotive Engineering Project		3(0-6-3)
Approved Electives	3	credits
2142352 Finite Element Methods and Applications		3(3-0-6)
2142411 Automotive Hvac Fundamentals		3(3-0-6)
2142422 Vehicle Aerodynamics		3(3-0-6)
2142423 Power Train Systems		3(3-0-6)
2142426 Noise, Vibration and Harshness		3(3-0-6)
2142428 Automotive Diagnostics and Maintenance		2(1-3-2)
2142433 Failure Analysis and NDT		3(2-3-4)
2142453 Concept Car Design		3(3-0-6)
2142461 Automation and Robotics		3(3-0-6)
2142481* Independent Project I		1(0-2-1)
2142482* Independent Project II		1(0-2-1)
2142483* Independent Project III		1(0-2-1)
2142488 Measurement, Instrumentation And Data Acquisition		3(3-0-6)
2142492 Selected Topics in Automotive Engineering I		3(2-3-4)
2142493 Selected Topics in Automotive Engineering II		3(2-3-4)
2142495 Independent Studies		3(0-6-3)
2145421 Introduction to Computational Fluid Dynamics		3(3-0-6)
2182442 Embedded Systems in Automotive		3(3-0-6)

Engineering

2182444 Power Electronics for Automotive Engineering 3(3-0-6)

2182445* Battery Design and Management 1(1-0-2)

2182446* Process Management and Lean Manufacturing 2(2-0-4)

2184410* Fundamental of Autonomous Vehicle 1(1-0-2)

2184411* System Dynamics and Controls Project 2(1-3-3)

2184412* Product Planning and Control 2(2-0-4)

2184413* Quality Control and Management for Automotive Industry 2(2-0-4)

2190445* Software Engineering for Embedded Systems 3(3-0-6)

3. Free Electives 6 credits

Select 6 credits from any courses offered in English by any International Programs in Chulalongkorn University.

AUTOMOTIVE DESIGN AND MANUFACTURING

ENGINEERING CURRICULUM

(INTERNATIONAL PROGRAM)

(B.ENG)

COURSE NO.	SUBJECT	CREDITS
	FIRST SEMESTER	
2190101	Computer Programming	3
2190151	Computer Programming Laboratory	1
2301107	Calculus I	3
2302103	General Chemistry Laboratory	1
2302105	Chemistry for Eng.	3
2304153	Physics for Eng.	3
2304193	Physics Lab for Engineers	1
5501214	Communication and Presentation Skills	3
		18
	SECOND SEMESTER	
2140111	Exploring Engineering World	3
2183103*	Fundamentals of Engineering Graphics	2
2189101	Engineering Materials	3
2301108	Calculus II	3
2304154	Physics and Electronics for Eng.	3
2304194	Physics and Electronics Lab for Eng.	1
5501225	Technical Writing	3
		18
	THIRD SEMESTER	
2142413*	Manufacturing Process Engineering for Automotive	2
2183212	Statics	3
2183221	Thermodynamics	3
2183281	Introduction to Automotive Eng.	3
2184201	Probability and Statistics for Auto Eng.	3
2301312	Differential Equations	3
		17
	FOURTH SEMESTER	
2147104*	Engineering Design Thinking	3
2182214*	Fundamentals of electrical circuits	2
2183213	Mechanics of Materials	3
2183231	Dynamics	3
2301216*	Linear Algebra	3
XXXXXX*	General Education for Foreign Language	3
		17
	FIFTH SEMESTER	
2183325*	System Modeling and Vibrations	2
2182215*	Fundamentals of Electrical Machines	2
2182216*	Electrical Engineering Laboratory	1
2183323	Fundamentals of Fluid Mechanics and Heat Transfer	3
2183261	Mechanical Engineering Laboratory	2
2183332	CAD/CAM/CAE	3
XXXXXX*	General Education for Foreign Language	3
		16
	SIXTH SEMESTER	
2142424	Vehicle Dynamics	3
2183351	Mechanical Engineering Design	3
2184344*	XEv Propulsion System	3
2142344	Management for Automotive Industry	3
2301215*	Multivariable Calculus	3
XXXXXX	General Education	3
		18
	SUMMER SEMESTER	
2140301	Industrial Training	2
	SEVENTH SEMESTER	
2183427*	Modern Vehicle System Design	3
2182431*	System Dynamics	2
XXXXXX	Compulsory Elective I	3
XXXXXX	General Education	3
XXXXXX	General Education	3
XXXXXX	Free Elective	3
		17
	EIGHTH SEMESTER	
2142499	Automotive Engineering Project	3
2182570*	Digital System and IoT Automotive Technology	3
2100201*	Introduction to Artificial Intelligence	3
XXXXXX	General Education	3
XXXXXX	Free Elective	3
		15
	TOTAL CREDITS FOR GRADUATION	**138**

COURSE NO.	SUBJECT	CREDITS

COURSES DESCRIPTIONS IN AUTOMOTIVE DESIGN AND MANUFACTURING ENGINEERING (B.ENG)

General Education

2140111 Exploring Engineering World 3(3-0-6)

Engineering topics related to daily life: energy, resources, environment manufacturing, process, industry, material, automotive, infrastructure, information system and bio engineering.

2183282* Introduction to Modern Automotive Engineering 3(3-0-6)

Lecture: Basic Principles of automotive systems, components, and design; internal combustion engine; transmission; chassis (suspension; steering; brake); body; vehicle aerodynamics; automotive electronics; basic vehicle dynamics (performance and handling). Introduction to next generation automotive; electric vehicle; connected vehicle; autonomous vehicle; mobility services. Basic Principles of XEV system configuration, components, and design; HEV; PHEV; BEV; FCEV. Introduction to automotive industry and eco systems. Workshop: Hand-on study of automotive systems and components; names and functions of components and parts; basic mechanical parts; engine; electronic systems; transmission and drivetrain; brake systems; steering mechanism; basic diagnosis.

5501214 Communication and Presentation Skills 3(3-0-6)
Condition: PRER 5501123

Practice using English for social communication and giving oral presentation on engineering related topics.

5501225 Technical Writing 3(3-0-6)
Condition: PRER 5501123

Practice in writing summaries composing different types and styles of writing in the field of engineering and writing reports of studies and experiments.

Core Course

2301107 Calculus 1 3(3-0-6)

Limit, continuity, differentiation and integration of real-valued functions of a real variable and their applications; techniques of integration; improper integrals.

2301108 Calculus 2 3(3-0-6)
Condition: PRER 2301107

Mathematical induction; sequences and series of real numbers; Taylor series expansion and approximation of elementary functions; numerical integration; vectors, lines and planes in three-dimensional space; calculus of vector valued functions of one variable; calculus of real valued functions of two variables; introduction to differential equations and their applications.

2301312 Differential Equations 3(3-0-6)
Condition: PRER 2301108

Existence and uniqueness theorem of solution of first order equations; initial value problem; Laplace transform; Taylor series expansion of elementary functions; numerical methods; general linear equations; solution in series; linear partial differential equations boundary value problems.

2302103 General Chemistry Laboratory 1(0-3-0)

Standard solution preparation; qualitative analysis; titration; electrochemistry, pH metric titration; spectroscopy; calculation and evaluation of data; calibration curve; introduction to polymer.

2302105 Chemistry for Engineers 3(3-0-6)

Stoichiometry and basis of the atomic theory; properties of the three states of matter and solution; thermodynamics; chemical equilibrium; Oxidation-reduction; chemical kinetics; the electronic structures of atoms and the chemical bond; periodic table; nonmetal and transition metal.

2304153 Physics for Engineers 3(3-0-6)

Mechanics of particles and rigid bodies; properties of matter; fluid mechanics; heat; vibrations and waves; elements of electromagnetism; optics; modern physics.

2304154 Physics and Electronics for Engineers 3(3-0-6)

Electricity DC circuits; AC circuits; basic electronics; electrical actuators.

2304193 Physics Laboratory for Engineers 1(0-3-0)

Measurement and precision; experiments on simple harmonic motion; radius of gyration; dynamics of rotation; velocity of sound; viscosity of fluids.

2304194 Physics and Electronics Laboratory for Engineers 1(0-3-0)

Resistance and electromotive force measurements; experiments on ammeter; voltmeter; oscilloscope; AC circuit; transistor; lenses and mirrors; polarization; interference; diffraction.

2184201 Probability and Statistics for Automotive Engineering 3(3-0-6)

Engineering basis in statistics and probability; discrete and continuous probability distribution; joint probability distribution; parameter estimation: esto,atpr. Bias, consistency; point estimation; interval estimation; automotive engineering applications in measurement and uncertainty, linear regression, introduction to random process; integration of statistics in automotive engineering applications; case studies.

2301216* Linear Algebra 3(3-0-6)

systems of linear algebraic equations; linear spaces; inner products; eigenvalues and eigenvectors; principal axis theorem.

2301215* Multivariable Calculus 3(3-0-6)
Condition: PRER 2301108

Vector; curves, planes and surfaces; derivatives of vector-valued functions; partial, total and directional derivatives; implicit differentiation; maxima-minima; gradient, divergence, curl; scalar and vector fields; line integral; surface integral and volume integral; integral theorems of vector analysis.

AI-Digital Bigdata

2100201* Introduction to Artificial Intelligence 3(3-0-6)

Introduction to artificial intelligence related to scope, historial background; Comcept for design; knowledge representation; memory structures; probabilistic reasoning; decision making; fuzzy logic; genetic algorithm; chaotic.

2182570* Digital System and IOT in Automotive Technology 3(3-0-6)

Number systems and codes; Boolean algebra; minterms and maxterms; sum-of products and product-of-sums; Karnaugh maps; medium-scale combinational circuits; combinational

circuit design; sequential circuits; embedded system architecture; microprocessor/microcontroller; introduction to IoT; cloud platforms; application of IoT in automotive industry.

Interdisciplinary and 21st Century Skills

2147104* Engineering Design Thinking 3(2-3-4)

Principles of Design Thinking; Design thinking process: defining design problems from the real complicated problem, Emphaty, product, information, and patent reviews, brain storming, concept generation and evaluation, conceptual design using CAD; Phycology of design; Design Thinking Project to create a real prototype.

2142344 Management for Automotive Industry 3(3-0-6)

Study of modern management principle; Learn the methods of increasing productivity in automotive industry, human relation; industrial safety, commercial laws, basis of engineering economy, finance, marketing, project management in automotive industry.

Basic Engineering

2183103* Fundamentals Engineering 2(1-3-2)

Lettering; orthographic projections; sketching and drawing; pictorial drawing; dimensioning; tolerancing and geometrical tolerancing; section; working drawing; mechanical parts drawing; introduction to CAD.

2183212 Statics 3(3-0-6)

Force systems; resultants; equilibrium; structure; distributed force; friction; virtual work; stability.

2189101 Engineering Materials 3(3-0-6)

Important engineering materials: metals, plastics, asphalt, wood and concrete; phase diagram and its interpretation; testing and meaning of various properties; macroscopic and microscopic structure which are correlating with properties of the engineering materials; production process of products from engineering materials.

2142232* Manufacturing Process for Automotive Engineering 3(2-3-4)

Introduction of automotive and parts manufacturing, product planning and manufacturing, System and process in automotive and parts manufacturing, Quality control in automotive parts manufacturing

Compulsory Course

2140301 Industrial Training 2(0-12-0)

Engineering practice in related areas under supervision of experienced engineers in private sectors or government agencies.

2142413* Manufacturing Process for Automotive Engineering 2(2-0-4)

Introduction of automotive and parts manufacturing, product planning and manufacturing, System and process in automotive and parts manufacturing, Quality control in automotive parts manufacturing

2142414* Fundamentals of Electrical Circuits 2(2-0-4)

DC circuits; electric power and sign convention; transient and steady-state responses; AC circuits; phasor and impedance; power and power factor in AC circuits; threephase AC circuits; three-phase power.

2182210* Electrical Engineering Laboratory 1(0-3-0)

Laboratory topics related to the contents of 2182214 and 2182215

2183221 Thermodynamics 3(3-0-6)

Basic concepts; thermodynamic state and process; properties of pure substances and ideal gases; energy; the first law of thermodynamics and the first law analysis for isolated, closed, and open systems; entropy; the second law of thermodynamics and the second law analysis for isolated, closed, and opens systems; gas power cycles; Carnot, Otto, and Brayton cycles; refrigeration cycle; introduction to gas mixtures; introduction to combustion.

2183213 Mechanics of Material 3(3-0-6)
Condition: PRER 2183212

Force and stress; stresses and strains relationship; Hooke's law; modulus of elasticity; stresses in beams; shear force; bending moment diagrams; deflection of beams; torsion; buckling of columns; Mohr's circle; combined stresses; failure criterion; safety factors.

2183323 Fundamentals of Fluid Mechanics and Heat Transfer 3(3-0-6)

Properties of fluid, fluid static; momentum and energy equations; equation of continuity and motion; steady incompressible flow. Modes of heat transfer: conduction, convection, radiation and applications of heat transfer, heat exchangers and heat transfer enhancement, boiling and condensation.

2183261 Mechanical Engineering Laboratory 2(1-3-2)

Experimentation and basic concepts; error and uncertainty analysis; measurement and instrumentation; data analysis; interpretation of experimental results; reporting of experimental results; basic experiments in solid mechanics, thermodynamics, fluid mechanics and basic engine testing.

2190101 Computer Programming 3(3-0-6)

Introduction to computer systems; problem-solving using computers; programming in high level languages; program structure, programming style and convention; control statements, data handling and processing; subprograms; classes and objects.

2190151 Computer Programming Laboratory 1(0-3-0)

Computer programming in Engineering; reviews of computer programming concepts; hands-on experience on computer programming using contemporary Engineering tools.

2183231 Dynamics 3(3-0-6)

Kinematics of three-dimensional curvilinear motion of a particle; kinetics of a particle: force and acceleration, work and energy, impulse and momentum; kinematics of planar motion of a rigid body: absolute and relative motion analysis; kinetics of planar motion of a rigid body: absolute and relative motion analysis; kinetics of planar motion at a rigid body; force and acceleration, work and energy, impulse and momentum; introduction to kinematics and kineties of three-dimensional motion of a rigid body.

2183325* System Modeling and Vibrations 2(2-0-4)

ODE system modeling and simulations; System responses with Laplace Transform; Transfer function and frequency response (Bode and Transmissibility); Application on vibrations of engine and suspensions.

2183332 Computer Aided Design/Computer Aided Manufacturing and Computer Aided Engineering **3(2-3-4)**

Introduction to CAD/CAM/CAE, 3D solid modeling, design concepts and implementation; link to manufacturing interface.

2142424 Vehicle Dynamics **3(3-0-6)**
Condition: PRER 2183231

Dynamics of motor vehicles; properties of pneumatic tire; suspension and steering mechanism; vehicle longitudinal dynamics; linear bicycle models; stability; linear engine models; pleasure in driving.

2183351 Mechanical Engineering Design **3(3-0-6)**

Fundamentals of mechanical engineering design; properties of materials; theory of filure; fatigue; design of basic machine elements; design project of a simple mechanical machine.

2183427* Modern Vehicle System Design **3(3-0-6)**

Lettering; orthographic projections; sketching and drawing; pictorial drawing; dimensioning; tolerancing and geometrical tolerancing; section; working drawing; mechanical parts drawing; introduction to CAD.

212431* System Dynamics and Controls **2(2-0-4)**

System dynamics modeling; responses; introduction to control systems; feedback control system characteristics; the performance of feedback control systems; the stability of linear feedback systems; essential principles of feedback; the root locus method; time-domain analysis and design of control systems; frequency response method; stability of the frequency domain and compensation; use of computer in the design of control systems.

2142499 Automotive Engineering Project **3(0-6-3)**

Group or individual project on a subject related to automotive engineering and manufacturing.

Approved Elective Courses

2142352 Finite Element Methods and Applications **3(3-0-6)**

Basic principles of finite element methods; applications of finite elements in analysis using computer programs.

2142411 Automotive Hvac Fundamental **3(3-0-6)**

Fundamentals of fluid dynamics and heat transfer; automotive air handling system; engine coolant loop; heat exchanger characteristics; blower performance laws; automotive air conditioning system; key aspect in designing automotive climate control systemand its operation.

2142422 Vehicle Aerodynamics **3(3-0-6)**

Effects of vehicle design on aerodynamics; wind tunnel testing; boundary layers and wakes; friction and pressure drag; aerodynamic forces and moments; center of pressure and vehicle stability.

2142423 Power Train Systems **3(3-0-6)**

Manual and automatic transmission; basic operation of transmission; peripheral components.

2142426 Noise, Vibration and Harshness **3(3-0-6)**

NVH and its importance for automotive industry. Sources of sound and vibration. Noise quality. Acceleration. Velocity, displacement, and sound pressure/intensity. DB Scales. Introduction to vibration. Free and forced vibration response of one and two degrees of freedom systems. Methods for determining natural frequencies and mode shapes for multi-degrees of freedom systems. Vibration measurement and control. Suspensions mounting systems. Road Simulators and wind tunnels. Noise and vibrations standards

2142428 Automotive Diagnostics and Maintenance **2(1-3-2)**

Basic knowledge in Automobile components and its functions; troubleshooting guides, diagnostic tools for automobiles; do-it-yourself car care; knowledge in schedule services, maintenances and repair; defensive driving techniques.

2142433 Failure Analysis and Nondestructive Testing **3(2-3-4)**

Analysis and diagnosis of the causes of failure; physics of failure; concepts of reliability, the use of failure analysis as part of the design process, time based/related failure modes, safety factors; case studies; elimination of failures through proper material selection, treatment and use; case histories; examination of fracture surfaces; laboratory investigations of different failure mechanisms.

2142453 Concept Car Design **3(3-0-6)**

Introduction to concept car design; design process overview; functional objectives; conceptual package development; product benchmarking process; interior system and application; power train anatomy and layout; wheels and tires system; suspension and chassis system; bodies construction design; design integration.

2142461 Automation and Robotics **3(3-0-6)**

Basic automation systems, equipment, sensors, actuators, material handling system, robots and their applications.

2142481* Independent Project I **1(0-2-1)**

Self-study on topics related to automotive engineering with consent of the instructor, the study may be theoretical or experimental in nature

2142481* Independent Project II **1(0-2-1)**

Self-study on topics related to automotive engineering with consent of the instructor, the study may be theoretical or experimental in nature

2142481* Independent Project III **1(0-2-1)**

Self-study on topics related to automotive engineering with consent of the instructor, the study may be theoretical or experimental in nature

2142488 Measurement, Instrumentation and Data Acquisition **3(3-0-6)**

Basic electromechanical techniques used in modern instrumentation and control systems; use of transducers and actuators; signal conditioning, grounding, and shielding; signal processing and feedback control methods with emphasis on frequency domain techniques; low-level measurements; lock-in technique.

2142492 Selected Topics in Automotive Engineering I **3(2-3-4)**

Selected interesting topics in automotive engineering

2142493 Selected Topics in Automotive Engineering II **3(2-3-4)**

Selected interesting topics in automotive engineering.

2142495 Independent Studies **3(0-6-3)**

Self-study on topics related to automotive engineering with consent of the instructor, the study may be theoretical or experimental in nature.

2145421 System Dynamics and Controls **3(3-0-6)**

System dynamics modeling; responses; introduction to control systems; feedback control system characteristics; the performance of feedback control systems; the stability of linear feedback systems; essential principles of feedback; the root locus method; time-domain analysis and design of control systems; frequency response method; stability of the frequency domain and compensation; use of computer in the design of control systems.

2142442 Embedded Systems in Automotive Engineering **3(3-0-6)**

Microprocessor architecture; introduction to embedded systems; programming concepts in C; software engineering practices; buses; device drivers and interrupt; inter-process communication; real-time operating system; hardware/software co-design.

2182444 Power Electronics for Automotive Engineering **3(3-0-6)**

Fundamentals of power electronics. DC-DC converters, DC-AC converters, AC-DC converters. Fundamentals of energy-storage technologies and power converters for EV, HEV and PHEV.

2182445* Battery Design and Management **1(1-0-2)**

Fundamental of electrochemical cells, Battery terminology, Battery components, Lithium-ion battery, Introduction to battery management system (BMS), Equivalent circuit cell model simulation, Battery state of charge (SOC) estimation, Battery state of health (SOH) estimation, Battery pack balancing and power estimation, Thermal model and management of battery

2182446* Process Management and Lean Manufacturing **2(2-0-4)**

Introduction to process management; key techniques and managing approaches commonly used in automotive industry; application and case studies.

2184410* Fundamental of Autonomous Vehicle **1(1-0-2)**

Basic Principles of autonomous driving system; terminology; system architecture; design considerations and safety assessment of autonomous vehicle. Basic demonstration of autonomous vehicle prototype.

2184411* System Dynamics and Controls Project **2(1-3-3)**

Project on system dynamics and controls. For example, simulation of mathematical model of dynamical systems, constructing and evaluation of real-word dynamical system, and construction of control systems with microcontrollers.

2184412* Product Planning and Control **2(2-0-4)**

The role of production planning and control in the manufacturing system; strategic planning of manufacturing systems; demand forecasting; inventory control, planning, scheduling, and control of operation; capacity planning.

2184413* Quality Control and Management For Automotive Industry **2(2-0-4)**

Introduction to metrology and characterization; principles of destructive and nondestructive testing as applied in automotive part manufacturing. concept of quality control, quality improvement, quality assurance, quality management, cost of quality; quality management systems: ISO series; failure mode and effects analysis; basic quality control tools; statistical process control: control charts, process capability analysis, measurement system analysis, acceptance sampling plans.

2190445* Software Engineering for Embedded Systems **3(3-0-6)**

Concept of embedded systems, software development life cycle, requirements gathering, software implementation, testing, software development, project management, software tools.

INFORMATION AND COMMUNICATION ENGINEERING CURRICULUM (INTERNATIONAL PROGRAM)

ICE is a new and exciting integration of Computer Engineering, Electrical Engineering, and Industrial Engineering, key subjects at the very core of Chulalongkorn's Engineering School. You will learn the fundamental of computing, become equipped with skills in communication, and complement all this with a solid grounding in management science. Our combination will prepare you for the many stimulating challenges of the IT world.

The ICE program offers students a chance to become hardcore programmers, serving the international community with IT architecture for enterprises, software on mobile devices, satellite communications, game programming, computer networking, and software engineering, to name but a few. The discipline will be strengthened with training in management science that will heighten your competency to an international level. ICE is your future.

Each student is required to accumulate a minimum of 140 credits to graduate for Bachelor of Engineering Program in Information and Communication Engineering (International Program) which has already includes 2 credits of industrial training and 3 credits of senior project.

Curriculum Board

Atiwong	Suchato	Ph.D. (Massachusetts)
Daricha	Sutivong	Ph.D. (Stanford)
David	Banjerdpongchai	Ph.D. (Stanford)
Charnchai	Pluempitiwiriyawej	Ph.D. (USA)
Proadpran	Punyabukkana	Ph.D. (Claremont)
Chate	Patanothai,	M.Eng. (Miami)
Sirin	Nitinawarat	Ph.D. (Maryland)

Professor

Prabhas	Chongstitvattana,	Ph.D.(Edinburgh)
Parames	Chutima,	Ph.D.(Nottingham

Associate Professors

Computer Engineering

Kultida	Rojviboonchai	Ph.D.(Tokyo)
Vishnu	Kotrajaras	Ph.D.(London)
Chotirat	Ratanamahatana	Ph.D.(California)
Krerk	Piromsopa	Ph.D.(Michigan State)

Electrial Engineering

Chaiyachet	Saivichit,	Ph.D.(London)
Chaodit	Aswakul,	Ph.D.(London)
Charnchai	Pluempitiwiriyawej	Ph.D.(USA)
Lunchakorn	Wuttisittikulkij,	Ph.D.(Essex)

Industrial Engineering

Oran	Kittithreerapronchai	Ph.D.(Georgia)
Wipawee	Thammaphornphilas,	Ph.D.(Pittsburgh)

Assistant Professors

Electrial Engineering

Pasu	Kaewplung,	Ph.D (Tokyo)
Widhyakorn	Asdornwised,	Ph.D.(Chula)

Computer Engineering

Pizzanu	Kanongchaiyos	Ph.D.(Tokyo)
Sukree	Sinthupinyo	Ph.D.(Chula)

Industrial Engineering

Arisara	Jiamsanguanwong	Ph.D.(Tokyo)

Lecturer

Electrial Engineering

Boonchuay	Supmonchai,	M.Eng.(Chula)

Guest lecture

Dechanuchit	Katanyutaveetip	Ph.D.(Chula)

ISE Staffs

Yan	Zhao,	Ph.D.(London)
Aung	Pyae	Ph,D. (Finland)

Manufacturing Engineering Operations Management

Natcha	Thaweesaengsakulthai	Ph.D.(Nottingham)

Curriculum

Total number of credits requirement	133	credits
General Education	30	credits
Core Courses	97	credits
Basic Sciences	27	credits
Compulsory	61	credits
Approved Electives	9	credits
Free Electives	6	credits

1. General Education 30 credits

Social Science	3	credits
Humanity	3	credits
Science and Mathematics	3	credits
Interdisciplinary	3	credits
Foreign Language	12	credits
5501214 Communication and Presentation Skills		3(3-0-6)
5501225 Technical Writing		3(3-0-6)
xxxxxxx General Education (Foreign Language)		3(3-0-6)
xxxxxxx General Education (Foreign Language)		3(3-0-6)
General Education (Special)	6	credits
2140111 Exploring Engineering World		3(3-0-6)
2182205 Probability and Statistics for Data Analysis		3(3-0-6)

2. Core Courses 91 credits

Basic Sciences 27 credits

2301107	Calculus I	3(3-0-6)
2301108	Calculus II	3(3-0-6)
2304153	Physics for Engineers	3(3-0-6)
2304154	Physics and Electronics for Engineers	3(3-0-6)
2304193	Physics Lab. For Engineers	1(0-3-0)
2304194	Physics and Electronics Lab For Engineers	1(0-3-0)
2182202	Advanced Mathematics Methods	3(3-0-6)
2182204	Signals and Linear System	3(3-0-6)
2182214	Electrical Circuit for ICE	3(3-0-6)
2182212	Fundamental of Circuit and Digital Electronics Laboratory	1(0-3-0)
2190200	Discrete Structures	3(3-0-6)

Compulsory Courses 61 credits

2140301	Industrial Training	2(0-12-0)
2143101	Introduction to ICE	3(3-0-6)
2143399	ICE Capstone	3(3-0-6)
2143491	ICE Pre-Project	1(0-2-1)
2143499	ICE project	3(0-6-3)
2182371	Principles of Data Communication	3(3-0-6)
2182372	Principle of Telecommunications	3(3-0-6)
2184301	Eng. Economy and Applications	3(3-0-6)
2190101	Computer Programming	3(3-0-6)
2190103	Advanced Computer Programming	3(3-0-6)
2190222	Fundamental Data Structure and Algorithm	4(3-3-6)
2190250	Computer Architecture and Organization	3(3-0-6)
2190413	System Security	3(3-0-6)
2190426	Database Systems	3(3-0-6)
2190423	Software Engineering	3(3-0-6)
2190472	Netcentric Architecture	3(3-0-6)
2190443	User Interface Design	3(3-0-6)
2190512	Application Development	3(3-0-9)
2190513	Data Science	3(3-0-9)
2190514	Artificial Intelligence	3(3-0-9)
2190516	Technology Management	3(3-0-9)

Approved Electives 9 credits

2143480	Independent Study I	1(0-3-0)
2143423	High Technology Entrepreneurship	3(3-0-6)
2143480	Independent Study I	1(0-3-0)
2143481	Independent Study II	1(0-3-0)
2143482	Independent Study III	1(0-3-0)
2143485	Special Topics in ICE I	2(2-0-4)
2143486	Special Topics in ICE II	2(2-0-4)
2143487	Special Topics in ICE III	2(2-0-4)
2143495	Selected Topics in ICE I	3(3-0-6)
2143497	Selected Topics in ICE II	3(3-0-6)
2143498	Selected Topics in ICE III	3(3-0-6)
2182473	Signal Transmission System	3(3-0-6)
2182475	Tele traffic Engineering and Network Optimization	3(3-0-6)
2184402	Introduction to Stochastic Models	3(3-0-6)
2184403	Theory and Applications of Optimization	3(3-0-6)
2184408	Supply Chain Management	3(3-0-6)
2190479	Graphics Computing	3(3-0-6)
2190517	Software Architecture	3(3-0-9)
2190518	Data Engineering and Big Data	3(3-0-9)
2190519	Natural Language Processing	3(3-0-9)
2190520	Computer Vision	3(3-0-9)
2190521	Cloud Computing	3(3-0-9)
2190523	Game Design	3(3-0-9)
2190524	Embedded Systems Programming	3(3-0-9)

3. Free Electives 6 credits

Select 6 credits from any courses offered in English by any International Programs in Chulalongkorn University.

INFORMATION AND COMMUNICATION
ENGINEERING CURRICULUM
(INTERNATIONAL PROGRAM)

OURSE NO.	SUBJECT	CREDITS
	FIRST SEMESTER	
2140111	Exploring Engineering World	3
2190101	Computer Programming	3
2301107	Calculus I	3
2304153	Physics for Engineers	3
2304193	Physics Laboratory for Engineers	1
xxxxxxx	General Education (Foreign Language)	3
xxxxxxx	General Education	3
		19
	SECOND SEMESTER	
2143101	Introduction to ICE	3
2182205	Probability and Statistics for Data Analysis	3
2190103	Advanced Computer Programming	3
2301108	Calculus II	3
2304154	Physics and Electronics for Engineers	3
2304194	Physics and Electronics Laboratory for Engineers	1
xxxxxxx	General Education (Foreign Language)	3
		19
	THIRD SEMESTER	
2182202	Advanced Mathematics Methods	3
2182214	Electrical Circuit for ICE	3
2182212	Fundamental of Circuit and Digital Electronics Lab	1
2190200	Discrete Structure	3
2190222	Fundamental Data Structure and Algorithm	4
2190513	Data Science	3
		17
	FOURTH SEMESTER	
2182204	Signals and Linear Systems	3
2190512	Application Development	3
2190514	Artificial Intelligence	3
5501214	Communication and Presentation Skills	3
xxxxxxx	General Education	3
xxxxxxx	Free Elective	3
		18

COURSE NO.	SUBJECT	CREDITS
	FIFTH SEMESTER	
2190250	Computer Architecture and Organization	3
2190423	User Interface Design	3
2182372	Principles of Telecommunications	3
2184301	Engineering Economy and Applications	3
2190472	Netcentric Architecture	3
xxxxxxx	Approved Elective	3
		18
	SIXTH SEMESTER	
2143399	ICE Capstone	3
2182371	Principles of Data Communication	3
2190426	Database Systems	3
2190423	Software Engineering	3
2190413	System Security	3
5501225	Technical Writing	3
		18
	SUMMER SEMESTER	
2140301	Industrial Training	2
		2
	SEVENTH SEMESTER	
2143491	ICE Pre-project	1
xxxxxxx	Approved Elective	6
xxxxxxx	Free Elective	3
		10
	EIGHTH SEMESTER	
2143499	ICE Project	3
2190516	Technology Management	3
xxxxxxx	General Education	6
		12
	TOTAL CREDITS FOR GRADUATION	**133**

COURSES DESCRIPTIONS IN INFORMATION AND COMMUNICATION ENGINEERING CURRICULUM (B.ENG)

General Education

2140111 Exploring Engineering World 3(3-0-6)

Engineering topics related to daily life: energy, resources, environment manufacturing, process, industry, material, automotive, infrastructure, information system and bio engineering.

2182205 Probability and Statistics for Data Analysis 3(3-0-6)

Basic probability concepts including independent events, conditional probability, and total probability theorem. Discrete and continuous random variables including probability distribution functions, expected value, variance, and moments. Joint distribution functions including covariance, law of large numbers, and central limit
theorem. Descriptive statistics and statistical inferences including point and interval estimations, hypothesis testing and regression analysis. Using MATLAB and Excel programs for statistical analysis, which are essential tools for data analysis, problem solving, and decision-making processes for various fields.

5501214 Communication and Presentation Skills 3(3-0-6)

Practice using English for social communication and giving oral presentation on engineering related topics.

5501225 Technical Writing 3(3-0-6)

Practice in writing summaries composing different types and styles of writing in the field of engineering and writing reports of studies and experiments.

Core Course

2301107 Calculus 1 3(3-0-6)

Limit, continuity, differentiation and integration of real variable and their applications; techniques of integration; improper integrals.

2301108 Calculus 2 3(3-0-6)
CONDITION: PRER 2301107

Mathematical induction; sequences and series of real numbers; Taylor series expansion and approximation of elementary functions; numerical integration; vectors, lines and planes in three-dimensional space; calculus of vector valued functions of one variable; calculus of real valued functions of two variables; introduction to differential equations and their applications.

2304153 Physics for Engineers 3(3-0-6)

Mechanics of particles and rigid bodies; properties of matter; fluid mechanics; heat; vibrations and waves; elements of electromagnetism; optics; modern physics.

2304154 Physics and Electronics for Engineers 3(3-0-6)

Electricity DC circuits; AC circuits; basic electronics; electrical actuators.

2304193 Physics Laboratory for Engineers 1(0-3-6) Measurement and precision; experiments on simple harmonic motion; radius of gyration; dynamics of rotation; velocity of sound; viscosity of fluids.

2304194 Physics and Electronics Laboratory for Engineers 3(3-0-6)

Resistance and electromotive force measurements; experiments on ammeter; voltmeter; oscilloscope; AC circuit; transistor; lenses and mirrors; polarization; interference; diffraction.

2190200 Discrete Structures 3(3-0-6)

Sets, relations, functions, theorem and proof; combinatorics; counting, principle of inclusion exclusion, recurrent relations, generating functions; graphs and trees; introduction to number theory.

2182202 Advanced Mathematics Methods 3(3-0-6)
CONDITION: PRER 2301108

Complex functions, analytic functions, Cauchy integral theorem, Laurent series, Residue theorem, solving linear systems by row reduction of a matrix, inverse matrices and determinants, rowspace and columnspace of a matrix, rank and nullity, change of basis, linear transformations, orthonormal bases and the Gram-Schmidt process, eigenvectors and eigenvalues, diagonalization of a matrix. First-order ODE, Second-order ODE, Higher-order linear ODE.

2182204 Signals and Linear Systems 3(3-0-6))

Basic circuit elements: resistor, capacitor, inductor, diode and transistor; Kirchhoff's laws; node and mesh analysis; DC and AC circuit analysis; Thevenin's and Norton's theorem; logic and digital circuits.

2182214 Electrical Circuit for ICE 3(3-0-6)

Basic circuit elements: resistor, capacitor, inductor, diode and transistor; Kirchhoff's laws; node and mesh analysis; DC and AC circuit analysis; Thevenin's and Norton's theorem; logic and digital circuits.

2182212 Fundamental of Circuit and Digital Electronics Laboratory 3(3-0-6)
CONDITION: COREQ 2182214 or consent from instructor

Electronic instruments: multimeter, oscilloscope, DC circuit, voltage regulators, filter circuit, transistor amplifier circuit, digital circuits.

Compulsory Courses

2140301 Industrial Training 2(0-12-0)

Engineering practice in related areas under supervision of experienced engineers in private sectors or government agencies.

2143101 Introduction to ICE 3(3-0-6)

Fundamentals of computer and telecommunication concepts for information systems; technology and trends underlying current and future uses of information and communication technology; Introduction to engineering management including important aspects of management science; real-world experience sharing and tools related to each topic.

2190101 Computer Programming 3(3-0-6)

Introduction to computer systems; problem-solving using computers; programming in high-level languages; program structure, programming style and convention; control statements, data handling and processing; subprograms; classes and objects.

2190222 Fundamental Data Structure and Algorithm 4(3-3-6)
CONDITION: PRER 2190101

Introduction to computer systems; problem-solving using computers; programming in high-level languages; program structure, programming style and convention; control statements, data handling and processing; subprograms; classes and objects.

2143399 Information and Communication Engineering Capstone 3(3-0-6)

Culminating and applying of knowledge to develop information and communication systems using design thinking; developing a software starting from gathering all the needs of the system to its application under the instructor's supervision; peer collaboration; giving presentations.

2143491 Information and Communication Engineering Pre-project 1(0-2-1)

Specifying topics or problems, scope, problem-solving methodologies and expected benefits from projects on information and communication engineering

2143499 ICE Project 3(3-0-6)
CONDITION: PRER 2143491

Group or individual projects on a subject related to information and communication engineering.

2182371 Principles of Data Communication 3(3-0-6)

Introduction to data communication and networking: layer modeling protocols and architectural network (OSI vs. TCP/IP); basic data transmission, physical layer transmission, data link layer protocols, Network layer protocols, standardization, IPbased network protocols; transport layer: Recap on TCP vs UDP, performance analysis, quality of service, congestion management.

2182372 Principles of Telecommunications 3(3-0-6)

Introduction to telecommunications; overview of digital communication systems; signal and noise analysis; PCM encoding: Nyquist's sampling theorem, quantization and companding; digital baseband systems: NRZ, RZ, bi-phase, bipolar RZ, AMI; digital bandpass systems: ASK, PSK, FSK, MSK and QAM; information theory: entropy, source and channel models, channel capacity, Shannon's theorem and introduction to source coding, error detection/correction codes; overviews of cellular mobile phone networks, optical networks, Internet and satellite systems; introduction to radio propagation in wireless communications.

2184301 Engineering Economy and Applications 3(3-0-6)

Interest calculation; time value of money; equivalent value and rate of return; project analysis and evaluation; break-even point; sensitivity analysis; decisions under risk and uncertainty; economic life and replacement analysis.

2190103 Advanced Computer Programming 3(2-3-6)
CONDITION: PRER 2190101

Concepts and practice of object-oriented programming; usage of design patterns in object-oriented programming; programming in application development frameworks: graphical user interface and event- driven programming, collection framework, concurrent programming, socket programming, and/or frameworks of contemporary interest; hands- on practice in developing application software through the application of development frameworks.

2190250 Computer Architecture and Organization 3(3-0-6)

Computer evolution and performance; computer structure, function, and interconnection; memory hierarchy; cache memory; virtual memory; storage; input/output; operating system support; process; interrupt; system call; instruction set; processor structure and function; RISC vs CISC; pipelining; superscalar processors; multi-core computers.

2190426 Database Systems 2(2-0-4)

Database management system concepts, terminology, and architecture; entityrelationship modeling; database design and implementation; relational data model; relational algebra and calculus; SQL; functional dependencies and normalization; indexing; non-relational databases

2190423 Software Engineering 3(3-0-6)

Systems development life cycle; systems development methodologies; software project management; requirements determination and analysis; business process and functional modeling; structural modeling; behavioral modeling; verification and validation; human-computer interaction design; software testing.

2190443 User Interface Design 3(3-0-6)

Human-computer interaction concepts; HCI guidelines; HCI theories; design steps; evaluation; future of HCI; HCI for immersive technologies.

2190472 Netcentric Architecture 3(3-0-6)
CONDITION: PRER 2190101

TCP/IP architecture; application layer: principles of network applications, File Transfer Protocol (FTP), electronic mail, Domain Name Systems (DNS), web caching, Content Distribution Networks (CDN) through multimedia, peer-to- peer applications, socket programming, client- server model, peer- to- peer model; transport layer: User Datagram Protocol (UDP) , reliable data transfer protocols, Transmission Control Protocol (TCP) , principles of congestion control; network layer: virtual circuit and datagram networks, internet Protocol (IP) , routing in the Internet; multimedia networking: streaming stored audio and video, protocols for real-time interactive applications; security in computer networks.

2190513 Data Science 3(3-0-9)
CONDITION: PRER 2190101, 2182205

Data science definition; data science pipeline; data preparation; exploratory data analysis; statistical analysis; model development; model evaluation; data visualization.

2190512 Application Development 3(3-0-9)

Full-stack development from backend to frontend. Modern backend development tools; data analysis. Current database tools. Well-known frontend development framework for web and mobile applications. Hands-on practice in all levels of software application development.

2190413 System Security 3(3-0-6)

Principles of security and privacy, authentication, authorization, auditing, confidentiality, integrity, availability, fundamental of cryptography, network security, secure software design, penetration test, interdisciplinary in cybersecurity.

2190514 Artificial Intelligence 3(3-0-9)

Search; evolutionary algorithms; K-mean clustering; regression analysis; naïve Bayes; Gaussian mixture models; expectation maximization; dimensionality reduction; support vector machines; deep neural networks.

2190516 Technology Management 3(3-0-9)

Classification of technology; Investment in technology; technology strategy; technology adoption; technology management framework: identification, selection, acquisition, exploitation, protection; concept proof tool; technology roadmap.

Approved Elective

2143423 High Technology Entrepreneurship 3(3-0-6)

Establishing technological or new businesses based on knowledge in technology and innovation, starting from basic ideas to ideas that can be implemented in terms of business; project analysis in terms of technical and business readiness, setting up business plan to prepare to investors who are interested; use of problem-based teaching to achieve results and exchange knowledge among all segments involved.

2143480 Independent Study I 1(0-3-0)

Independent study and investigation in topics related to information and communication engineering under the supervision of an instructor.

2143481 Independent Study II 1(0-3-0) Independent study and investigation in topics related to information and communication engineering under the supervision of an instructor.

2143482 Independent Study III 1(0-3-0)

Independent study and investigation in topics related to information and communication engineering under the supervision of an instructor.

2143485 Special Topics in ICE I 2(2-0-4)

Review and discussion of special topics in information and communication engineering

2143486 Special Topics in ICE II 2(2-0-4)

Review and discussion of special topics in information and communication engineering

2143487 Special Topics in ICE III 2(2-0-4)

Review and discussion of special topics in information and communication engineering.

2143495 Selected Topics in ICE I **3(3-0-6)**

Topics of current interest and in new developments in information and communication engineering

2143497 Selected Topics in ICE II **3(3-0-6)**

Topics of current interest and in new developments in information and communication engineering

2143498 Selected Topics in ICE III **3(3-0-6)**

Topics of current interest and in new developments in information and communication engineering

2182475 Teletraffic Engineering and Network Optimization **3(3-0-6)**

Teletraffic engineering overview; quality of service and network performance optimization; classification of teletraffic engineering systems and teletraffic parameters; teletraffic data collection techniques and statistics; modeling of non- queuing/ loss- type system and queuing/ delay- type system; modeling of system with mobile users; fundamentals of modeling network of by computer program ; simulation program; real-time network management and long-term network planning; application of optimization techniques in network controls; case studies in network design.

2184402 Introduction to Stochastic Models **3(3-0-6)**

Unconditional and conditional probability; discrete and continuous random variables; moments; Poisson processes; discrete time Markov chain and applications; stochastic analysis and modeling.distributed transaction under failure conditions; security; distributed services.

2184403 Theory and Applications of Optimization **3(3-0-6)**

Introduction to theory, algorithms, and applications of optimization; optimization methodologies: linear programming, network optimization, and integer programming.

2184408 Supply Chain Management **3(3-0-6)**

Definition of supply chain; coordination difficulties; pitfalls and opportunities in supply chain management; inventory/ service level tradeoffs; performance measurement and incentive; extensive supply chain management; mass customization; supplier management; design and redesign of products and process for supply chain management; analytical tools; industrial applications; current industry initiatives.

2190473 Ubiquitous Computing and Networking **3(3-0-6)**

Introduction to ubiquitous computing, overview and basic terminologies; visions and fundamental challenges; wireless MACs; mobile IP; wirelessad hoc networks; wireless sensor networks; programming wireless networks of embedded systems; adaptive topology; time synchronization; localization; IPv6; internet of things; energy saving; smart grid.

2190479 Graphics Computing **3(3-0-6)**

Hierarchy of graphics software, use of graphics API: simple color models (RGB, HSB, CMYK) ; homogeneous coordinates, affine transformations: scaling, rotation and translation; viewing transformation clipping, raster and vector graphics system.

2190517 Software Architecture **3(3-0-9)**
CONDITION: PRER 2190426, 2190423

Principles of software architectures; architectural styles; architectural description language; software architectural analysis and design; software architecture specification tools; software architecture- based testing; use of software architectures in the software development process; software design pattern; continuous Integration and continuous delivery.

2190518 Data Engineering and Big Data **3(3-0-9)**
CONDITION: PRER 2190101

Data gathering and cleansing; data modeling; data ingestion; structured and unstructured data stores; big data platform; workflow management.

2190519 Computer Vision **3(3-0-9)**

Digital image formation and representation; image enhancement; feature detection; color; texture; image segmentation; object recognition; deep learning for computer vision; object detection; 3D vision; dynamic vision; vision- based application development and deployment.

2190521 Cloud Computing **3(3-0-9)**
CONDITION: PRER 2190472, 2190250

Definition and benefits of cloud computing; cloud migration; infrastructure-as-aservice; platform- as- a-service; storage- as- a- service; auto- scaling and service availability; virtualization technologies and software-defined networks for cloud; cloud security

2190523 Game Design **3(3-0-9)**

Player psychology; brainstorming techniques; Game Elements and Game Development Process; Playtesting and Game Balancing; Principles of Puzzle Design; Level Design; User Interface Design; Game Community

2190524 Embedded Systems Programming **3(3-0-9)**

Limitations of embedded processors; embedded software development environment; reading and writing digital I/O; configuring timers/counters, analog to digital converter and communication modules: SPI, I2C, WiFi,

Bluetooth; real-time operating system: multitask programming, inter- process communication; power management for optimization of performance and power consumption; interrupt service routines; configuring security modules; secured communication.

AEROSPACE ENGINEERING CURRICULUM
(INTERNATIONAL PROGRAM)

Aerospace engineers play an invaluable role in the development of modern aircraft and spacecraft. Ever since the advent of the first flying machines, new technologies have propelled us faster, further and more efficiently than ever before. Today there is an ever-increasing need for human resources with the capability to not only repair, maintain and construct today's aircraft, but also to look to the future and design those of tomorrow.

Global air travel is expanding at an unprecedented pace, prompting the foundation of many new commercial airlines in Southeast Asia. What's more, only aerospace engineers can provide the necessary innovation to advance strategic defence and satellite technologies. At a time when the big players in space travel are looking to set up lunar bases and manned missions to Mars, aerospace engineers are in high demand. Our AERO curriculum, developed by a collaboration of Chulalongkorn University with the Royal Thai Air Force, is tailor-made to meet this new hunger for aerospace expertise. Are you a high flyer?

Each student is required to accumulate a minimum of 139 credits to graduate for Bachelor of Engineering Program in Aerospace Engineering (International Program) which also includes 2 credits of industrial training and 3 credits of senior project.

Curriculum board

Joshua	Staubs	Ph.D.(Virginia)
Niphon	Wansophark,	D.Eng.(Chula)
Tawan	Papapote	Ph.D.(Lllinois)
Pinunta	Rojratsirikul	Ph.D.(Bath, UK)
Pitaakphong	Pattanagraikanakorn	Ph.D.(Delft)

Professors

Electrical Engineering

Pramote	Dechaumphai,	Ph.D.(USA)

Associate Professors

Mechanical Engineering

Asi	Bunyajitradulya	Ph.D.(UC.Lrvine)
Kuntinee	Maneeratana	Ph.D.(London)
Niphon	Wansophark,	D.Eng.(Chula)
Nopdanai	Ajavakom	Ph.D.(UC Berkeley)
Alongkorn	Pimpin,	Ph.D.(Tokyo)
Thanyarat	Singhanart	Ph.D.(Tokyo)

Metallurgical Engineering

Seksak	Asavavisithchai	Ph.D.(Nottingham)

Electrical Engineering

Thavatchai	Tayjasanant	Ph.D.(Alberta)

Assistant Professors

Mechanical Engineering

Tawan Paphapote	Ph.D.C.(USA)

Lecturer

ISE Staffs

Prabhath	De Silva	Ph.D.(USA)
Pinunta	Rojratsirikul	Ph.D.(Bath, UK)
Joshua	Staubs	Ph.D.(Virginia)
Pitaakphong	Pattanagraikanakorn	Ph.D.(Delft)

Guest Lecturer

Boonchai	Watjatrakul	Ph.D. (Cranfield)
Jeerasak	Pitakarnnop	Ph.D.(France)
Wicha	Mektrakran	B.Eng(USA)

Curriculum

Total number of credits requirement	136	credits
General Education	30	credits
Core Courses	100	credits
Basic Sciences	18	credits
Basic Engineering	23	credits
Compulsory	53	credits
Approved Electives	6	credits
Free Electives	6	credits

1. General Education 30 credits

Social Science	3	credits
Humanity	3	credits
Science and Mathematics	3	credits
Interdisciplinary	3	credits
Foreign Language	12	credits

XXXXXX	General Education (Foreign Language)	6	credits
5501214	Communication/Presentation	3	3(3-0-6)
5501225	Technical Writing	3	3(3-0-6)

General Education (Special)		6	credits
2140111	Exploring Engineering World	3	3(3-0-6)
2145211	Introduction to Aerospace Engineering	3	3(3-0-6)

2. Core Courses 100 credits

Basic Sciences 18 credits

2301107	Calculus I	3(3-0-6)
2301108	Calculus II	3(3-0-6)
2302103	General Chemistry Laboratory	1(0-3-0)
2302105	Chemistry for Engineers	3(3-0-6)
2304153	Physics for Engineers	3(3-0-6)
2304154	Physics and Electronics for Engineers	3(3-0-6)
2304193	Physics Laboratory for Engineers	1(0-3-0)
2304194	Physics and Electronics Laboratory for Engineers	1(0-3-0)

Basic Engineering 23 credits

2140301	Industrial Training	2(0-6-0)
2182203	Probability and Statistics For Engineers	3(3-0-6)
2183102	Computer Aided Design for Engineers	3(2-3-4)
2183211	Engineering Mechanics	4(4-0-8)
2183231	Dynamics	3(3-0-6)
2145218*	Scientific Programming	2(2-0-4)
2301215	Multivariable Calculus	3(3-0-6)
2301216	Linear Algebra and Differential Equations	3(3-0-6)

Compulsory 53 credits

2145221	Introduction to Aircraft Design	1(1-0-4)
2145311	Aerodynamics I	3(3-0-6)
2145312	Aerodynamics II	3(3-0-6)
2145326	Aircraft Structure	3(3-0-6)
2145328	Aircraft Stability and Control	3(3-0-6)
2145327	Aircraft Performance	3(3-0-6)
2145427*	Electronics for Aerospace Engineering	2(1-3-2)
2145365*	Experiment Aerospace Engineering	2(1-3-2)
2145329	Aircraft Propulsion	3(3-0-6)
2145461	Aircraft Design	3(3-0-6)
2145475*	Aerospace Engineering Project I	2(0-3-3)
2145476*	Aerospace Engineering Project I	3(0-6-3)
2183221	Thermodynamics	3(3-0-6)
2183222	Fluid Mechanics	3(3-0-6)
2183381	Numerical Methods for Engineers	3(3-0-6)
2145453	Materials for Aerospace Engineering	3(3-0-6)
2145473	Rocket Propulsion	2(2-0-4)
2145493	Introduction to space environment And space mission	2(2-0-4)

AI & Big Data 3 credits

2100201*	Introduction to Artificial Intelligence	3(2-2-5)
2140200*	Exploratory Data Analysis and Visualization	3(3-0-6)

Interdisciplinary & 21st Century Skills 3 credits

2100223*	Introduction to Artificial Intelligence	3(2-2-5)
2100224*	Technopreneurship	3(3-0-6)
2100225*	Design Thinking Principle	3(3-0-6)
2100226*	Problem Solving Principle	3(3-0-6)

Approved Electives 6 credits

2145421	Introduction to Computational Fluid Dynamics	3(3-0-6)
2145422	Gas Dynamics	3(3-0-6)
2142352	Finite Element Methods and Applications	3(3-0-6)
2145460	Aircraft Repair Philosophy	3(3-0-6)
2145471	Flight Experience	3(2-3-4)
2135481	Introduction to Unmanned Aerial Vehicles (UAV)	3(3-0-6)
2142433	Failure Analysis and NDT	3(3-0-6)
2145440	Airframe Structure and Systems	3(3-0-6)
2183321	Heat Transfer	3(3-0-6)
2184407	Quality Design and Innovation Management	3(3-0-6)
2145420	Avionics	3(3-0-6)
2145492	Unmanned Aerial Vehicles Flight Operation and Certification	3(3-0-6)

2145494	Advanced Unmanned Aerial Vehicles	3(2-2-5)
2145462	Topics in Aerospace Engineering I	3(3-0-6)
2145463	Topics in Aerospace Engineering II	3(3-0-6)
2145465	Topics in Engineering I	3(3-0-6)
2145466	Topics in Engineering II	3(3-0-6)
2145480	Topics and Projects in Aerospace Industry I	3(2-3-4)
2145482	Topics and Projects in Aerospace Industry II	3(2-3-4)
2145483	Topics and Projects in Aerospace Industry III	3(2-3-4)
2145484	Topics and Projects in Aerospace Industry IV	3(2-3-4)
2145485	Topics and projects in Aerospace Engineering I	3(2-3-4)
2145486	Topics and projects in Aerospace Engineering II	3(2-3-4)
2145495	Independent Studies	3(0-6-3)

3. Free Electives **6 credits**

Any two subjects at the university level that are taught in English

AEROSPACE ENGINEERING CIRRICULUM
(INTERNATIONAL PROGRAM)

(B.ENG)

OURSE NO.	SUBJECT	CREDITS
	FIRST SEMESTER	
2183102*	Computer Aided Design for Engineers	3
2145211	Introduction to Aerospace Engineering	3
2301107	Calculus I	3
2304153	Physics for Engineers	3
2304193	Physics Laboratory for Engineers	1
5501112	Communicative English I	3
		16
	SECOND SEMESTER	
2145221	Introduction to Aircraft Design	1
2140111	Exploring Engineering World	3
2301108	Calculus II	3
2302103	General Chemistry Laboratory	1
2302105	Chemistry for Engineers	3
2304154	Physics and Electronics for Engineers	3
2304194	Physics and Electronics Laboratory for Engineers	1
5501125	Technical Writing	3
		18
	THIRD SEMESTER	
2145218*	Scientific Programming	3
2183211	Engineering Mechanics	4
2183221	Thermodynamics	3
2301215	Multivariable Calculus	3
2301216	Linear Algebra and Differential Equations	3
XXXXXX	General Education (Foreign Language)	3
		19
	FOURTH SEMESTER	
2182203	Probability and Statistics for Engineers	3
2183222	Fluid Mechanics	3
2183231	Dynamics	3
2183381	Numerical Methods for Engineers	3
XXXXXX	Interdisciplinary & 21st Century Skills	3
XXXXXX	General Education (Foreign Language)	3
		18

COURSE NO.	SUBJECT	CREDITS
	FIFTH SEMESTER	
2145311	Aerodynamics I	3
2145326	Aircraft Structure	3
2145427*	Electronics for Aerospace Engineering	2
2145327	Aircraft Performance	3
2145453	Materials for Aerospace Engineering	3
xxxxxxx	General Education	3
		17
	SIXTH SEMESTER	
2145312	Aerodynamics II	3
2145328	Aircraft Stability and Control	3
2145365*	Experiments in Aerospace Engineering	2
2145329	Aircraft Propulsion	3
xxxxxxx	Free Elective	3
xxxxxxx	General Education	3
		17
	SUMMER SEMESTER	
2140301	Industrial Training	2
		2
	SEVENTH SEMESTER	
2145475*	Aerospace Engineering Project I	2
2145461	Aircraft Design	3
xxxxxxx	Approved Elective	3
xxxxxxx	Approved Elective	3
xxxxxxx	General Education	3
xxxxxxx	AI & Big Data	3
		17
	EIGTHTH SEMESTER	
2145473	Rocket Propulsion	2
2145476*	Aerospace Engineering Project II	3
2145493	Space Environment and Space mission	2
xxxxxxx	Free Elective	3
xxxxxxx	General Education	3
		13

TOTAL CREDITS FOR GRADUATION **136**

COURSES DESCRIPTIONS IN AEROSPACE ENGINEERING (B.ENG)

1. General Education

Foreign Language

5501214 Communication and Presentation Skills 3(3-0-6)
CONDITION: PRER 5501123

Practice using English for social communication and giving oral presentation on engineering-related topics.

5501225 Technical Writing 3(3-0-6)
CONDITION: PRER 5501123

Students are to practice extensive academic writing at paragraph level. Selected readings in the related field are included. More discussion and presentation skills are to be taught including listening input.

General Education (Special)

2140111 Exploring Engineering World 3(3-0-6)

Engineering solutions to the 21st century problems, fundamental skill and tools in engineering; design thinking process; problem solving skill; introduction to data science, product design, ecological and pollution management and disaster mitigation, innovation business idea development; feasibility analysis, project planning, business idea presentation.

2145211 Introduction to Aerospace Engineering 3(3-0-6)

Overview of aerospace engineering with a focus on using group projects to enhance critical thinking and problem solving applied to aerospace engineering related problems; group projects will facilitate creativity in solving complex problems, as well as communication and collaboration between students; introductory aerodynamics including lift, drag and the standard atmosphere; aircraft performance, stability, and control; propulsion; structures; rocket and spacecraft trajectories and orbits; introduction to unmanned aerial vehicles and applications of artificial intelligence in autonomous flight.

2. Core Courses

Basic Sciences

2301107 Calculus I 3(3-0-6)

Limit, continuity, differentiation and integration of real-valued functions of a real variable and their applications; techniques of integration; improper integrals

2301108 Calculus II 3(3-0-6)
CONDITION: PRER 2301107

Mathematical induction; sequences and series of real numbers; Taylor series expansion and approximation of elementary functions; numerical integration; vectors, lines and planes in three-dimensional space; calculus of vector valued functions of one variable; calculus of real valued functions of two variables; introduction to differential equations and their applications.

2302103 General Chemistry Laboratory 1(0-3-0)

Standard solution preparation; qualitative analysis; titration; electrochemistry; pH metric titration; spectroscopy; calculation and evaluation of data; calibration curve; introduction to polymer.

2302105 Chemistry for Engineers 3(3-0-6)

Stoichiometry and basis of the atomic theory; properties of the three states of matter and solution; thermodynamics; chemical equilibrium; Oxidation; chemical kinetics; the electronic structures of atoms and the chemical bond; periodic table; nonmetal and transition metal.

2142153 Physics for Engineers 3(3-0-6)

Mechanics of particles and rigid bodies, properties of matter, fluid mechanics, heat, vibrations and waves, elements of electromagnetism, optics, modern physics.

2304154 Physics and Electronics for Engineers 3(3-0-6)

Electricity; DC circuit; AC circuit; basic electronics; solid state devices; electrical actuators.

2304193 Physics Laboratory for Engineers 1(0-3-0)

Measurement and precision; experiments on simple harmonic motion, radius of gyration, dynamics of rotation, velocity of sound, viscosity of fluids.

2304194 Physics and Electronics Laboratory for Engineers PHYS ELEC LAB ENGS 1(0-3-0)

Resistance and electromotive force measurements; experiments on amp meter, voltmeter, oscilloscope, AC circuit, transistor, lenses and mirrors, polarization, interference, diffraction.

Compulsory Courses

2140301 Industrial Training 2(0-6-0)

Engineering practice in related areas under supervision of experienced engineers in private sectors or government agencies.

2182203 Probability and Statistics for Engineers 3(3-0-6)
CONDITION: PRER 2301108

Engineering basis in statistics and probability; discrete and continuous probability distribution; joint probability distribution; parameter estimation: estimator, bias, consistency; point estimation; interval estimation; engineering applications in measurement and uncertainty, linear regression, introduction to random process; integration of statistics in engineering applications; case studies.

2183102 Computer Aided Design for Engineers 3(2-3-4)

Introductory course in computer aided drafting/design; basic CAD commands, tools, multi view drawing and dimensioning techniques; sketching; solid modeling; engineering drawings; assembly model ling;

parametric curves and surfaces; rotation, translation, scaling, and projection matrices

2183211 Engineering Mechanics 4(4-0-8)

Analysis of force systems and their equilibrium as applied to engineering systems; stresses and strains; mechanical properties of materials; Hooke's law, elastic modulus, stress in beam, shear force, bending moment diagram, torsion, buckling of columns, Mohr's circle.

2183231 Dynamics 3(3-0-6)

Kinematics of three-dimensional curvilinear motion of a particle; kinetics of a particle: force and acceleration, work and energy, impulse and momentum; kinematics of planar motion of a rigid body: force and acceleration, work and energy, impulse and momentum; introduction to kinematics and kinetics of three-dimensional motion of a rigid body.

2145218* Scientific Programming 2(2-0-4)

Introduction to the concept of programming using a high-level language, focusing on Visual Basic in Excel and MATLAB. The topic includes variable types, mathematics computation, simple I O, conditional and repetitive control structures, function, arrays, and symbolic computing, the procedure of running, testing, and debugging the computer code, Fundamental of data visualization, data analytics.

2301215 Multivariable Calculus 3(3-0-6)
CONDITION: PRER 2301108

Vector; curves, planes and surfaces; derivatives of vector-valued functions; partial, total and directional derivatives; implicit differentiation; maxima-minima; gradient, divergence, curl; scalar and vector fields; line integral; surface integral and volume integral; integral theorems of vector analysis.

2301216 Linear Algebra and Differential Equations 3(3-0-6)
CONDITION: PRER 2301108

System of linear algebraic equations; linear spaces; inner products; eigenvalues and eigenvectors; principal axis theorem; higher-order linear differential equations; method of variation of parameters; system of first-order linear differential equations; qualitative analysis and dynamical system.

2145221 Introduction to Aircraft Design 1(1-0-4)

I Introduction to aerospace design methodology and system engineering with a focus on systematic and critical thinking skill; Group design projects based on real world p roblems to enhance creat ivity, team communication, collaboration; fundamental to aircraft systems; requirements discovery and analysis process; introduction to elements of aerodynamic, airfoi ls, and wings, aspect of vehicle conceptual design; configuration s section; aircraft initial sizing; introduction to novel aerospace design concept such as unmanned aerial v ehicles, urban airmobility vehicle, and integration of artificial intelligence in modern aerospace design.

2145311 Aerodynamics I 3(3-0-6)
CONDITION: PRER 2183222

Atmosphere and properties of air; airfoil geometry; aerodynamic forces; stream function; vorticity and circulation; elementary flows; incompressible flow over aerofoils; irrotational flow; lifting flow; the Kutta Joukowski theorem; Kutta condition; Kelvin's circulation theorem and starting vortex; thin aerofoil theory; flapped aerofoil; thick cambered aerofoil; maximum lift coefficient a nd stall; high lift devices; incompressible flow over finite wings; Prandtl's lifting line theory; elliptical and general lift distribution; fundamental of viscous flow; conservation of mass and continuity equation; conservation of momentum and momentum equation; boundary layers; flow instabilities; turbulence

2145312 Aerodynamics II 3(3-0-6)
AERODYNAMICS II
CONDITION: PRER 2183221 and 2145311

Fundamental of compressible flow, acoustic waves, normal and oblique shock waves, expansion waves, Prandtl-Meyer flow, convergent-divergent nozzle, flow with friction and heat transfer, unsteady wave motion, perturbation theory, linearized flow and theory of characteristics.

2145326 Aircraft Structure 3(3-0-6)

Overview of aircraft structural external loads analysis including criteria, design, analysis, fatigue, certification, validation, and testing. Covers FAR 23 and FAR 25 airplane loads requirements. Includes introduction to the use of finite element package in structural analysis. Course will provide students with an understanding of fuselage/wing design and analysis including frames and ribs. Also provides an introduction to structural dynamics including aeroelasticity.

2145328 Aircraft Stability and Control 3(3-0-6)

Equilibrium and stability; functions of aircraft controls; static stability and trim; stability derivatives for longitudinal motions; stick-fixed, stick-free and control stick forces; wing and tail contributions; maneuver stability; roll stability and roll control; yaw stability and yaw control; dynamic behavior of aircraft and equations of motion; phugoid and short period oscillation; Dutch roll; spiral mode and roll subsidence; dihedral effect and weathercock stability

2145327 Aircraft Performance 3(3-0-6)

Principles of jet and propeller aircraft performance; equations of motions; cruise flight, climb and descent; turning flight; takeoff and landing performance; range and endurance; payload-range diagram; maneuvering V-n diagram.

2145427* Electronics for Aerospace Engineering 2(1-3-2)

Introduction to electronics and sensors used in aerospace engineering applications; basic electronics circuits involving analog components; design electronic

circuits for amplifying, detecting, timing, etc; introduction to computer- based data acquisition.

2145365* Experiment in Aerospace Engineering 2(1-3-2)

Concepts in experimentation introduction to systematic design of an experiment using data reduction diagram (DRD); setting up objectives of an experiment, constructing the set of data reduction diagrams DRDs) of the experiment according to the objectives; measurement and instrumentation; uncertainty analysis; experiments and laboratories in aerodynamics, structure, propulsion, performance, dynamics, and control.

2145329 Aircraft Propulsion 3(3-0-6)
CONDITION: PRER 2183221 and 2183222

Introduction to propulsion, air-breathing and non-air-breathing engines; brief review of the thermodynamics and compressible flow; basic thrust equation of aircraft gas turbine and jet engines; Brayton cycle, axial flow turbomachines, momentum theory and blade element theory; gas turbine component performance, inlet, compressor, turbine and nozzle; cycle analysis of gas turbine engines, rocket, ramjet, turbojet, turbofan and turboprop covering introduction to preliminary propulsion design

2145461 Aircraft Design 3(3-0-6)

Fundamentals of aircraft design process including wing design, tail design, and undercarriage arrangement. Also covers initial take-off mass estimation, detailed mass calculation, and mission fuel requirement. Incorporates principles from prior aerospace engineering courses including center of gravity calculation, basic aerodynamics estimation, static stability and control analysis, propulsion consideration and analysis, performance analysis, aircraft cost prediction, preliminary and detailed design concepts, quality control of aircraft design.

2145475* Aerospace Engineering Project I 2(0-3-3)

Design project of aerospace systems, components, and/or processes to meet a desired need with consideration of public health, safety, and welfare, as well as global, cultural, social, environment al, and economic factors; follow a well defined design process by working on a team; project identification, selection, and team formation, definition of project including specifications and background research; project planning and definition of tasks; comprehensive literature review; preliminary design; oral p resentation and submission of report.

2145476* Aerospace Engineering Project II 3(0-6-3)
Condition: PRER 2145475*

Design project of aerospace systems, components, and/or processes to meet a desired need with consideration of public health, safety and welfare, as well as global, cultural, social, environmental, and economic factors; follow a well defined design process by working on a team; detailed design development and parts acquisition; system simulation and optimization; design iteration; construction and testing; final design review and assessment of limitations and flaws; oral presentation and final report

2183221 Thermodynamics 3(3-0-6)

Basic concepts; thermodynamic state and process; properties of pure substances and ideal gases; energy; the first law of thermodynamics and the first law analysis for isolated, closed, and open systems; entropy; the second law of thermodynamics and the second law analysis for isolated, closed, and opens systems; gas power cycles; Carnot, Otto, and Brayton cycles; refrigeration cycle; introduction to gas mixtures; introduction to combustion.

2183222 Fluid Mechanics 3(3-0-6)

Basic concepts in physics: physical quantity and physical quantity relations, dimensions of physical quantity and the principle of dimensional homogeneity, dimensionless variables; basic concepts in fluid mechanics: continuum assumption, methods of description: Lagrangian and Eulerian descriptions, field quantity and classification of flow fields; geometric and kinematics of fluid motion: path lines, streamlines, and streak lines; forces and stressed in fluids: pressure and pressure force, shear stress and shear force: convection flux and Reynold's transport theorem; physical laws of finite control volume: conservations of mass, linear momentum, and energy; conservation of angular momentum with application to turbomachines; physical laws of infinite control volume: conservation of mass and linear momentum, introduction to Navier-Stokes and Euler's equations; Bernoulli's equation from momentum and conservation of mechanical energy viewpoints; introduction to vorticity and vortex; dimensional analysis: Buckingham's PI theorem, similarity, and model testing; internal viscous flows, energy consideration in pipe flows and piping system; external flows, boundary layer, and aerodynamic force and moment; applications: turbomachines, model testing, piping and pumping system, aerodynamic force and moment.

2183381 Numerical Methods for Engineers 3(3-0-6) Basic numerical methods for solving algebraic and transcendental equations, simultaneous linear and nonlinear equations, ordinary and partial differential equations. Introduction to Computer Aided Engineering (CAE). Use of numerical and CAE software for physical modeling and simulation of engineering problems and related applications.

2145453 Materials for Aerospace Engineering 3(3-0-6) Design, selection and utilization of engineering materials for aircraft structure and engine components; ferrous alloy, nonferrous alloys; aluminum, magnesium, copper, titanium, superalloy, polymer and composi te materials; manufacturing process for compos ite materials; recycling and repair of composite materials; future trends in aerospace engineering materials.

2145493 Introduction to Space environment and Space mission 2(2-0-4)

Space environment, phenomena in space that affect space missions and various payload systems to enable satellites to complete their assigned mission.

2145473 Rocket Propulsion 2(2-0-4)

Fundamental rocket propulsion, covering classical chemical rocket propulsion for launch, orbital, and interplanetary flight; flight mission and performance; rocket equations, nozzle theory and design; future trend in rocket propulsion and the preliminary design of engine devices.

AI & Big Data

2100201* Introduction to Artificial Intelligence 3(3-0-6)

Introduction to artificial intelligence related to scope, historical background; Concept for design; knowledge representation; memory structure; probabilistic reasoning; decision making; fuzzy logic; genetic algorithms; chaotic.

2140200* Exploratory Data Analysis and Visualization 3(3-0-6)
Condition: PRER Probability and Statistics

To learn the essential fundamental exploratory techniques for analyzing and visualizing data, and to gain hands-on experience of using software tools for data analysis. The following topics are covered: overview of exploratory data analytics, data acquisition, data analytic tools, data pre-processing, pattern discovery, graphical visualization, data forecasting, storytelling with data, and case studies.

Interdisciplinary & 21st Century

2100223* Entrepreneurship and New Venture Creation 3(3-0-6)

Concepts of entrepreneurship, concepts and processes of business opportunity analysis, design thinking for innovation business idea development, identifying target customers, analysis of customer's problem and need, developing unique value position for product and service, business models and revenue models, legal aspects for innovative entrepreneur, business idea presentation

2100224* Technopreneurship 3(3-0-6)

Concept of technopreneurship, characteristics and motivation for technopreneurs, intrapreneurship, entrepreneurial mindset and process, opportunity analysis of technology business, technology business model design, sources of fund for technology business.

2100225* Design Thinking Principle 3(3-0-6)

Principles of Design Thinking method; Basic concept of prototype design; Basic concepts of self-assessment; Self-assessment based on knowledge, skills, people and working conditions; Research and analysis of information given by professional opinions; Development of action plan for sustainability.

Approved Electives

2145421 Introduction to Computational Fluid Dynamics 3(3-0-6)

Physical and mathematical foundations of computational fluid mechanics with emphasis on applications; solution methods for model equations, the Euler and the Navier-Stokes equations; classification of partial differential equations and solution techniques.

2145422 Gas Dynamics 3(3-0-6)

Introduction to gas dynamics, covering fundamental concepts in thermodynamics and fluid dynamics; molecular and continuum concepts for fluids, first and second laws of thermodynamics, conservation laws for moving fluids, one-dimensional compressible flows, shock and expansion waves, flows in nozzles, and two- and three-dimensional compressible flows.

2142352 Finite Element Methods and Applications 3(3-0-6)

Basic principles of finite Element methods; applications of finite Element in analysis using computer programs.

2145460 Aircraft Repair Philosophy 3(3-0-6)

Aircraft repair terminology; introduction to aircraft repair philosophy and technique, holes, bushings, fasteners, washers, dents; damage tolerance; basic repair disposition; corrosions; aircraft loads; introduction to joint failures, splices, doublers, angles and straps; introduction to aircraft sealant and nondestructive inspection.

2145471 Flight Experience 3(2-3-4)

Aircraft characteristics; aerodynamics and flight control; basic aircraft instrument; basic aviation knowledge; basic flying skill of airline planes.

2145481* Introduction to Unmanned Aerial Vehicles (UAV) 3(3-0-6)

Introduction to unmanned aerial vehicles; UAV payload; communication system and data link; aircraft design process and initial sizing; basic aerodynamics of small UAVs; propulsion and flight control system for small UAV; structural design and basic detailed design, UAV construction; flight test.

2142433 Failure Analysis and Nondestructive Testing 3(2-3-4)

Analysis and dianosis of the causes of failure; physics of failure; concepts of reliability, the use of failure analysis as part of the design process, time based/related failure modes, safety factors; case studies; elimination of failures through proper material selection, treatment and use; case histories; examination of fracture surfaces; laboratory investigations of different failure mechanisms.

215440 Airframe Structure and Systems 3(3-0-6)

Introduction to airframe structure and systems; introduction to product design and related philosophy; introduction to airframe design; introduction to detailed part fabrication; introduction to aircraft systems;

introduction to bonding and grounding; introduction to newly designed aircraft and materials.

2183321 Heat Transfer 3(3-0-6)
Condition: PRER 2183222

Modes of heat transfer; general forms of heat conduction equations; steady one-dimensional heat conduction; steady two-dimensional heat conduction, transient one-dimensional heat conduction; introduction of convection and boundary layer; external flow; internal flow; free convection; heat exchangers; introduction of radiation of black body and gray surfaces; view factors; radiation exchange between gray, diffuse surfaces in an enclosure.

2184407 Quality Design and Innovation Management 3(3-0-6)

Key issues and core concept of quality design and innovation management, innovation strategy; project management; concept formation and selection, quality design and innovation development process, business plan, risk management, techniques and tools for effective implementation of innovation.

2145420 Avionics 3(3-0-6)

Basic avionic system, air data system, flight instrument, terrestrial enroute radio navigation system, terrestrial landing aids, satellite navigation system, radar systems, indicators and displays, airborne communications, autopilot and flight management system, avionic systems intergration.

2145420 Unmanned Aerial Vehicle Flight Operation An Certification 3(3-0-6)

Topics on UAV laws, operational guidelines and regulations that are stipulated by both domestic and overseas aviation organizations; aviation meteorology; mission planning and weight calculations; communication with flight controllers, including estimation of flight operation risk.

2145494 Advanced Unmanned Aerial Vehicle 3(3-0-6)

Advanced UAV platform which are more complex in engineering system and flight operations multicopter and hybrid vertical takeoff landing (VTOL) UAVs; applications of the knowledge in assembling of UAS and fine tuning system parameters to operate in real-world missions.

2145462 Topics in Aerospace Engineering I 3(3-0-6)

Selected technical topics in aerospace engineering.

2145463 Topics in Aerospace Engineering II 3(3-0-6)

Selected technical topics in aerospace engineering.

2145465 Topics in Engineering I 3(3-0-6)

Selected technical topics in engineering.

2145466 Topics in Engineering II 3(3-0-6)

Selected technical topics in engineering.

2145480 Topics and Projects in Aerospace Industry I 3(2-3-4)

Topics and projects in aerospace industry. An engineering project in aerospace engineering is required.

2145482 Topics and Projects in Aerospace Industry II 3(2-3-4)

Topics and projects in aerospace industry. An engineering project in aerospace engineering is required.

2145483 Topics and Projects in Aerospace Industry III 3(2-3-4)

Topics and projects in aerospace industry. An engineering project in aerospace engineering is required.

2145484 Topics and Projects in Aerospace Industry IV 3(2-3-4)

Topics and projects in aerospace industry. An engineering project in aerospace engineering is required.

2145485 Topics and projects in Aerospace Engineering I 3(2-3-4)

Topics and projects in aerospace engineering. An engineering project in aerospace engineering is required.

2145486 Topics and projects in Aerospace Engineering II 3(2-3-4)

Topics and projects in aerospace engineering. An engineering project in aerospace engineering is required.

2145495 Independent Studies 3(0-6-3)

Self-study on topic relate to aerospace engineering with consent of the instructor, the study may theoretical or experimental in nature.

ROBOTICS AND ARTIFICIAL INTELLIGENCE ENGINEERING
(INTERNATIONAL PROGRAM)
(B.ENG)

Robotics and artificial intelligence engineering is an interdisciplinary engineering field that combines principles of mechanical, electrical, computer, system, and mechatronics engineering. It covers the advanced machine design with a computer-based controller, which is the mechatronics system concept. The advanced machine design with the advanced automatic control design would increase the system mechanism performance. Moreover, electrical engineering, computer-based automatic control, and artificial intelligence algorithm would enhance the system to be more intelligent and be able to complete complicated tasks.

Robotics and artificial intelligence engineering focuses on the advanced machine design, manufacturing process, and maintenance process consisting of mechanisms and electronic system. Thus, the system can be automatically operated and work with high precision. This system consists of system or plant, actuators, sensors, controllers, and intelligence. Therefore, robotics and artificial intelligence engineer would learn the knowledge on these components as well as industrial standard, industrial safety standard, and management process to effectively use the advanced machines.

Each student is required to accumulate a minimum of 146 credits to graduate for Bachelor of Engineering Program in Automotive Design and Manufacturing Engineering (International Program) which also includes 2 credits of industrial training and 3 credits of senior project.

Curriculum board

Viboon Sangveraphunsiri	Ph.D. (Georgia Tech)
Ratchatin Chancharoen	Ph.D. (Chula)
Phongsaen Pitakwatchara	Ph.D. (M.S.M.E.)
Manop Wongsaisuwan	D.Eng. (Tokyo Inst. Tech)
Attawith Sudsang	Ph.D. (Illinois)
Surat Kwanmuang	Ph.D. (Minnesota)
Nattee Niparnan	D.Eng. (Chula)
Gridsada Phanomchoeng	Ph.D. (Minnesota)

Professors

Mechanical Engineering

Pramote Dechaumphai	Ph.D. (Old Dominion)
Viboon Sangveraphunsiri	Ph.D. (Georgia Tech)

Associate Professors

Mechanical Engineering

Asi Bunyajitradulya	Ph.D. (UC Irvine)
Kuntinee Maneeratana	Ph.D. (London)
Ratchatin Chanchareon	D.Eng. (Chula)
Witaya Wannasuphoprasit	Ph.D. (Northwestern)
Nopdanai Ajavakom	Ph.D. (UC. Berkeley)
Niphon Wansophark	D.Eng. (Chula)
Alongkorn Pimpin	D.Eng. (Tokyo)
Chanat Ratanasumawong	D.Eng. (Tokyo Tech)
Thanyarat Singhanart	Ph.D. (Tokyo)
Boonchai Lertnuwat	Ph.D. (Tokyo)

Industrial Engineering

Somkiat Tangjitsitchareon	D.Eng. (Kobe Japan)
Oran Kittithreerapronchai	Ph.D. (Georgia)

Metallurgical and materials Engineering

Seksak Asavavisithchai	Ph.D. (Nottingham)

Assistant Professors

Electrial Engineering

Suree Pumrin	Ph.D. (Washington)

Mechanical Engineering

Sunhapos Chantranuwathana	Ph.D. (Michigan)

Lecturer

Electrial Engineering

Boonchuay Supmonchai	M.Eng. (Chula)

Mechanical Engineering

Nuksit Noomwongs	D.Eng. (TUAT)
Tawan Paphapote	Ph.D.C. (USA)

ISE Staffs

Yan Zhao	Ph.D. (London)
Prabhath De Silva	Ph.D. (USA)

Guest lecturer

Kaukeart Boonchukosol	Poitiers (Frence)

Visiting Professor (USA)

Stanley Peter Lynch	Ph.D. (UK)

Curriculum

Total number of credits requirement	138	credits
General Education	30	credits
Core Courses	102	credits
Math & Sciences	30	credits
Basic Engineering	18	credits
Compulsory	37	credits
Concentration	15	credits
Industrial Training	2	credits
Free Electives	6	credits

1. General Education **30 credits**

Social Science	3	credits
Humanity	3	credits
Science and Mathematics	3	credits
Interdisciplinary	3	credits
Foreign Language	12	credits
5501214 Communication and Presentation Skills		3(3-0-6)
5501225 Technical Writing		3(3-0-6)
XXXXXX General Education (Foreign Language)	6	credits
General Education (Special)	6	credits
2147111 Exploring Robotics Engineering		3(3-0-6)
2147104* Engineering Design Thinking		3(3-0-6)

2. Core Course **102 credits**

Science and Mathematics 30 credits

2301107	Calculus I	3(3-0-6)
2301108	Calculus II	3(3-0-6)
2147103	Discrete Mathematics	3(3-0-6)
2304153	Physics for Engineers	3(3-0-6)
2304154	Physics and Electronics for Eng	3(3-0-6)
2304193	Physics Laboratory for Engineers	1(0-3-0)
2304194	Physics and Electronics Laboratory for Engineers	1(0-3-0)
2182203	Probability and Statistics for Eng	3(3-0-6)
2147207*	Linear Algebra	3(3-0-6)
2147208*	Multivariable Calculus	3(3-0-6)
2147209*	Differential Equations for Dynamic Modelling and Numerical Simulation	3(3-0-6)

Basic Engineering 18 credits

2190101	Computer Programming	3(3-0-6)
2147210*	Fundamentals of Digital Circuits	3(3-0-6)
2147215*	Data Science, Data Visualization And Analytics	3(3-0-6)
2147332	Artificial Intelligence	3(3-0-6)
2183212	Statics	3(3-0-6)
2100227*	Project Management	3(3-0-6)

Compulsory 37 credits

2147105	Data Structure and Algorithm	3(3-0-6)
2147311*	Digital Logic Design	3(3-0-6)
2183231	Dynamics	3(3-0-6)
2147320	Feedback Control Systems	3(3-0-6)
2147312*	Robotics	3(3-0-6)
2183213	Mechanics of Materials	3(3-0-6)
2147313*	Design of Machine Elements	3(3-0-6)
2147214*	3D CAD Modeling in Mechanical Design	3(2-3-4)
2147216*	Sensors, Signaling, and Actuators for Robotics Projects	3(1-6-2)
2147301*	Robotics Lab	1(0-3-0)
2147302*	Automation, Robotics, and Intelligent System Projects	3(1-6-2)
2147498*	Capstone Design Project I	3(0-6-3)
2147499*	Capstone Design Project I	3(0-6-3)

Concentration course 15 credits

a) Robotics Systems development and Application

2147319	Mechanics of Machinery	3(3-0-6)
2147321	Modern Control and Digital Control Systems	3(3-0-6)
2147326	Mobile Robot	3(3-0-6)
2147427	Advanced Mobile Robot	3(3-0-6)
2182307	Signals and Systems	3(3-0-6)
2147327	Design of Microprocessor-Based Mechanical Systems	3(3-0-6)
2147309	Mechatronics	3(3-0-6)
2147328	System Identification	3(3-0-6)
2147329	Digital Image Processing and Vision Systems	3(3-0-6)
2147237	Manufacturing Workshop	1(1-4-0)
2147238	Manufacturing Processes	3(3-0-6)
2189101	Engineering Materials	3(3-0-6)
2147239	Materials in Daily Life	3(3-0-6)
2147250*	Topics in Robotics and Artificial Intelligence I	3(3-0-6)
2147251*	Topics in Robotics and Artificial Intelligence II	3(3-0-6)
2147252*	Topics in Robotics and Artificial Intelligence III	3(3-0-6)
2147253*	Topics in Robotics and Artificial Intelligence IV	3(3-0-6)
2147480*	Independent Study I	1(0-3-0)
2147481*	Independent Study II	1(0-3-0)
2147482*	Independent Study III	1(0-3-0)

b) Robotics Software and Artificial Intelligence

2147330	Programming methodology	3(3-0-6)
2147331	Perception of Cognitive Robots	3(3-0-6)
2147433	Advanced Artificial Intelligence	3(3-0-6)
2148333	Cyber Physical Robotics	3(3-0-6)
2147334	Machine learning or Depp learning	3(3-0-6)
2147338*	Virtual Reality and Augmented Reality	3(3-0-6)
2147336	Internet of Things	3(3-0-6)
2100310	Global Awareness for Technology Implementation	3(3-0-6)
2147337*	Database and Simulation	3(3-0-6)
2147250*	Topics in Robotics and Artificial Intelligence I	3(3-0-6)
2147351*	Topics in Robotics and Artificial Intelligence II	3(3-0-6)

2147352*	Topics in Robotics and Artificial Intelligence III	3(3-0-6)
2147453*	Topics in Robotics and Artificial Intelligence IV	3(3-0-6)
2147480*	Independent Study I	1(0-3-0)
2147481*	Independent Study II	1(0-3-0)
2147482*	Independent Study III	1(0-3-0)

Industrial Training

2140301	Industrial Training	2(0-12-0)

3. Free Electives **6 credits**

Select 6 credits from any courses offered in English by any International Programs in Chulalongkorn University.

ROBOTICS AND ARTIFICIAL INTELLIGENCE ENGINEERING
(INTERNATIONAL PROGRAM)
(B.ENG)

COURSE NO.	SUBJECT	CREDITS
	FIRST SEMESTER	
2147103*	Discrete Mathematics	3
2190101	Computer Programming	3
2301107	Calculus I	3
2304153	Physics for Engineers	3
2304193	Physics Laboratory for Engineers	1
XXXXXX	General Education (Foreign Language)	3
2147111	Exploring Robotics Engineering	3
		19
	SECOND SEMESTER	
2301108	Calculus II	3
2304154	Physics and Electronics for Engineers	3
2304194	Physics and Electronics Laboratory for Engineers	1
2182203	Probability and Statistics for Engineers	3
XXXXXX	General Education (Foreign Language)	3
XXXXXX	General Education	3
		16
	THIRD SEMESTER	
2147207*	Linear Algebra	3
2147208*	Multivariable Calculus	3
5501214	Communication and Presentation Skills	3
2183212	Statics	3
2147210*	Fundamentals of Digital Circuits	3
2147214*	3D CAD Modeling in Mechanical Design	3
		18
	FOURTH SEMESTER	
5501225	Technical Writing	3
2183213	Mechanics of Materials	3
2147209*	Differential Equations for Dynamics Modelling and Numerical Simulation	4
2147215*	Data Science, Data Visualization and Analytics	3
2147216*	Sensors, Signaling, and Actuators For Robotics Projects	3
2183231	Dynamics	3
		19

COURSE NO.	SUBJECT	CREDITS
	FIFTH SEMESTER	
2147320	Feedback Control systems	3
2147313*	Design of Machine Elements	3
2147105	Data Structure and Algorithm	3
2147104*	Engineering Design Thinking	3
2147301*	Robotics Lab	1
2147311*	Digital Logic Design	3
2147332	Artificial Intelligence	3
		19
	SIXTH SEMESTER	
XXXXXX	Marketing and Management In Engineering	3
2147312*	Robotics	3
XXXXXX	Concentration Course	3
XXXXXX	Concentration Course	3
XXXXXX	General Education	3
2147302*	Automation, Robotics, and Intelligent System Projects	3
		18
	SUMMER SEMESTER	
2140301	Industrial Training	2
	SEVENTH SEMESTER	
XXXXXX	Concentration Course	3
XXXXXX	Concentration Course	3
XXXXXX	Free Elective	3
XXXXXX	General Education	3
2147498*	Capstone Design Project I	3
		15
	EIGHTH SEMESTER	
XXXXXX	Concentration Course	3
XXXXXX	Free Elective	3
XXXXXX	General Education	3
2147499*	Capstone Design Project II	3
		12
	TOTAL CREDITS FOR GRADUATION	**138**

ROBOTICS AND ARTIFICIAL INTELLIGENCE ENGINEERING
(B.ENG)

General Education (Foreign Language)

5501214 Communication and Presentation Skills **3(3-0-6)**
Condition: PRER 5501123*

Practice using English for social communication and giving oral presentation on engineering related topics.

5501225 Technical Writing **3(3-0-6)**
Condition: PRER 5501123*

Practice in writing summaries composing different types and styles of writing in the field of engineering and writing reports of studies and experiments.

General Education (Special Gened)

2147111* Exploring Robotics Engineering **3(3-0-6)**

Engineering topics related to daily life: energy, resources, environment manufacturing, process, industry, material, automotive, infrastructure, information system and bio engineering

2147104* Engineering Design Thinking **3(2-3-4)**

Principles of Design Thinking; Design thinking process: defining design problems from the real complicated problem, Empathy, product, information, and patent reviews, brain storming, concept generation and evaluation, conceptual design using CAD; Phycology of design; Design Thinking Project to create a real prototype.

Math & Sciences

2301107 Calculus 1 **3(3-0-6)**

Limit, continuity, differentiation and integration of real-valued functions of a real variable and their applications; techniques of integration; improper integrals.

2301108 Calculus 2 **3(3-0-6)**
Condition: PRER 2301107

Mathematical induction; sequences and series of real numbers; Taylor series expansion and approximation of elementary functions; numerical integration; vectors, lines and planes in three-dimensional space; calculus of vector valued functions of one variable; calculus of real valued functions of two variables; introduction to differential equations and their applications.

2147103 Discrete Mathematics **3(3-0-6)**

This course covers elementary discrete mathematics for computer science and engineering. It emphasizes mathematical definitions and proofs as well as applicable methods. Topics include formal logic notation, proof methods; induction, well-ordering; sets, relations; elementary graph theory; integer congruence; asymptotic notation and growth of functions; permutations and combinations, counting principles; discrete probability. Further selected topics may also be covered, such as recursive definition and structural induction; state machines and invariants; recurrences; generating functions.

2304193 Physics Laboratory for Engineers **1(0-3-0)**
CONDITION: Co-requisite 2304153

Measurement and precision; experiments on simple harmonic motion, radius of gyration, dynamics of rotation, velocity of sound, viscosity of fluids.

2304154 Physics and Electronics for Engineers **3(3-0-6)**
CONDITION: PRER 2304153

Electricity; DC circuit; AC circuit; basic electronics; solid state devices; electrical actuators

2304194 Physics and Electronics Laboratory for Engineers **1(0-3-0)**
CONDITION: Co-requisite 2304154

Resistance and electromotive force measurements; experiments on amp meter, voltmeter, oscilloscope, AC circuit, transistor, lenses and mirrors, polarization, interference, diffraction.

2182203 Probability and Statistics for Engineers **3(3-0-6)**

Engineering basis in statistics and probability; discrete and continuous probability distribution; joint probability distribution; parameter estimation: estimator, bias, consistency; point estimation; interval estimation; engineering applications in measurement and uncertainty, linear regression, introduction to random process; integration of statistics in engineering applications; case studies.

2147207* Linear Algebra **3(3-0-6)**
CONDITION: PRER 2301108

System of linear algebraic equations; linear spaces; inner products; eigenvalues and eigenvectors; principal axis theorem; higher-order linear differential equations; method of variation of parameters; system of first-order linear differential equations; qualitative analysis and dynamical system

2147208* Multivariable Calculus **3(3-0-6)**
CONDITION: PRER 2301108

Vector; curves, planes and surfaces; derivatives of vector-valued functions; partial, total and directional derivatives; implicit differentiation; maxima-minima; gradient, divergence, curl; scalar and vector fields; line integral; surface integral and volume integral; integral theorems of vector analysis.

2147209* Differential Equations for Dynamics Modelling and Numerical Simulation **4(3-3-6)**
CONDITION: PRER 2183231

Differential Equations; Mechanical background; mathematical modeling and numerical solution of engineering problems; modeling of mechanical systems; model representation and response; modeling of electrical, hydraulic and thermal system; modeling of mixed systems; time response analysis of linear dynamic systems; introduction to optimization and numerical solution; solution techniques for nonlinear systems; signal processing.

Basic Engineering

2190101 Computer Programming **3 (3-0-6)**

Computer concepts, computer system components, hardware and software interaction, electronic information and data processing concepts; programming: data types, operators, statements, control structures; programming tools; programming styles and conventions; debugging; program design and development with applications to engineering problems using a high-level language.

2147210* **Fundamentals of Digital Circuits** **3(3-0-6)**

Number systems; logic gates and logic expressions; Boolean algebra: Karnaugh map and tabulation method; combination logic circuit and applications: adder, subtractor, multiple outputs circuit, decoder, encoder, multiplexer and demultiplexer; gate implementation: tristate; speed and delay in logic circuits; sequential circuits and design; flip-flop, and counter; register.

2147215* **Data Science, Data Visualization And Analytics** **3(3-0-6)**

Probability and Statistics (do not require the coding skill) To learn the essential fundamental exploratory techniques for analyzing and visualizing data, and to gain hands-on experience of using software tools for data analytics. The following topics are covered: overview of exploratory data analysisytics, data acquisition, data analytic tools, data pre-processing, pattern discovery, graphical visualization, data forecasting, storytelling with data, and case studies.

2147105* **Data Structure and Algorithm** **3(3-0-6)**
Condition: Prerequisite 2190101

Linear allocation: array, stack, queue, dequeues; linked allocation: singly linked lists, and doubly linked lists; trees: binary tree, traversal, representation, AVL-tree; heap storage, hash coding

2147332 Artificial Intelligence **3(3-0-6)**

Definitions and application of artificial intelligence; knowledge representation; Prolog programming; natural language processing; machine learning techniques.

2183212 Statics **3(3-0-6)**

Force-couple system; resultants; equilibrium; factor of safety; frames and machines; truss; Pappus theory; distributed forces; fluid statics; flexible cable; friction, friction in machines; principle of virtual work; stability.

2100227* **Project Management** **(3-0-6)**

Concept of technopreneurship, characteristics and motivation for technopreneurs, intrapreneurship, entrepreneurial mindset and process, opportunity analysis of technology business, technology business model design, sources of fund for technology business.

Compulsory

2147105* **Data structure and algorithm** **3(3-0-6)**
Condition: PRER 2190101

Linear allocation: array, stack, queue, dequeues; linked allocation: singly linked lists, and doubly linked lists; trees: binary tree, traversal, representation, AVL-tree; heap storage, hash coding

2147311* **Digital Logic Design** **3(3-0-6)**

Introduction to digital circuit design; synthesis of logic circuit; CAD tools and VHDL; standard chips, programmable logic devices and gate arrays; optimized implementation of logic functions; combinational circuit design; synchronous sequential circuit design; controller; digital system design; microcontroller; digital system design; microcontroller-based design.

2183231 Dynamics **3(3-0-6)**
Condition: Corequisite 2183212

Kinematics and kinetics of particles and planar rigid body; Newton's second law; equations of motion; work and energy; impulse and momentum of particles and planar rigid body.

2147320* **Feedback Control Systems** **3(3-0-6)**
Condition: PRER 2147209

Introduction to control system; mathematical models of systems; state-space description; dynamics simulation; feedback control system characteristics; the performance of feedback control systems; the stability of linear feedback systems; essential principles of feedback, the root-locus method; frequency response methods; stability of the frequency domain, time-domain analysis of control systems; the design and compensation of feedback control systems.

2147312* **Robotics** **3(3-0-6)**
Condition: PRER 2183231

Introduction to Industrial Robots; robot reference frames; manipulator kinematics; inverse manipulator kinematics; Jacobian; manipulator dynamics; introduction to robot controls; trajectory generation; mechanism design; introduction to hybrid force/position control

2183213 Mechanics of Materials I **3(3-0-6)**
Condition: PRER 2183212

Concept of stress and strain; stress and strain components; plane stress and plane strain; Mohr's circle of plane stress; Hooke's law and modulus of elasticity; engineering stress-strain diagrams; working stress; factor of safety; problems in axial loading including statically indeterminate problems and temperature changes; thin-walled pressure vessel; torsion of circular shaft; statically indeterminate shaft; beam; stress in beam; deflection of beam; statically indeterminate beam; Euler's formula; combined stress.

2147313* **Design of Machine Elements** **3(3-0-6)**

Design machine concept; design of robotics components; joints and transmission system design of robots; link and joint connection design, design standard; materials used in robots, design for manufacturing.

2147214* **3D CAD Modeling in Mechanical Design** **3(2-3-4)**

Engineering design process for product development; conceptual design; detail design; introduction to computer aided design, computer aided manufacturing, and computer aided engineering; 3D solid modeling, design concepts and implementation; link to manufacturing.

2147216 Sensors, Signaling, and Actuators For Robotics Projects **3(1-6-2)**
Condition: 2nd Student

Conduct and complete a engineering project in a team such that the processes comply with prescribed design processes as well as documenting and presenting the project in a professional manner.

2147301 Robotics Lab **1(0-3-0)**

Conduct and complete a engineering project in a team such that the processes comply with prescribed design

processes as well as documenting and presenting the project in a professional manner.

2147302 Automation, Robotics And Intelligent System Projects **1(0-3-0)**
Condition: PRER 2147301

Conduct and complete a engineering project in a team such that the processes comply with prescribed design processes as well as documenting and presenting the project in a professional manner.

2147498* Capstone Design Project I **1(0-3-0)**
Condition: 4th student

Conduct and complete a engineering project in a team such that the processes comply with prescribed design processes as well as documenting and presenting the project in a professional manner.

2147499* Capstone Design Project II **1(0-3-0)**
Condition: PRER 2147498

Conduct and complete a engineering project in a team such that the processes comply with prescribed design processes as well as documenting and presenting the project in a professional manner.

Concentration Course

(a) Robotics Systems Development and Application

2147319 Mechanics of Machinery **3(3-0-6)**
Condition: PRER 2183231

Basic Mechanisms; Position, velocity and acceleration of Linkages, Graphical linkage synthesis; Linkage synthesis; Static and dynamic force analysis; Static and dynamic balancing of a simple rotating and reciprocating machine.

2147321 Modern Control and Digital Control Systems **3(3-0-6)**
Condition: PRER 2147320*

Describing-function analysis of non-linear control systems, phase-plane analysis, state-space analysis of control system; linear dynamical equations and impulse-response matrices; controllability and observability of linear dynamical equations, irreducible realizations: strict system, equivalence and identification; digital control design

2147326 Mobile Robots **3(3-0-6)**

Types and application of mobile robots, control of mobile robots

2147427 Advanced Mobile Robots **3(3-0-6)**

Types and application of mobile robots, control of mobile robots

2182307 Signals and Systems **3(3-0-6)**

Classification of signals and systems; linear time-invariant (LTI) systems; time domain and frequency domain models of the continuous linear time-invariant (LTI) systems;convolution integral and impulse response; Fourier series and Fourier transforms; Bode plot of signals and LTI systems; Laplace transforms; analysis of LTI systems using Laplace transforms; applications to circuit analysis, feedback control, and communications.

2147327 Design of Microprocessor-Based Mechanical Systems **3(3-0-6)**

Fundamentals of embedded system hardware and firmware, real-time processing, feedback loop control, communication protocols, transistor logic, memory circuits, interfacing logic families, standard bus interfaces, interrupt, boot-loading stages and direct-memory access (DMA); microprocessors related to problems in mechanical systems

2147309 Mechatronics **3(3-0-6)**

Introduction to mechanical system interfacing; combinational digital logic; industrial electronic components; industrial sensors; simple computer structure; low level programming techniques; embedded control computers; microcontroller; stepping motors; DC motors; analog/digital conversion; position and velocity measurement; amplifiers; projects related to mechatronics.

2147328 System Identification **3(3-0-6)**

Models for linear time-invariant and time-varying systems; nonparametric time- and frequency-domain methods; parameter estimation methods; convergence and consistency; asymptotic distribution of parameter estimates; computing the estimate; recursive identification methods; experiment design; choice of identification criterion; model structure selection and model validation.

2147329 Digital Image Processing and Vision Systems **3(3-0-6)**

Visual perception, digitization and coding of images, converting pictures to discrete(digital) forms; image enhancement; image restoration including improving degraded low-contrast, blurred, or noisy pictures; image compression: data compression used in image processing; image segmentation referred to as first step in image analysis.

2147237 Manufacturing Workshop **1(0-3-0)**

Manufacturing process: casting, turning, milling, welding, heat treatment; manufacturing process selection for materials and shapes; manufacturing process selection for linear tolerance and geometric tolerance; surface roughness; metrology and examination techniques.

2147238 Manufacturing Processes **3(3-0-6)**

Manufacturing process; casting, plastic processing, metal forming, sheet metalworking, turning, milling, welding and assembly process; Manufacturing process selection for materials and shapes; dimensions, tolerances, surfaces and their measurement.

2189101 Engineering Materials **3(3-0-6)**

Crystal structure of solids. Crystal defects. Mechanical properties of materials. Dislocation and strengthening mechanism of metals. Mechanical failure of materials. Phase diagram and solid state reaction. Fabrication and applications of metals. Structure, properties, and applications of ceramic. Structure, properties, and applications of polymers. Structure, properties, and application of composite materials. Corrosion and degradation of materials. Properties and applications of

2147239 Materials in Daily Life 3(3-0-6)

Learn different aspects of materials as found in daily life, in various occupations and in suitable applications. Environmentally friendly materials. Full utilization of materials in both efficient sense and aesthetic sense. Topics include materials for design and 126 architecture, fashion, arts and craft materials, biomedical materials and biomaterials, automotive materials and household materials.

(b) Robotics Software and Artificial Intelligence

2147330 Programming Methodology 3(3-0-6)
Condition: PRER 2190101

Programming methodology: object-oriented programming, event-driven programming, concurrent programming; error and exception handling; application programming interface (API); programming tools; programming styles and practice.

2147331 Perception of Cognitive Robots 3(2-2-6)

Programming of robots to enable the achievement of goals in environments, cognitive capabilities such as perception, attention, anticipation, planning, memory, learning, and reasoning. social capabilities, such as communication, collaborative task execution, and reasoning about the mental states of other agents. artificial intelligence techniques, as well as insights from cognitive science.

2147433 Advanced Artificial Intelligence 3(3-0-6)

Definitions and application of artificial intelligence; knowledge representation; Prolog
programming; natural language processing; machine learning techniques.

2147333 Cyber Physical Robotics 3(3-0-6)

The mathematics of complex networks/systems in natural and man-made environments; bacteria swarms; smart grid; social media; models for network design; control and optimization, identifying their limitations in relation to the actual characteristics of physical processes; developing advanced mathematical models of CPR based on actual measurements; overview of network theory and research in applied mathematics, physics, and engineering.

2147334 Machine Learning or Deep Learning 3(3-0-6)

Computing with logic; using logic set theory, number theory, algebras graph theory, automata; language of first order logic, model theory and logic programming; problems of inductive inference in the framework of first-order predicate calculus and the probability calculus; introduction of computational learning theory.

2147338* Virtual Reality and Augmented Reality 3(3-0-6)

Theory, development, and applications of virtual reality (VR) technology for the generation of the virtual environments (VE); human-computer interaction based on
the 5 basic senses of human perception; use of 3D software and some scripting language to generate models in the CAVE system; application of VR technology in product and production design and others.

2147336 Internet of Things 3(3-0-6)

This course covers the topics of smart things network and communication: architectures, services and protocols; privacy and security; enabling technologies of
IoT; IoT and smart system applications: smart cities, smart energy, smart transportation and mobility, smart home and building, smart factory and manufacturing, smart health and up-to-date applications related to RAI; smart things networks for data management; IoT related standardization. The course also includes a substantial group design project.

2100310 Global Awareness for Technology Implementation 3(3-0-6)

Global awareness; current mainstream technologies; understanding of a variety of cultures, traditions, laws and regulations, beliefs, concepts, practices, values in each
society technology implementation in various societies; important factors for success in technology implementation.

2147337* Database and Simulation 3(3-0-9)

Introduction of database management; data models (ER, rational, and others); SQL (Structured Query Language); databases in applications; data warehousing; distributed
and no SQL databases; introduction of modeling and simulation; discrete event simulation; system dynamics simulation; agent-based simulation.

Approved Elective Course

2147250* Topics in Robotics Engineering and Artificial Intelligence I 3(3-0-6)

Selected technical topics in robotics engineering

2147251* Topics in Robotics Engineering and Artificial Intelligence II 3(3-0-6)

Selected technical topics in robotics engineering

2147352* Topics in Robotics Engineering and Artificial Intelligence III 3(3-0-6)

Selected technical topics in robotics engineering

2147453* Topics in Robotics Engineering and Artificial Intelligence IV 3(3-0-6)

Selected technical topics in robotics engineering

2147480* Independent Study I 1(0-3-0)

Independent study and investigation, theoretically and practically, in robotics and artificial intelligence engineering topics according to each student's interest underthe supervision and guidance of the instructor.

2147481* Independent Study II 1(0-3-0)

Independent study and investigation, theoretically and practically, in robotics and artificial intelligence engineering topics according to each student's interest underthe supervision and guidance of the instructor.

2147482* Independent Study III 1(0-3-0)

Independent study and investigation, theoretically and practically, in robotics and artificial intelligence engineering topics according to each student's interest underthe supervision and guidance of the instructor.

2140301 Industrial Training **2(0-6-0)**

Industrial Training in related areas under supervision of experience experienced engineers in private sectors or government agencies.

COURSES DESCRIPTIONS IN BASIC SCIENCES AND ENGLISH

2301107 Calculus I 3(3-0-6)

Limits, continuity; differentiation and integration of real-valued functions of a real variable and their applications; techniques of integration; improper integrals.

2301108 Calculus II 3(3-0-6)
CONDITION: PRER 2301107

Mathematical induction; sequences and series of real numbers; Taylor series expansion and approximation of elementary functions; numerical integration; vectors, lines and planes in three dimensional space; calculus of vector valued functions of one variable; calculus of real valued functions of two variables; introduction to differential equations and their applications.

2301201 Advanced Calculus I 4(4-0-8)

Algebra and calculus of vectors, vector differential operators (gradient, divergence and curl), cylindrical and spherical coordinates, Green's Gauss's and Stokes' theorems, tensors

2301312 Differential Equations 3(3-0-6)
CONDITION: PRER 2301108

Differential equations with constant coefficients of second order and n-th order; linear differential equations with variable coefficients; system of linear differential equations; Laplace transforms and its applications; Fourier series; boundary value problems; introduction to partial differential equations.

2302103 General Chemistry Laboratory 1(0-3-0)

Standard solution preparations; quantitative analysis; electrochemistry; enthalpy of solution and reaction; chemical kinetics; spectroscopy; qualitative analysis.

2302105 Chemistry for Engineers 3(3-0-6)

Structure of atoms; chemical bonding; ionic bonding, covalent bonding, valence bond theory, hybridization-interaction coordination, intermolecular forces, molecular movement; state of matter: gases, structure of solid, liquid, and solutions; chemical reactions; interaction of matters with electromagnetic radiation and electrical energy; chemical thermodynamics.

2302106 BASIC ORGANIC CHEMISTRY 3(3-0-6)

Structure and bonding, stereochemistry, spectroscopy, hydrocarbon, halogen-containing compounds, oxygen-containing compounds, nitrogen-containing compounds, biomolecules

2302203 Organic Chemistry Laboratory 1(0-3-0)

Fundamental techniques for the use of organic laboratory equipments and instruments; determination of boiling and melting points of organic compounds; separation and purification techniques for organic compound; isolation and study of natural products; synthetic processes of target molecules using principle reactions of compounds in each functional group.

2302207 BASIC INORGANIC CHEMISTRY 2(2-0-4)

Fundamental concepts in inorganic chemistry; atomic structure; chemical periodicity; chemical bonding and molecular structures; crystal structures; Inorgainc solids; symmetry and group theory; molecular orbitals.

2303111 Biology for Engineers 3(3-0-6)

Biological principles: the modern cell concept, life energy, principles of classification, comparative aspects of anatomy and physiology, genetics, DNA, behavior and relationships of organisms and their environments.

2303112 Biology Laboratory for Engineers 1(0-3-0)

Biological experiments which accord with biology for engineer.

2304153 Physics for Engineers 3(3-0-6)

Basic mathematics for general physics; mechanics and its applications; gases and kinetic theory; thermodynamics; transport phenomena and heat transfer; physical properties of matter.

2304154 Physics and Electronics for Engineers 3(3-0-6)

Electrostatic; direct current; alternating current; electrical circuits; eletromagnetism and magnetic materials; mechanical and electromagnetic waves; modern physics; nuclear physics; relativity.

2304193 Physics Laboratory for Engineers 1(0-3-0)

Measurement and precision; experiments on simple harmonic motion; moment of inertia; circular motion; dynamics of rotation; standing waves; viscosity of fluids; heat capacity; beats and sound analysis.

2304194 Physics and Electronics Laboratory for Engineers 1(0-3-0)

Electrical measurements and basic electrical equipments; ammeter and voltmetter; AC circuit; semiconductor devices; lense and spherical mirror; diffraction and interference of light; polarization; radioactivity; electromagnetic induction.

5501111 English for Engineering I (S/U) 3(3-0-6)

Grammar; use of simple sentences; writing mechanics and process; writing and vision aids to good English.

5501122 English for Engineering II (S/U) 3(3-0-6)

Use of more complex sentences; expressive and creative writing; writing research papers and technical reports.

The Regional Centre for Manufacturing Systems Engineering

The Regional Centre for Manufacturing Systems Engineering was established in the Faculty of Engineering, with the initial support of the Federation of Thai industries and the British Council, to be the focal point of graduate-level teaching and research in engineering management and manufacturing systems engineering in the South-East Asian region. Since the first group in January 1996, the Centre has graduated several hundred master degree graduates in its unique dual-degree programme with the University of Warwick.

Established in 1996 the Regional Centre for Manufacturing Systems Engineering offers a postgraduate programme leading to the degree of Master of Engineering in Engineering Management. It is based on the successful model at the University of Warwick which is supported by a number of leading international companies. The current programme in Thailand is supported by The Federation of Thai industries. It allows the transfer of leading edge technologies and manufacturing strategies to Thai companies.

Academic staff from both the Warwick Manufacturing Group and Chulalongkorn University contribute to teaching of the programme. The Master of Engineering award is granted by Chulalongkorn University and the Master of Science award is granted, concurrently, by the University of Warwick providing truly international credibility.

ENGINEERING MANAGEMENT
(International Program)

NAME OF THE DEGREE

: Master of Engineering
: M. Eng.

ADMISSION

1. The applicant must hold a Bachelor's Degree of Engineering or equivalent with the minimum TOEFL iBT score of 92 or with the certificate of proficiency in English (IELTS 6.5) from the British Council or with WELT B,C,C.

2. The Applicant must meet other qualifications set by the regulations of the Graduate School, Chulalongkorn University, which will be annually announced. Otherwise the applicant must earn the approval by the graduate study committee of the Faculty of Engineering.

DEGREE REQUIREMENTS

Number of credits for curriculum not less than 42 credits: 2 credits for required courses (non-credit), 22 credits for elective courses, 18 credits for thesis.

PROFESSORS :

Parames	Chutima,	Ph.D. (Nottingham)
Somkiat	Tangjitsitchareon,	Ph.D. (Kobe)

ASSOCIATE PROFESSORS :

Jeerapat	Ngaoprasertwong,	M.S. M.A. (Iowa) B.Eng. Hons. (Chula)
Natcha	Thawesaengskulthai,	Ph.D. (Nottingham) M.S. (Linköping)
Krerk	Piromsopa,	Ph.D. (Michigan)
Oran	Kittithreerapronchai,	Ph.D., M.S. (Georgia Tech)
Naragain	Phumchusri,	Ph.D., M.S. (Georgia Tech)
Pisit	Jarumaneeroj,	Ph.D., M.S. (Georgia Tech)
Arisara	Jiamsanguanwong,	Ph.D., M.S. (Tokyo Tech)

COURSE REQUIREMENTS

	1) Required Courses	***2 credits***
2163601	Fundamentals of Integrated Engineering Business Management	2(2-0-6)
	2) *Approved Electives*	***10 credits***
2163610	Service Support Technologies	2(2-0-6)
2163620	Logistics and Operation Management	2(2-0-6)
2163630	Business Strategy and Strategic Management	2(2-0-6)
2163631	Project Planning Management and Control	2(2-0-6)
2163632	Organisations, People and Performance	2(2-0-6)
	3) *Elective Courses*	***12 credits***

Technology

2163611	Computer Aided Design and Manufacture	2(2-0-6)
2163612	Automation and Robotics	2(2-0-6)
2163613	E-Commerce Technologies	2(2-0-6)
2163614	Metallic Materials: Properties Processes and Applications	2(2-0-6)
6163615	Polymer Materials: Processes and Applications	2(2-0-6)
2163616	Information and Communication Technologies	2(2-0-6)
2163617	Manufacturing Process Technology	2(2-0-6)
2163618	Design for the Environment	2(2-0-6)

Operation

2163621	Supply Chain Management	2(2-0-6)
2163622	Technology Management	2(2-0-6)
2163623	Product Design and Development Management	2(2-0-6)
2163624	Quality Management and Techniques	2(2-0-6)
2163625	Applied Statistical Methods	2(2-0-6)

Management

2163633	Operations Strategy for Industry	2(2-0-6)
2163634	Strategic Marketing	2(2-0-6)
2163635	Information System Strategy	2(2-0-6)
2163636	Innovative Strategy	2(2-0-6)
2163637	Financial Analysis and Control Systems	2(2-0-6)
2163638	Financial Strategy	2(2-0-6)
2163639	Management of Change	2(2-0-6)
2163640	International Joint Venture	2(2-0-6)
2163641	Establishing New Business	2(2-0-6)
2163642	Business Environment and Economics	2(2-0-6)

General

2163691	Advanced Topics in Engineering Management I	2(2-0-6)
2163692	Advanced Topics in Engineering Management II	2(2-0-6)
2163693	Advanced Topics in Engineering Management III	2(2-0-6)
2163694	Advanced Topics in Engineering Management IV	2(2-0-6)
2163695	Advanced Topics in Engineering Management V	2(2-0-6)
2163696	Advanced Topics in Engineering Management VI	2(2-0-6)
	4) *Thesis*	
2163813	Thesis	18 credits

COURSE DESCRIPTIONS

2163601 Fundamentals of Integrated Engineering Business Management 2(2-0-6)

Introduction to engineering business management; manufacturing and engineering industry today; international challenge; the change of management process; IEBM programmer rationale; introduction to strategic planning tools; introduction to manufacturing operations strategy; manufacturing operations strategy formulation process; systems approach; product strategy and innovation; role of technology; tools and techniques of operational management.

2163610 Service Support Technologies 2(2-0-6)

The Service Support Technologies looks at the technologies available to both deliver and support service. It will consider diagnostic tools both in terms of healthcare diagnostics and machinery diagnostics. The secondary level of technological support in terms of information systems and global business implications will also be covered.

2163620 Logistics and Operation Management 2(2-0-6)

The logistics function in the supply chain; establishing a logistics strategy; customer and supplier relationship; operations planning and control; material requirements planning; just-in-time philosophies; the use of computers in logistics and operations management; distribution networks; measuring logistics performance.

2163630 Business Strategy and Strategic Management 2(2-0-6)

Introduction and International economic background; economic and business trends in the Asia Pacific area; the strategic management process; analysis of the external environment; analysis of the internal environment; Alternative approaches to strategic thinking; financial aspects of strategic management; organizational and human resource aspects; global business strategies; Cross-cultural aspects of strategic management; Case studies.

2163631 Project Planning Management and Control 2(2-0-6)

Project organization, planning and content analysis; estimating; and tendering; budgeting and cost control; network planning; project monitoring; partnership/contractor relationships.

2163632 Organisations People and Performance 2(2-0-6)

Company organization, cultures and management styles; payment schemes; trade unions and industrial relations; legislation; the role of the individual, career and personal development; technological implications; manpower and succession planning, selection and motivation; communications; conflicts between company and individual objectives.

2163611 Computer Aided Design and Manufacture 2(2-0-6)

Basis CAD concepts; 3-D concepts; 2 ½ axis NC. Programming; finite element analysis; surface modeling; coding and classification; cell control; computer aided inspection; 3 axis NC. Programming; computer aided process planning; parametric; knowledge based systems in CAD/CAM; CAD/CAM-design to manufacture demonstration; role of CAD/CAM; introduction to computer integrated manufacture (CIM); emerging technologies; case study.

2163612 Automation and Robotics 2(2-0-6)

Principles and implementation of automatic and robotics systems; automatic process control logic and sequence; automated materials handling and storage; economic justification for AMT projects; flexible manufacturing systems; vision engineering; robots at work; importance of design in automation; case studies, syndicate exercises and a visit.

2163613 e-Commerce Technologies 2(2-0-6)

E-Commerce in perspective; the application of E-Commerce tools and techniques; Internet, Intranet and Extranet; communication and network technologies; privacy and security; collaborative product commerce; data warehouses, mining and knowledge engineering; evaluation of e-commerce in functional operations; legal implications; virtual enterprises; the future of e-commerce technologies.

2163614 Metallic Materials: Properties Processes and Applications 2(2-0-6)

The structure/ property relationship - mechanical properties of metals and alloys, methods of measuring and increasing them, and their influence on process ability and application; Properties and selection of steels; heat treatment; effect of alloying; Properties and selection of cast irons; introduction to tool materials; properties and selection of non-ferrous metals; failure investigation; introduction to engineering ceramics; electronic and optical materials; metal matrix composites; introduction to primary production processes.

2163615 Polymer Materials: Processes and Applications 2(2-0-6)

Polymers as an engineering material; manufacturing technologies for polymeric materials; economics of material selection and aspects of environmental considerations; computer simulation: component, tooling and manufacturing techniques; high and low volume production manufacturing technologies; plastic component market opportunities; case study; laboratory visit

2163616 Information and Communication Technologies 2(2-0-6)

Systematic project management methodology; data modeling; database design and management; computer architectures and operating environments; system development tools and programming; data communication and network technologies; internet and world-wide-web technologies; emerging technologies; human aspects of systems implementation.

2163617 Manufacturing Process Technology 2(2-0-6)

An appreciation of the application capabilities and limitation of primary and secondary manufacturing processes.

2163618 Design for the Environment 2(2-0-6)

Train a new generation of product designers and managers who will play a major role in the move towards sustainable development. Integrate the needs of the customer with those of the environment to ensure that the society can reach a more balanced trade-off between economy and environment. An appreciation of sustainable buisness practice, energy, design, materials and life cycle analysis is key. New eco-friendly products and clean production technologies need to be developed and utilised in our drive towards sustainable development at national and global level.

2163621 Supply Chain Management 2(2-0-6)

Meaning of supply chain management; designing the supply base and selecting suppliers; supply chain relationships; measuring suppliers and the supply chain; supplier development and continuous improvement; organization design; technology
in supply chain management.

2163622 Technology Management 2(2-0-6)

Technology and its importance; case studies on the benefits/consequences of adopting/ignoring technology; how business needs and product strategy drive technological requirements; evaluation of capability of the competitors, companies to deliver technology: SWOT and benchmarking exercises; formulating company technology strategy - accessing technology; justifying technological investment - persuading decision makers; tools and techniques for assessing technology and delivering it at acceptable risk; implementation of strategy for technological change; future opportunities and developments.

2163623 Product Design and Development Management 2(2-0-6)

The role of the marketing organization; methods to turn concepts into engineering solutions; content of a design specifications; sources of costs associated with introduction of a new product; prevention of defects and scrap of rejects during manufacture and assembly; cost of ownership concept; design for simple maintenance.

2163624 Quality Management and Techniques 2(2-0-6)

Management for Quality; Motivation and Employee Involvement; Economics of Quality; Design for Quality; Basic Tools of Quality Improvement; Variability in Processes; Product Liability; Quality Systems; Failure Modes, Effects and Criticality Analysis; Quality Function Deployment.

2163625 Applied Statistical Methods 2(2-0-6)

Descriptive statistics; probability; distributions: binomial, Poisson, exponential and normal: exploratory data analysis; sampling and testing; analysis of variance; regression analysis; goodness of fit; distribution-free (non parametric) statistics; design of experiments; statistics on computer.

2163633 Operations Strategy for Industry 2(2-0-6)

The company and corporate strategy; the market requirements; products and product design; subcontracting, sourcing, make and buy decision; technology, processes, plant replacement and investment; total quality; manufacturing operations organization; diversification factoring and acquisition; joint venture and collaboration; human factors; company structure; external factors; financial controls.

2163634 Strategic Marketing 2 (2-0-6)

Introduction to marketing; types of market; marketing research and analysis; managing the marketing mix regarding product, price, place and promotion as well as the impact on it of information technology; strategic market planning perquisites and methods and management.

2163635 Information System Strategy 2 (2-0-6)

Information systems evolution; data and information presentation and management; business activity and information analysis; organizational implications; information systems architecture and selection; strategy development; legal and financial implications; industrial sector comparisons.

2163636 Innovative Strategy 2(2-0-6)

Environments for learning and innovation; The barriers to creative thinking; Understanding mind-sets through a manufacturing strategy role play; the design/development of business processes for innovation; an innovation strategy workshop; approaches to business strategies; the world of systems thinking; a business systems simulation; national issues for innovation policy; leadership styles; development of innovation action plans.

2163637 Financial Analysis and Control Systems 2(2-0-6)

Financial objectives; profitability and liquidity; analysis and interpretation of published financial statements; cost behavior analysis; profit/volume analyses; budget preparation and control; standard costing; divisional/segmental performance measurement; capital investment; risk and uncertainty analysis; effects of inflation and taxation; introduction to computer-based financial modeling.

2163638 Financial Strategy 2(2-0-6)

Capital expenditure appraisal and present value concept; taxation. Inflation and life cycle costing; financial modeling; risk and return on investment; sources of finance and market efficiency; mergers and acquisitions; international financial markets.

2163639 Management of Change 2(2-0-6)

Concept and consideration of mapping the organization, people's used in reaction to changes, concepts and consideration of individual territories, journeys to success, tools and techniques, major change programs, planning and implementing change, model for change, continuous learning and change, planning for the future

2163640 International Joint Ventures 2(2-0-6)

Collaboration strategy, concepts and types of collaborative venture, international joint venture management, guidelines for practice and culture, low and finance, negotiation and international joint venture exercises.

2163641 Establishing New Business 2(2-0-6)

Explores the personal motivators and implementation issues in setting up a new business. It explores options on the types of businesses, and the resulting legal requirements and operational regulations that may apply and how these impact on the operational structure of the business. It explores the personal compromises that will be required.

2163642 Business Environment and Economics 2(2-0-6)

Economics data; econometrics; demand/supply and the market; national and international level of economic activity; microeconomic at industry level; markets and efficiency; market failure; industry structure.

2163691 Advanced Topics in Engineering Management I 2(2-0-6)

Study of current interesting topics and new development in engineering management I.

2163692 Advanced Topics in Engineering Management II 2(2-0-6)

Study of current interesting topics and new development in engineering management II.

2163693 Advanced Topics in Engineering Management III 2(2-0-6)

Study of current interesting topics and new development in engineering management III.

2163694 Advanced Topics in Engineering Management IV 2(2-0-6)

Study of current interesting topics and new development in engineering management IV.

2163695 Advanced Topics in Engineering Management V 2(2-0-6)

Study of current interesting topics and new development in engineering management V.

2163696 Advanced Topics in Engineering Management VI **2(2-0-6)**

Study of current interesting topics and new development in engineering management VI.

2163813 Thesis **18 Credits**

Please visit our website:
https://cuse2.eng.chula.ac.th/

BIOMEDICAL ENGINEERING PROGRAM
(INTERDISCIPLINES)

Biomedical Engineering (BME) Program was founded in 2006 with the main purpose to educate the graduates who are interested in BME.

BME program involves the application of principles and practice for engineers in order to create the novel knowledge for medical purposes and to develop the diagnosis and the treatment of diseases. For example, the applications of sound waves and electromagnetic waves for diagnosis, the applications of nanotechnology for tissue transplantation and artificial organs.

After the year 2010, BME administration was transferred from the Graduate School to the Faculty of Engineering. Nowadays, BME program provides Master of Science (M.Sc.), Master of Engineering (M.Eng.), and Doctor of Philosophy (Ph.D.) degrees.

HEAD:

Pakpum	Somboon	Ph.D. (T.I.T)

PROFESSORS:

Siriporn	Damrongsakkul	Ph.D. (London)
Muenduen	Phisalaphong	Ph.D. (Colorado)
Roongroj	Bhidayasiri	Diploma (American Board of Psychiatry and Neurology, USA)
Duangporn	Werawatganon	M.D. (Chula)
Pornanong	Aramwit	Ph.D. (Wisconsin-Madison)
Somsak	Kuptniratsaikul	M.Sc. (TMC)
Voravee	Hoven	Ph.D. (Massachusetts)

ASSOCIATE PROFESSORS:

Sorada	Kanokpanont	Ph.D. (Drexel)
Pairat	Tangpornprasert	D.Eng. (Tokyo)
Saknan	Bongsebandhu-phubhakdi	Ph.D. (Tokyo)
Setha	Pan-ngum	Ph.D. (University of Warwick, UK)
Wasan	Udayachalerm	M.Sc. (Chula)
Juthamas	Ratanavaraporn	Ph.D. (Chula)
Thanarat	Chalidabhongse	Ph.D. (Maryland)
Alongkorn	Pimpin	Ph.D. (Tokyo)
Jitkomut	Songsiri	Ph.D. (California)
Nuntaree	Chaichanawongsaroj	Ph.D. (Mahidol)
Duangdao	Wichadakul	Ph.D. (Illinois)
Supatana	Auethavekiat	Ph.D. (Tokyo)
Charnchai	Pluempitiwiriyawej	Ph.D. (Carnegie Mellon)
Boonrat	Lohwongwatana	Ph.D. (California Institute of Technology,USA)
Wasuwat	Kitisomprayoonkul	Diploma Thai Board of Rehabilitation Medicine (TMC)
Pornchai	Rojsitthisak	Ph.D. (Southern California, USA)
Suwimon	Sapwarobol	DrPH. (Loma Linda University, USA)
Pranee	Rojsitthisak	Ph.D. (AIT)
Waranyoo	Phoolcharoen	Ph.D. (Arizona State University, USA)
Praneet	Pensri	Ph.D. (University of Ulster, UK)
Chanyaphan	Virulsri	Ph.D. (Tokyo)
Kumpanart	Soontornvipart	Ph.D. (University of Veterinary and Pharmaceutical Sciences, Czech Republic)
Charusluk	Viphavakit	Ph.D. (London)
Peerapon	Vateekul	Ph.D. (University of Miami, USA)

ASSISTANT PROFESSORS:

Pakpum	Somboon	Ph.D. (T.I.T)
Peerapat	Thongnuek	Ph.D. (Cambridge)
Werayut	Srituravanich	Ph.D. (California)
Arporn	Teeramongkonrasmee	Ph.D. (Chula)
Pasakorn	Watanatada	M.D. Ph.D. (Oregon State University, USA)
Chanchai	Boonla	Ph.D. (Khon Kaen)
Tewin	Tencomnao	Ph.D. (Verginia)
Apiwat	Lek-Uthai	Dr.Ing. (Karlsruhe)
Krisnachai	Chomtho	Diplomate Thai Board of Family Medicine (TMC)
Yothin	Rakvongthai	Ph.D. (Texas)
Jutarat	Kitsongsermthon	Ph.D. (Purdue University, USA)
Tippawan	Siritientong	Ph.D. (Chula)
Viroj	Boonyaratanakornkit	Ph.D. (Loma Linda University, USA)
Tewarit	Sarachana	Ph.D. George Washington University, USA
Montakarn	Chaikumarn	Ph.D. (Luleå University of Technology, Sweden)

Saran	Salakij	Ph.D. (Oregon State, USA)
Kritsada	Leungchavaphongse	M.D. Ph.D. (London)
Supansa	Yodmuang	Ph.D. (Columbia)
Thititip	Tippayamontri	Ph.D. (Canada)

INSTRUCTORS:

Trairak	Pisitkun	Board of Clinical Nephrology, Thailand (TMC)
Saran	Keeratihattayakorn	Ph.D. (Hokkaido, Japan)
Charasphat	Preuksarattanawut	D.Eng. (Chula)
Piyachai	Khomein	Ph.D. (University of Massachusetts Amherst, USA)

NAME OF THE DEGREE

: Master of Science
: M.Sc.

ADMISSION

The applicants must hold a bachelor's degree in any field of science, health science (medicine, dentistry, veterinary medicine, pharmacy, nursing, or allied health sciences), or engineering; having a GPA not lower than 2.00 based on 4 point grading system, and also passed the requirements of the Graduate School or got approval from the program committee for admission.

DEGREE REQUIREMENTS

1. The students have to pass a minimum of 12 credits of the required course, 6 credits of elective courses, and 18 credits of the thesis, a total of them not less than 36 credits.
2. The students have to pass an oral thesis examination. Some part of the thesis has to be published or accepted for publication in a journal or is presented in an academic conference having proceedings.
3. The degree will be awarded to the students who fulfill the requirements as followed; GPA. not less than 3.00, and a period of study not less than 4 semesters and not more than 8 semesters.

STUDY PROGRAM

Module 1(1)

The First Semester

2100791	Biomedical Engineering Seminar I	(2)*
2100816	Thesis	9
		9

The Second Semester

2100792	Biomedical Engineering Seminar II	(2)*
2100816	Thesis	9
		9

The Third Semester

2100816	Thesis	9
		9

The Fourth Semester

2100816	Thesis	9
		9

Module 1(2)

The First Semester

2100600	Introduction to Biomedical Engineering	3
2100791	Biomedical Engineering Seminar I	(2)*
3017767	Human Body for Biomedical Engineering	3
XXXXXXX	Approved Elective	3
		9

The Second Semester

2100792	Biomedical Engineering Seminar II	(2)*
2100601	Basic Engineering Knowledge for Biomedical Engineering	3
XXXXXXX	Approved Elective	3
XXXXXXX	Elective	6
		9

The Third Semester

2100813	Thesis	9
		9

The Fourth Semester

2100813	Thesis	9
		9

Remarks:

* No credit will be granted, evaluation will be only S/U

COURSE REQUIREMENTS

1) Required Courses 9 credits

2100600	Introduction to Biomedical Engineering	3(2-3-7)
2100601	Basic Engineering Knowledge for Biomedical Engineering	3(2-3-7)
3017767	Human Body for Biomedical Engineering	3(2-3-7)

2) Approved elective Courses 3 credits

2100640	Biomedical Statistics	3(3-0-9)
3000704	Biostatistics in Clinical Science Research	3(1-6-5)
3000793	Fundamental Biostatistics in Clinical Science Research	3(2-3-7)

3) Elective Courses 6 credits

2100510	Introduction to Biomedical Engineering for Medical Students	3(3-0-9)
2100511	Special Topics in Biomedical Engineering for Medical Students I	3(3-0-9)
2100512	Special Topics in Biomedical Engineering for Medical Students II	3(3-0-9)
2100513	Special Topics in Biomedical Engineering for Medical Students III	3(3-0-9)
2100514	Special Topics in Biomedical Engineering for Medical Students IV	3(3-0-9)
2100515	Special Topics in Biomedical Engineering for Medical Students V	3(3-0-9)
2100516	Introductory Research Experience in Biomedical Engineering	4(4-0-12)
2100517	Advanced Research Experience in Biomedical Engineering I	4(4-0-12)
2100518	Advanced Research Experience in Biomedical Engineering II	3(3-0-9)
2100519	Advanced Research Experience in Biomedical Engineering III	3(3-0-9)
2100520	Advanced Research Experience in Biomedical Engineering IV	4(4-0-12)
2100521	Advanced Research Experience in Biomedical Engineering V	4(4-0-12)
2100522	Advanced Research Experience in Biomedical Engineering VI	4(4-0-12)
2100604	Strategic Tissue Engineering and Controlled Release System	3(3-0-9)
2100605	Biomedical Embedded System	3(3-0-9)
2100606	Cell Culture and Genetic Engineering for Tissue Regeneration	3(3-0-9)
2100611	Special Topics in Biomedical Engineering I (Medical Instrument and Rehabilitation Engineering	3(3-0-9)
2100612	Special Topics in Biomedical Engineering II (Biomechanics)	3(3-0-9)
2100613	Special Topics in Biomedical Engineering III (Tissue Engineering and Drug Delivery)	3(3-0-9)
2100614	Special Topics in Biomedical Engineering IV (Medical Imaging)	3(3-0-9)
2100615	Special Topics in Biomedical Engineering V (Bioinformatics and Mathematical Biology)	3(3-0-9)
2100616	Materials chemistry and molecular characterization of materials	3(3-0-9)
2100617	Assistive and Rehabilitation Technology	3(3-0-9)
2100618	Biomechanics	3(3-0-9)
2100619	Advanced Embedded System Design	3(3-0-9)
2100620	Biosensors and Bioelectronics	3(3-0-9)
2102505	Introduction to Optimization Techniques	3(3-0-9)
2102507	Computational Techniques for Engineers	3(3-0-9)
2102524	Medical Imaging Technology	3(3-0-9)
2102546	Analog Integrated Circuits	3(3-0-9
2102611	Medical Instrumentation	3(3-0-9)
2102635	Control System Theory	3(3-0-9)
2102785	Advanced Sensor Theory	3(3-0-9)
2102876	Adaptive Signal Processing	3(3-0-9)
2103571	Micro and Nano Electromechanical Systems	3(3-0-9)
2105641	Biodegradable Material Engineering	3(3-0-9)
2110675	Biomedical Information and Communication Systems	3(3-0-9)
2110743	Machine Learning	3(3-0-9)
2110746	Big Data Analytics	3(3-0-9)
2301675	Mathematical Modeling	3(3-0-9)
3000716	Basic Mathematical Biology	3(3-0-9)
3000748	Tissue and Cell Engineering	3(3-0-9)
3000767	Systems Biology	2(2-0-6)
3011964	Digital Processing of Medical Images	2(2-0-6)
3011967	PET and SPECT Image Reconstruction and Analysis	2(2-0-6)
3011969	Advanced Medical Imaging Physics	2(2-0-6)

2) Thesis

2100813	Thesis	18 credits
2100816	Thesis	36 credits

Remarks:

** New course

NAME OF THE DEGREE

: Master of Engineering
: M.Eng.

ADMISSION

The applicants must hold a bachelor's degree in engineering; have GPA not less than 2.00 based on 4 point grading system, and also passed the requirements of the Graduate School or got approval from the program committee for admission.

DEGREE REQUIREMENTS

1. The students have to pass a minimum of 9 credits of the required course, 3 credits of approved elective, 6 credits of elective courses, and 18 credits of the thesis, a total of them not less than 36 credits.
2. The students have to pass an oral thesis examination. Some part of thesis has to be published or accepted for publication in a journal or is presented in an academic conference having proceedings.
3. The degree will be awarded to the students who fulfill the requirements as followed; GPA not less than 3.00, and a period of study not less than 4 semesters and not more than 8 semesters.

STUDY PROGRAM

Module 1(1)

The First Semester

2100791	Biomedical Engineering Seminar I	(2)*
2100816	Thesis	9
		9

The Second Semester

2100792	Biomedical Engineering Seminar II	(2)*
2100816	Thesis	9
		9

The Third Semester

2100816	Thesis	9
		9

The Fourth Semester

2100816	Thesis	9
		9

Module 1(2)

The First Semester

2100600	Introduction to Biomedical Engineering	3
2100791	Biomedical Engineering Seminar I	(2)
3017767	Human Body for Biomedical Engineering	3
XXXXXXX	Approved Elective Group 1	3
		9

The Second Semester

2100792	Biomedical Engineering Seminar II	(2)*
XXXXXXX	Approved Elective Group 2	3
XXXXXXX	Elective	6
		9

The Third Semester

2100813	Thesis	9
		9

The Fourth Semester

2100813	Thesis	9
		9

Remarks:

* No credit will be granted, evaluation will be only S/U

COURSE REQUIREMENTS

1) Required Courses 6 credits

2100600	Introduction to Biomedical Engineering	3(2-3-7)
3017767	Human Body for Biomedical Engineering	3(2-3-7)

2) Approved elective Courses 6 credits

Group 1

2100640	Biomedical Statistics	3(3-0-9)
3000704	Biostatistics in Clinical Science Research	3(1-6-5)
3000793	Fundamental Biostatistics in Clinical Science Research	3(2-3-7)

Group 2

2100611	Special Topics in Biomedical Engineering I (Medical Instrument and Rehabilitation Engineering)	3(3-0-9)
2100612	Special Topics in Biomedical Engineering II (Biomechanics)	3(3-0-9)
2100613	Special Topics in Biomedical Engineering III (Tissue Engineering and Drug Delivery)	3(3-0-9)

2100614	Special Topics in Biomedical Engineering IV (Medical Imaging)	3(3-0-9)
2100615	Special Topics in Biomedical Engineering V (Bioinformatics and Mathematical Biology)	3(3-0-9)

3) Elective Courses 6 credits

2100604	Strategic Tissue Engineering and Controlled Release System	3(3-0-9)
2100605	Biomedical Embedded System	3(3-0-9)
2100606	Cell Culture and Genetic Engineering for Tissue Regeneration	3(3-0-9)
2100616	Materials chemistry and molecular characterization of materials	3(3-0-9)
2100617	Assistive and Rehabilitation Technology	3(3-0-9)
2100618	Biomechanics	3(3-0-9)
2100619	Advanced Embedded System Design	3(3-0-9)
2100620	Biosensors and Bioelectronics	3(3-0-9)
2102505	Introduction to Optimization Techniques	3(3-0-9)
2102507	Computational Techniques for Engineers	3(3-0-9)
2102524	Medical Imaging Technology	3(3-0-9)
2102546	Analog Integrated Circuits	3(3-0-9
2102611	Medical Instrumentation	3(3-0-9)
2102635	Control System Theory	3(3-0-9)
2102785	Advanced Sensor Theory	3(3-0-9)
2102876	Adaptive Signal Processing	3(3-0-9)
2103571	Micro and Nano Electromechanical Systems	3(3-0-9)
2105641	Biodegradable Material Engineering	3(3-0-9)
2105651	Bioreactor Design and Control	3(3-0-9)
2110675	Biomedical Information and Communication Systems	3(3-0-9)
2110743	Machine Learning	3(3-0-9)
2110746	Big Data Analytics	3(3-0-9)
2301675	Mathematical Modeling	3(3-0-9)
3000716	Basic Mathematical Biology	3(3-0-9)
3000748	Tissue and Cell Engineering	3(3-0-9)
3000767	Systems Biology	2(2-0-6)
3011964	Digital Processing of Medical Images	2(2-0-6)
3011967	PET and SPECT Image Reconstruction and Analysis	2(2-0-6)
3011969	Advanced Medical Imaging Physics	2(2-0-6)

4) Thesis

2100813	Thesis	18 credits
2100816	Thesis	36 credits

NAME OF THE DEGREE

: Doctor of Philosophy
: Ph.D.

ADMISSION

The applicants have to pass the following basic requirements:

For Module 1:

Module 1(1) for applicants holding a master's degree in biomedical engineering and having the thesis comparable to the excellent level and also passed the requirements of the Graduate School or got approval from the program committee for admission.

Module 1(2) for applicants holding a bachelor's degree in engineering or science and having at least a second honors degree or having GPA not less than 3.25 based on 4 point grading system, and also passed the requirements of the Graduate School or got approval from the program committee for admission.

For Module 2:

Module 2(1) for applicants holding a master's degree in biomedical engineering, master's degree in engineering or science and having the thesis comparable to the good level , and also passed the requirements of the Graduate School or got approval from the program committee for admission.

Module 2(2) for applicants holding a bachelor's degree in engineering or science and having at least a second honors degree or having GPA not less than 3.25 based on 4 point grading system, and also passed the requirements of the Graduate School or got approval from the program committee for admission.

DEGREE REQUIREMENTS

For Module 1(1):

The students have to get 60 credits of the thesis, also pass an oral examination and some part of the thesis has to be published or accepted for publication in a journal. Two research articles must be published, and one of which has to in an international journal.

For Module 1(2):

The students have to get 72 credits of the thesis, also passed an oral examination and some part of thesis has to be published or accepted for publication in a journal. Two research articles must be published, and one of which has to in an international journal.

For Module 2(1):

The students have to get 12 credits of elective courses and 48 credits of the thesis, a total of 60 credits, also passed an oral examination and some part of thesis has to be published or accepted for publication in an international journal.

For Module 2(2):

The students have to get 24 credits of elective courses and 48 credits of the thesis, a total of 72 credits, also passed an oral examination and some part of thesis has to be published or accepted for publication in an international journal.

Remark:

Module 1 may require additional courses or other academic activities (no credit will be granted, evaluation will be only S/U) that are beneficial for the thesis, under consent of the advisor and the program committee.

STUDY PROGRAM

Module 1(1)

The First Semester

2100781	Biomedical Engineering Seminar I	(2)*
2100829	Dissertation	12
		12

The Second Semester

2100782	Biomedical Engineering Seminar II	(2)*
2100829	Dissertation	12
2100897	Qualifying Examination	(0)*
		12

The Third Semester

2100783	Biomedical Engineering Seminar III	(2)*
2100829	Dissertation	9
		9

The Fourth Semester

2100784	Biomedical Engineering Seminar IV	(2)*
2100829	Dissertation	9
		9

The Fifth Semester

2100829	Dissertation	9
2100884	Doctoral Dissertation Seminar	(0)*
		9

The Sixth Semester

2100829	Dissertation	9
2100884	Doctoral Dissertation Seminar	(0)*
		9

Module 1(2)

The First Semester

2100781	Biomedical Engineering Seminar I	(2)*
2100830	Dissertation	9
		9

The Second Semester

2100782	Biomedical Engineering Seminar II	(2)
2100830	Dissertation	9
2100897	Qualifying Examination	(0)
		9

The Third Semester

2100783	Biomedical Engineering Seminar III	(2)*
2100830	Dissertation	9
		9

The Fourth Semester

2100784	Biomedical Engineering Seminar IV	(2)*
2100830	Dissertation	9
		9

The Fifth Semester

2100830	Dissertation	9
2100884	Doctoral Dissertation Seminar	(0)*
		9

The Sixth Semester

2100830	Dissertation	9
2100884	Doctoral Dissertation Seminar	(0)*
		9

The Seventh Semester

2100830	Dissertation	9
2100884	Doctoral Dissertation Seminar	(0)*
		9

The Eighth Semester

2100830	Dissertation	9
2100884	Doctoral Dissertation Seminar	(0)*
		9

Remarks:

* No credit will be granted, Evaluation will be only S/U

Module 2(1)

The First Semester

2100791	Biomedical Engineering Seminar I	(2)*
XXXXXXX	Elective	9
		9

The Second Semester

2100792	Biomedical Engineering Seminar II	(2)*
2100828	Dissertation	6
XXXXXXX	Elective	3
2100897	Qualifying Examination	(0)*
		9

The Third Semester

2100793	Biomedical Engineering Seminar III	(2)*
2100828	Dissertation	9
		9

The Fourth Semester

2100794	Biomedical Engineering Seminar IV	(2)*
2100828	Dissertation	9
		9

The Fifth Semester

2100828	Dissertation	
	12	
2100894	Doctoral Dissertation Seminar	(0)*
		12

The Sixth Semester

2100828	Dissertation	12
2100894	Doctoral Dissertation Seminar	(0)*
		12

Module 2(2)

The First Semester

2100791	Biomedical Engineering Seminar I	(2)*
XXXXXXX	Elective	9
		9

The Second Semester

2100792	Biomedical Engineering Seminar II	(2)*
XXXXXXX	Elective	9
2100897	Qualifying Examination	(0)*
		9

The Third Semester

2100793	Biomedical Engineering Seminar III	(2)*
2100828	Dissertation	3
XXXXXXX	Elective	6
		9

The Fourth Semester

2100794	Biomedical Engineering Seminar IV	(2)*
2100828	Dissertation	9
		9

The Fifth Semester

2100828	Dissertation	9
2100894	Doctoral Dissertation Seminar	(0)*
		9

The Sixth Semester

2100828	Dissertation	9
2100894	Doctoral Dissertation Seminar	(0)*
		9

The Seventh Semester

2100828	Dissertation	9
2100894	Doctoral Dissertation Seminar	(0)*
		9

The Eighth Semester

2100828	Dissertation	9
2100894	Doctoral Dissertation Seminar	(0)*
		9

Remarks:

* No credit will be granted, Evaluation will be only S/U

COURSE REQUIREMENTS

1) Elective Courses

Module 2.1 = 12 credits and Module 2.2 = 24 credits

2100600	Introduction to Biomedical Engineering	3(2-3-7)
2100601	Basic Engineering Knowledge for Biomedical Engineering	3(2-3-7)
2100604	Strategic Tissue Engineering and Controlled Release System	3(3-0-9)
2100605	Biomedical Embedded System	3(3-0-9)
2100606	Cell Culture and Genetic Engineering for Tissue Regeneration	3(3-0-9)
2100611	Special Topics in Biomedical Engineering I	3(3-0-9)
2100612	Special Topics in Biomedical Engineering II	3(3-0-9)
2100613	Special Topics in Biomedical Engineering III	3(3-0-9)
2100614	Special Topics in Biomedical Engineering IV	3(3-0-9)
2100615	Special Topics in Biomedical Engineering V Advanced Topics in Biomedical Engineering II	3(3-0-9)
2100616	Materials Chemistry and Molecular Characterization of Materials	3(3-0-9)
2100617	Assistive and Rehabilitation Technology	3(3-0-9)
2100618	Biomechanics	3(3-0-9)
2100619	Advanced Embedded System Design	3(3-0-9)
2100620	Biosensors and Bioelectronics	3(3-0-9)
2102505	Introduction to Optimization Techniques	3(3-0-9)
2102507	Computational Techniques for Engineers	3(3-0-9)
2102524	Medical Imaging Technology	3(3-0-9)
2102546	Analog Integrated Circuits	3(3-0-9)
2102611	Medical Instrumentation	3(3-0-9)
2102635	Control System Theory	3(3-0-9)
2102785	Advanced Sensor Theory	3(3-0-9)
2102876	Adaptive Signal Processing	3(3-0-9)
2103571	Micro and Nano Electromechanical Systems	3(3-0-9)
2105641	Biodegradable Material Engineering	3(3-0-9)
2110675	Biomedical Information and Communication Systems	3(3-0-9)
2110743	Machine Learning	3(3-0-9)
2110746	Big Data Analytics	3(3-0-9)
2301675	Mathematical Modeling	3(3-0-9)
3000704	Biostatistics in Clinical Science	

	Research	3(1-6-5)
3000716	Basic Mathematical Biology	3(3-0-9)
3000748	Tissue and Cell Engineering	3(3-0-9)
3000767	Systems Biology	2(2-0-6)
3000793	Fundamental Biostatistics in Clinical Science	3(2-3-7)
3011964	Digital Processing of Medical Images	2(2-0-6)
3011967	PET and SPECT Image Reconstruction and Analysis	2(2-0-6)
3011969	Advanced Medical Imaging Physics	2(2-0-6)
3017767	Human Body for Biomedical Engineering	3(3-0-9)

2) Thesis

2100828	Dissertation	48 credits
2100829	Dissertation	60 credits
2100830	Dissertation	72 credits

COURSE DESCRIPTIONS IN BIOMEDICAL ENGINEERING
(M.Eng., M.Sc., Ph.D.)

2100510 Introduction to Biomedical Engineering for Medical Students 3(3-0-9)

Definition of biomedical engineering and other related fields; roles of biomedical engineers; introduction to technology, instruments and basic application programs required for biomedical engineering; ethics in biomedical engineering; case studies: problems and applications various fields in biomedical engineering; hospital and laboratory visits, and assigned projects to explore the breadth and depth of biomedical engineering.

2100511 Special Topics on Biomedical Engineering for Medical Students I 3(3-0-9)

Topics and technology on medical instruments and rehabilitation; namely, vital sign monitoring devices, biosensor, biomedical signal processing, biomedical embedded system, assistive technology, equipment for rehabilitation, telemedicine.

2100512 Special Topics on Biomedical Engineering for Medical Students II 3(3-0-9)

Topics and technology on biomechanics; namely, prosthetics, medical implants, microfluidics, MEMS technology, sports biomechanics and medical robotics.

2100513 Special Topics on Biomedical Engineering for Medical Students III 3(3-0-9)

Topics and technology on tissue engineering and drug delivery system; namely, biomaterials, scaffolds, cell culture, cell signaling, regenerative medicine, drug delivery, microspheres, liposomes and drug encapsulation.

2100514 Special Topics on Biomedical Engineering for Medical Students IV 3(3-0-9)

Topics and technology on medical imaging; namely, X-ray, SPECT, PET, MRI, ultrasound, image acquisition, image formation, image analysis, resolution and artificial intelligence.

2100515 Special Topics on Biomedical Engineering for Medical Students V 3(3-0-9)

Topics and technology on bioinformatics; namely, biological databases, genomics, biological computation, bioinformatics algorithms, bioinformatics Big data and indepth learning of bioinformatics.

2100516 Introductory research experience in biomedical engineering 4(1-9-2)**

Introductory topics and technology related to a specific branch in biomedical engineering including biomechanics, tissue engineering and drug delivery systems, medical devices and instrumentation, bioinformatics, medical imaging, and rehabilitation technology.

2100517 Advanced research experience in biomedical engineering I 4(1-9-2)**

Advanced topics and technology related to a specific branch in biomedical engineering including biomechanics, tissue engineering and drug delivery systems, medical devices and instrumentation, bioinformatics, medical imaging, and rehabilitation technology; Analysis and synthesis of scientific research articles related to the students' research area.

2100518 Advanced research experience in biomedical engineering II 3(3-0-9)**

Advanced topics and technology related to a specific branch in biomedical engineering including biomechanics, tissue engineering and drug delivery systems, medical devices and instrumentation, bioinformatics, medical imaging, and rehabilitation technology; Analysis and synthesis of scientific research articles related to the students' research area.

2100519 Advanced research experience in biomedical engineering III 3(3-0-9)**

Advanced topics and technology related to a specific branch in biomedical engineering including biomechanics, tissue engineering and drug delivery systems, medical devices and instrumentation, bioinformatics, medical imaging, and rehabilitation technology; Analysis and synthesis of scientific research articles related to the students' research area.

2100520 Advanced research experience in biomedical engineering IV 4(1-9-2)**

Advanced topics and technology related to a specific branch in biomedical engineering including biomechanics, tissue engineering and drug delivery systems, medical devices and instrumentation, bioinformatics, medical imaging, and rehabilitation technology; Analysis and synthesis of scientific research articles related to the students' research area.

2100521 Advanced research experience in biomedical engineering V 4(1-9-2)

Advanced topics and technology related to a specific branch in biomedical engineering including biomechanics, tissue engineering and drug delivery systems, medical devices and instrumentation, bioinformatics, medical imaging, and rehabilitation technology; Analysis and synthesis of scientific research articles related to the students' research area.

2100522 Advanced research experience in biomedical engineering VI 4(1-9-2)

Advanced topics and technology related to a specific branch in biomedical engineering including biomechanics, tissue engineering and drug delivery systems, medical devices and instrumentation, bioinformatics, medical imaging, and rehabilitation technology; Analysis and synthesis of scientific research articles related to the students' research area.

2100600 Introduction to Biomedical Engineering 3(2-3-7)

Definition of biomedical engineering and other related fields; role of biomedical engineers; introduction to technology, instruments and basic application programs required for biomedical engineering; ethics in biomedical engineering; case studies: problem and application in biomedical engineering fields; hospital and laboratory visit, and assigned projects to explore the breadth and depth of the biomedical engineering field.

2100601 Basic Engineering Knowledge for Biomedical Engineering 3(2-3-7)

Review of differential equations and transform techniques; signals, circuits and electronics; feedback mechanism, biomaterials; biomedical measurements and instrumentation; technological applications in medical practices; computer applications in biomedical engineering.

2100604 Strategic Tissue Engineering and Controlled Release System 3(3-0-9)

Basic principle, strategies and components of tissue engineering and controlled release system; combination and interaction of biomaterial scaffolds, cells, and biological signaling molecules; requirements and criteria of material design for strategic tissue engineering and controlled release system; functions, applications and limitations of materials in strategic tissue engineering and controlled release system; biological response to biomaterials; mechanism of material-induced tissue regeneration and material-governed controlled release.

2100605 Biomedical Embedded System 3(3-0-9)

Embedded system technology and its biomedical applications; types and selection of embedded system for biomedical applications; basic design of embedded system; hardware and sensor interface; real-time processing based on embedded system; advanced, design of embedded system for biomedical applications.

2100606 Cell Culture and Genetic Engineering for Tissue Regeneration 3(3-0-9)

Cell culture; stem cells; cell differentiation, cell proliferation, biological characterisation; sterile techniques; laboratory apparatuses and biosafety; lab skills; lab demonstration; cell culture experiment; cell visualisation; microscopic techniques; Genetic engineering; Tissue engineering; joint and cartilage, bone, tendon and ligament, muscles, blood vessels, eyes, cell encapsulation

2100611 Special Topics in Biomedical Engineering I 3(3-0-9)

Current advanced topics and new technologies in biomedical engineering

2100612 Special Topics in Biomedical Engineering II 3(3-0-9)

Current advanced topics and new technologies in biomedical engineering

2100613 Special Topics in Biomedical Engineering III 3(3-0-9)

Current advanced topics and new technologies in biomedical engineering

2100614 Special Topics in Biomedical Engineering IV 3(3-0-9)

Current advanced topics and new technologies in biomedical engineering

2100615 Special Topics in Biomedical Engineering V 3(3-0-9)

Current advanced topics and new technologies in biomedical engineering

2100616 Materials Chemistry and Molecular Characterization of Materials 3(3-0-9)

Atom structures; chemical bonding & molecules; reactions & kinetics; aqueous solutions; crystalline & amorphous materials; organic materials; spectrometry; Fourier-transformed infrared spectrometry (FTIR); Raman spectrometry; mass spectrometry; nuclear magnetic resonance (NMR); X-ray diffractometry (XRD); Cryo-electron microscopy (Cryo-EM)

2100617 Assistive and Rehabilitation Technology 3(3-0-9)

Problems and basic rehabilitation techniques; human centered concept and design of assistive and rehabilitation devices and technologies; examples of assistive devices, e.g. wheelchairs, prostheses, hearings aids, visual aids, specialized computer software and hardware, and rehabilitation robotics.

2100618 Biomechanics 3(3-0-9)

Biomechanics of human movement; static and dynamic biomechanics; forces and moments in human posture and movement; musculoskeletal anatomy; knowledge of joint mechanics and example of the analysis and design of artificial joints, biofluid mechanics.

2100619 Advanced Embedded System Design 3(3-0-9)

System configuration; power supply and power management; memory; clock controller; interrupts management; timer and RTC; DMA; analog and digital signal interface circuits; data communication and peripherals, low-power system design and testing.

2100620 Biosensors and Bioelectronics 3(3-0-9)

Principle and components of biosensors; classification of biosensor; fabrication proess; electronic circuit interface; signal processing; biomeical applications.

2100640 Biomedical Statistics 3(3-0-9)

Theory and methods for biomedical statistics.

2100781 Biomedical Engineering Seminar I 2(2-0-6)

Current topics in biomedical engineering.

2100782 Biomedical Engineering Seminar II 2(2-0-6)

Current topics in biomedical engineering.

2100783 Biomedical Engineering Seminar III 2(2-0-6)

Current topics in biomedical engineering.

2100784 Biomedical Engineering Seminar IV 2(2-0-6)

Current topics in biomedical engineering.

2100791 Biomedical Engineering Seminar I 2(2-0-6)

Current topics in biomedical engineering.

2100792 Biomedical Engineering Seminar II 2(2-0-6)

Current topics in biomedical engineering.

2100793 Biomedical Engineering Seminar III 2(2-0-6)

Current topics in biomedical engineering.

2100794 Biomedical Engineering Seminar IV 2(2-0-6)

Current topics in biomedical engineering.

2100813 Thesis 0(0-0-0)

2100816 Thesis 0(0-0-0)

2100828 Dissertation 0(0-0-0)

2100829 Dissertation 0(0-0-0)

2100830 Dissertation 0(0-0-0)

2100884 Doctoral Dissertation Seminar 0(0-0-0)

2100894 Doctoral Dissertation Seminar 0(0-0-0)

2100897 Qualifying Examination 0(0-0-0)

2102505 Introduction to Optimization Techniques 3(3-0-9)

Review of linear algebra; solution of nonlinear equations; optimality conditions for unconstrained optimization; numerical methods for unconstrained optimization: steepest descent, Newton's, variable metric, and conjugate gradient methods; optimality conditions for constrained optimization; numerical methods for constrained optimization: penalty and barrier functions, and sequential quadratic programming; solution of linear programming by simplex method.

2102507 Computational Techniques for Engineers 3(3-0-9)

Mathematical preliminaries; computer arithmetic; solution of nonlinear equations; solving systems of linear equations; approximating functions; numerical differentiation and integration; numerical solution of ordinary differential equations.

2102524 Medical Imaging Technology 3(3-0-9)

Introduction to the formation of various medical imaging modalities: computed tomography (CT), magnetic resonance imaging (MRI), and ultrasonography; image reconstruction, image enhancement, image segmentation, image representation and analysis, image registration, and image visualization.

2102546 Analog Integrated Circuits 3(3-0-9)

IC Technology; analog circuit modeling; device characterization; analog subcircuits; amplifiers; comparators; operational amplifiers; digital-analog and analog-digital converters; other analog circuits and systems; reference sources; multipliers.

2102611 Medical Instrumentation 3(3-0-9)

Basic concepts of amplifiers, signal processing, electrodes, biopotential, sensors, medical devices, therapeutic devices, medical imaging, electrical safety; measurement of blood pressure, blood flow, and biopotential signals; designing and constructing simple medical instruments.

2102635 Control System Theory 3(3-0-9)

Mathematical descriptions of dynamic systems; solutions of linear dynamic equations; stability, controllability and observability; internal stability of interconnected systems; state feedback; optimal regulation; observers and observer-based compensation; introduction to optimal control.

2102785 Advanced Sensor Theory 3(3-0-9)

Principle and theory of physical and chemical sensors; thermodynamics and sensor operation; sensor fabrication technology; micro-machining; sensor fusion; intelligent sensors; data processing and analytical methods.

2102876 Adaptive Signal Processing 3(3-0-9)

Performance analysis of the linear and non-linear adaptive filtering; the linear filtering: method of steepest descent, least-mean square algorithm; non-linear filtering: artificial neural network using the back-propagation algorithm, radial basis function network, and (unsupervised learning based on) k-means clustering.

2103571 Micro and Nano Electromechanical Systems 3(3-0-9)

Overview of MEMS-NEMS, review of engineering mechanics and thermo-fluid engineering, electromechanics and light phenomena, micro system design, scaling of micromechanical devices, MEMS materials, review of micro fabrication, applications of MEMS, and future trends in technology development.

2105641 Biodegradable Material Engineering 3(3-0-9)

Types of biodegradable materials : synthetic and natural materials, sources and production, properties, biocompatibility, biodegradation mechanism, test methods for biodegradable plastics: polysaccharides, biopolyester, and protein (collagen, gelatin), biodegradable polymers for tissue engineering and controlled release.

2110675 Biomedical Information and Communication Systems 3(3-0-9)

Selected topics in information systems: multimedia technology, database system, data security and encryption; selected topics in communication systems: telecommunication, data network technology, Internet; biomedical applications of information and communication systems: telemedicine, medical data communication system in hospitals, role of information and communication technology on health care.

2110743 Machine Learning 3(3-0-9)

Introduction to machine learning; concept learning; decision tree learning; linear regression; logistic regression; artificial neural networks; evaluating hypotheses, bayesian learning, computational learning theory; instance-based learning; support vector machines; learing set of rules.

2110746 Big Data Analytics 3(3-0-9)

Introduction to big data analytics; hadoop, map-reduce; spark, programming languages for big data analytics; search and indexing; recommendation system; regression; classification; clustering and feature selection.

2301675 Mathematical Modeling 3(3-0-9)

Formulation of discrete and continuous problems drawn from various applications leading to mathematical models; optimization techniques and solution techniques for integral equations; systems of algebraic equations and systems of algebraic equations and systems of differential equations.

3000704 Biostatistics in Clinical Science Research 3(1-6-5)

Basic concept for engineering of new cells and tissues: components, tissue and organ healing and regeneration processes, ligands and receptors, adhesion and migration of cells; roles of hormones, proteins, stem cells, and immunology on organ transplantation; technology for cell and tissue engineering, scaffolds, nanomaterials, controlled release of metabolites and proteins, surface modification, cell culture in 2- and 3-dimensions; including current clinical applications and future trends.

3000716 Basic Mathematical Biology 3(3-0-9)

Introduction to basic mathematical biology; enzyme kinetics and cooperative binding; Reynolds number and diffusive transport; Hodgkin Huxley nerve conduction model; electrocardiography (EKG) and cardiac contraction model; ventilation and perfusion in respiratory system; fluid flow in urinary system

3000748 Tissue and Cell Engineering 3(3-0-9)

Basic concept for engineering of new cells and tissues: components, tissue and organ healing and regeneration processes, ligands and receptors, adhesion and migration of cells; roles of hormones, proteins, stem cells, and immunology on organ transplantation; technology for cell and tissue engineering, scaffolds, nanomaterials, controlled release of metabolites and proteins, surface modification, cell culture in 2- and 3-dimensions; including current clinical applications and future trends.

3000767 Systems Biology 2(2-0-6)

Introduction to systems biology; genomics and transcriptomics; proteomics and post-translational modifications; protien-DNA interactions and protien-protien interactions; quantitative methods in systems biology; signal processing; statistical analysis and data validation in bioinformatics; basic bioinformatics programming in Java; systems modeling; application of systems biology in biomedical research.

3000793 Fundamental Biostatistics in Clinical Science Research 3(2-3-7)

Introduction to systems biology; genomics and transcriptomics; proteomics and post-translational modifications; protien-DNA interactions and protien-protien interactions; quantitative methods in systems biology; signal processing; statistical analysis and data validation in bioinformatics; basic bioinformatics programming in Java; systems modeling; application of systems biology in biomedical research.

3011964 Digital Processing of Medical Images 2(2-0-6)

Fundamental digital processing of medical images; image reconstruction; image corrections and

enhancements; image registration; image segmentation; quantitative image analysis; statistical processing methods including Monte Carlo methods; display methods and technology; and 3D visualization; advanced and mew techniques in digital processing of medical images at present.

3011967 PET and SPECT Image Reconstruction and Analysis **2(2-0-6)**

Principle of image reconstruction and data analysis in Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT), including image acquisition and processing, image correction techniques, partial volume effect correction technique, the kinetic modeling of radiopharmaceuticals; application of PET and SPECT imaging in various medical and advanced research.

3011969 Advanced Medical Imaging Physics **2(2-0-6)**

Current topics in diagnostic imaging, including linear system theory, image quality metrology, digital radiography and mammography; advanced three-dimensional imaging modalities; MRI, CT, ultrasound and evaluation methods of diagnostic imaging; modern digital designs, SPECT, coincidence imaging principles; PET instrumentation; radionuclide and x-ray CT transmission scanning techniques; nuclear medicine treatments; surgical probes.

3017767 Human Body for Biomedical Engineering **3(2-3-7)**

Anatomy, physiology and biochemistry of the human body, including the musculoskeletal, nervous, respiratory, cardiovascular, alimentary, urinary, endocrine and reproductive systems; physiological laboratories of systems related to biomedical engineering..

DEFENSE ENGINEERING AND TECHNOLOGY

This curriculum was created according to Her Royal Highness Princess Sirinthorn's wish to establish the academic collaborations between Chulachomkloa Royal Military Academy and Chulalongkorn University. The Memorandum of Understanding between two institutes was signed on September 23th, 2013 with 5-year duration. The faculty of engineering has initiate the academic collaborations by co-developing Master Program in Defense Engineering and Technology which is the result of merging engineerings and military defense technologies. Now, the program is open in 8 majors; Civil Engineering and Explosives, Electrical Engineering for Defense, Mechanical Engineering for Defense, Materials Engineering and technology for Defense, Computer Engineering for Defense, Environment Engineering for Defense, Nuclear Engineering for Defense, and Integrated Knowledge for National Defense Engineering

HEAD:

Panyawat	Wangyao	Ph.D. (Kosice)
Col.Phaderm	Nangsue	Ph.D. (Clarkson)

PROFESSORS:

Viboon	Sricharoenchaikul	Ph.D. (Georgia Institute of Technology, USA)
Lunchakorn	Wuttisittikulkij	Ph.D. (University of Essex)
Col.Suwimon	Saneewong	Ph.D. (Thammasat) Na Ayuttaya

ASSOCIATE PROFESSORS:

Withit	Pansuk	Ph.D. (Hokkaido)
Pichaya	Rachdawong	Ph.D. (Wisconsin-Milwaukee)
Nopdanai	Ajavakom	Ph.D. (California)
Sunchai	Nilsuwankosit,	Ph.D. (Wisconsin)
Sirima	Panyametheekul	Ph.D. (London)
Seksak	Asavavisithchai	Ph.D. (University of Nottingham, UK)
Proadpran	Punyabukkana	Ph.D. (Claremont Graduate University)
Col.Phaderm	Nangsue	Ph.D. (Clarkson)
Pasu	Kaewplung	Ph.D. (University of Tokyo)
Pol.Col.Surat	Sariung	(Nakhon Pathom Rajabhat University)

ASSISTANT PROFESSORS:

Panyawat	Wangyao	Ph.D. (Kosice)
Col.Nuthaporn	Nuttayasakol	Ph.D. (Virginia Polytechnic)
Col.Krittayaporn	Charoenpol	Ph.D. (Kasetsart University)
Col.Arsit	Boonyaprapasorn	Ph.D. (Case Western Reserve University)
Col.Pongpun	Juntakut	Ph.D. (Nebraska-Lincoln, USA)
Nuksit	Noomwongs	Ph.D. (Tokyo University of Agriculture and Technology, Japan)

INSTRUCTORS:

Lt.Col.Nawapong Unsuree	Ph.D. (Manchester, UK)
Teerapol Silawan	Ph.D.(Chulalongkorn University)
Pol.Lt.Col.Dr.Usanut Sangtongdee	Ph.D.(Mahidol University)
Pol.Lt.Col.Dr.Wongyos Kerdsri	Ph.D.(IIC University of Technology)
Pol.Lt.Col.Dr.Pinyo Mephium	Ph.D.(Rangsit Univers

NAME OF THE DEGREE

: Master of Engineering
: M.Eng.

ADMISSION

The applicants must hold a Bachelor degree in Engineering, Science, or equivalent and also passed the requirements of the Graduate School or got approval from the program committee for admission.

DEGREE REQUIREMENTS

1. **Pattern 1(1)** program consists of
   - 1.1 Thesis — 36 credits
   - 1.2 2120601 Defense Engineering and Technology Principles — S/U
   - 1.3 Seminar (2 credits) — S/U

2. **Pattern 1(2)** program consists of
   - **2.1 Core course — 3 credits**
     2120601 Defense Engineering and Technology Principles — 3(3-0-9)
   - **2.2 Approve elective course — 0-9 credits**

1) Explosive and civil engineering — 6 credits
2) Nuclear Engineering for Defense Engineering — 9 credits
3) Electrical Engineering for Defense/ Mechanical Engineering for Defense/ Environment Engineering for Defense/ Materials Engineering and Technology for Defense/ Computer Engineering for Defense/

Integrated Knowledge for National Defense Engineering
No prerequisite requirement

2.3 Free Elective 6-15 credits

1) Explosive and civil engineering 9 credits
2) Nuclear Engineering for Defense Engineering 6 credits
3) Electrical Engineering for Defense Engineering 15 credit
4) Mechanical Engineering for Defense Engineering 15 credit
5) Environmental Engineering for Defense Engineering 15 credit
6) Material Engineering and Technology for Defense Engineering 15 credit
7) Computer Engineering for Defense Engineering 15 credit
8) Integrated Knowledge for National Defense Engineering 15 credit

Students in Electrical Engineering for Defense/Mechanical Engineering for Defense/Material Engineering and Technology for Defense/Computer Engineering for Defense/ Environment Engineering for Defense must take signified course for their major at least 9 credits and take other course this program for 6 more credits.

2.4 Thesis 18 credits

2.5 Seminar (2 credits) S/U

COURSE REQUIREMENTS

1. ***Required Courses***

1) Pattern 1(1)

2120601 Defense Engineering and Technology Principles S/U
2120603 Defense Engineering and Technology Seminar I S/U
2120604 Defense Engineering and Technology Seminar II S/U

2) Pattern 1(2) 3 credits

2120601 Defense Engineering and Technology Concept 3(3-0-9)
2120603 Defense Engineering and Technology Seminar I S/U
2120604 Defense Engineering and Technology Seminar II S/U

2. Approve Elective course 0-9 credits

1.1) Explosive and civil engineering 6 credits

2101607 Advanced Mechanics of Materials 3(3-0-9)
2121677 Principles of Explosives Engineering 3(2-3-7)

1.2) Nuclear Engineering for Defense Engineering 9 credits

2111610 Nuclear Security 3(3-0-9)
2111651 Weapon Mass Destruction Nonproliferation 3(3-0-9)
2131501 Nuclear Technology for Military 3(3-0-9)

1.3) Electrical Engineering for Defense/ Mechanical Engineering for Defense/ Environment Engineering for Defense/ Material Engineering and Technology for Defense/Computer Engineering for Defense/ Integrated Knowledge for National Defense
No prerequisite requirement

3) Free Elective Courses 6-15 credits

2.1) Explosive and civil engineering 9 credits

2101535 Tunnel Engineering 3(3-0-9)
2101566 Dynamics of Structures 3(3-0-9)
2101567 Rail Transport System 3(3-0-9)
2101615 Advanced Prestressed Concrete Structures 3(3-0-9)
2101617 Structural Building Components 3(3-0-9)
2101619 Seismic Design of Structures 3(3-0-9)
2121670 Explosives Handling and safety 3(3-0-9)
2121671 Blasting Design and Technology 3(2-3-7)
2121672 Demolition of Building and Structures 3(2-3-7)
2121673 Scientific Instrumentation for Explosives Testing & Blasting 3(2-3-7)
2121674 Theory of High Explosive 3(3-0-9)
2121675 Advanced Explosives Engineering 3(3-0-9)
2121676 Exterior Ballistics 3(3-0-9)

2.2) Nuclear Engineering for Defense Engineering 6 credits

2111613 Radiation Safety and Shielding 3(3-0-9)
2111642 Nuclear Reactor Engineering 3(3-0-9)
2111646 Radioactive Waste Management 3(3-0-9)
2111653 Nuclear Safeguards 3(3-0-9)
2111654 Nuclear Fuel Cycle and Environmental Impacts 3(3-0-9)
2111656 Physical Protection of Nuclear Materials and Facilities I 3(3-0-9)
2111657 Advanced Detection Technologies of Radioactive and Nuclear materials 3(3-0-9)
2111658 Methods and Instrumentation for Nuclear Security and Safeguards 3(3-0-9)
2111678 Nuclear Materials Engineering 3(3-0-9)

2. 3) Students in Electrical Engineering for Defense/ Mechanical Engineering for Defense/ Environment Engineering for Defense/Material Engineering and Technology for Defense /Computer Engineering for Defense/ Integrated Knowledge for National Defense must take signified

course for their major at least 9 credits and take other course this program for 6 more credits.

	2.3.1) Electrical Engineering for Defense Engineering	**15 credits**
2102505	Introduction to Optimization Techniques	3(3-0-9)
2102531	System Identification	3(3-0-9)
2102544	Advanced Embedded Systems	3(3-0-9)
2102571	Multimedia Communication	3(3-0-9)
2102620	Electromagnetic Theory	3(3-0-9)
2102627	Reliability and Survivability of Communication Networks and Systems	3(3-0-9)
2102635	Control System Theory	3(3-0-9)
2102642	Computer Vision and Video Electronics	3(3-0-9)
2102668	Biosensors	3(3-0-9)
2102676	Digital Image Processing	3(3-0-9)

	2.3.2) Mechanical Engineering for Defense Engineering	**15 credits**
2103510	Mechanics of Composite Materials	3(3-0-9)
2103511	Introduction to Continuum Mechanics	3(3-0-9)
2103532	Computer Aided Design and Computer Aided Manufacturing	3(2-3-7)
2103535	Mechatronics	3(3-0-9)
2103540	Failure Analysis and Nondestructive Testing	3(2-3-7)
2103566	Compressible Fluid Dynamics	3(3-0-9)
2103571	Micro and Nano Electromechanical Systems	3(3-0-9)
2103601	Advanced Engineering Mathematic	3(3-0-9)
2103625	Advanced Finite Element Method	3(3-0-9)
2103631	Control of Dynamic Systems	3(3-0-9)
2103664	Design of Thermal Systems	3(3-0-9)
2103665	Advanced Computational Fluid Dynamics	3(3-0-9)

	2.3.3) Environmental Engineering for Defense Engineering	**15 credits**
2107607	Environmental Analysis	3(3-0-9)
2107616	Air Quality Management	3(3-0-9)
2107630	Treatment and Disposal of Industrial Wastes	3(3-2-7)
2107641	Air Pollution Control Technology	3(3-0-9)
2107642	Engineering Practices for Solid Wastes Disposal	3(3-0-9)
2107657	Energy and Environment	3(3-0-9)
2107658	Theory and Design of Advanced Water Treatment Processes	4(3-3-10)
2107659	Theory and Design of Advanced Wastewater Treatment Processes	4(3-3-10)

	2.3.4) Materials Engineering and Technology for Defense Engineering	**15 credits**
2109509	Stainless Steel Technology	3(3-0-9)
2109510	Instrumental Analysis	3(2-3-7)
2109516	Advanced Topics in Physical Metallurgy	3(3-0-9)
2109517	Composite Materials I	3(3-0-9)
2109518	Surface Technology	3(3-0-9)
2109519	Solidification of Casting	3(3-0-9)
2109525	Welding Engineering	3(3-0-9)
2109527	High Temperature Materials	3(3-0-9)
2109533	Powder Metallurgy	3(3-0-9)
2109535	Cellular Metal	3(3-0-9)
2109536	Advanced Topics in Production Metallurgy	3(3-0-9)
2109537	Tribology of Materials	3(3-0-9)

	2.3.5) Computer Engineering for Defense	**15 credits**
2108532	Satellite Surveying and Modern Techniques	3(2-3-7)
2108556	Online Spatial Information Technologies	3(2-3-7)
2108557	Spatial Data Structure and Models	3(3-0-9)
2108558	Spatial Data Handling and Analysis	3(2-3-7)
2108627	Geoimage Processing	3(2-3-7)
2108628	Radar Remote Sensing	3(2-3-7)
2108632	Advanced GNSS Surveying	3(2-3-7)
2110639	Computer System Security	3(3-0-9)
2110661	Computer Network	3(3-0-9)
2110681	Computer Algorithm	3(3-0-9)
2110682	Embedded and Real-time Systems	3(3-0-9)
2110743	Machine learning	3(3-0-9)

	2.3.6) Integrated Knowledge for National Defense	**15 credits**
2120611*	Critical Infrastructure Security	3(3-0-9)
2120612*	Information and Cyber Warfare	3(3-0-9)
2120613*	Surveillance Equipment	3(3-0-9)
2120614*	Defense Industries and Dual Uses	3(3-0-9)

Other Free Elective Courses

2120602	Advanced Topics in Defense Engineering and Technology	3(3-0-9)
2120607*	Industrial Experiences in Defense Engineering and Technology I	3(0-12-0)
2120608*	Industrial Experiences in Defense Engineering and Technology II	3(0-12-0)
2120609*	Special Problems in Defense Engineering and Technology I	3(3-0-9)
2120610*	Special Problems in Defense Engineering and Technology II	3(3-0-9)

In addition, students may take other additional course which the curriculum allows or which is opened in graduate program in Chulalongkorn University. The course must be corresponding to the thesis and consented by the academic advisor.

3) Thesis

Pattern 1(1)

2120816	Thesis	36 credits

Pattern 1(2)

2120813	Thesis	18 credits

Remarks:

* New course

STUDY PROGRAM

Pattern 1(1)

The First Semester

2120601	Defense Engineering and Technology Principles	S/U
2120603	Defense Engineering and Technology Seminar I	S/U
2120816	Thesis	9
		9

The Second Semester

2120604	Defense Engineering and Technology Seminar II	S/U
2120816	Thesis	9
		9

The Third Semester

2120816	Thesis	9
		9

The Fourth Semester

2120816	Thesis	9
		9

Pattern 1(2)

The First Semester

2120601	Defense Engineering and Technology Principles	3
2120603	Defense Engineering and Technology Seminar I	S/U
210XXXX	Approve Elective and/or Free Elective	6
		9

The Second Semester

2120604	Defense Engineering and Technology Seminar II	S/U
210XXXX	Approve Elective and/or Free Elective	9
		9

The Third Semester

2120813	Thesis	9
		9

The Fourth Semester

2120813	Thesis	9
		9

COURSE DESCRIPTIONS IN DEFENSE ENGINEERING AND TECHNOLOGY

ENGINEERING (M.Eng.)

2120601 Defense Engineering and Technology Principles 3(3-0-9)

Principles of defense and military development; national security and national strategy; organization, responsibilities, management and work operation of the Royal Thai Armed Forces; military standards, and national disaster relief and prevention.

2120602 Advanced Topics in Defense Engineering and Technology 3(3-0-9)

Recent interesting topics and technology development in various field of defense and engineering technology.

2120603 Defense Engineering and Technology Seminar I 1(1-0-3)

Analysis of research products or quality research papers; presentation of research papers or research findings of individual researchers, and discussions.

2120604 Defense Engineering and Technology Seminar II 1(1-0-3)

Analysis of research products or quality research papers; presentation of research papers or research findings which are parts of students' thesis, and discussions.

2120607* Industrial Experiences in Defense Engineering and Technology I 3(3-0-9)

Experience at related industrial in defense engineering and technology, research, or government sectors under supervision of a mentor engineer and thesis advisor.

2120608 Industrial Experiences in Defense Engineering and Technology II 3(3-0-9)

Experience at related industrial in defense engineering and technology, research, or government sectors under supervision of a mentor engineer and thesis advisor.

2120609* Special Problems in Defense Engineering and Technology I 3(3-0-9)

Specials problems in various fields of defense engineering and technology.

2120610* Special Problems in Defense Engineering and Technology II 3(3-0-9)

Specials problems in various fields of defense engineering and technology.

2120611* Critical Infrastructure Security 3(3-0-9)

Introduction; energy, transportation, communication, and water security concepts; management of critical infrastructure security; incident response; organizations; case studies from US and Europe.

2120612* Information and Cyber Warfare 3(3-0-9)

Introduction, intelligence, domain, meaning and boundaries, landscape, types of weapons, damage control, protection, damage assessment, case studies from abroad.

2120613* Surveillance Equipment 3(3-0-9)

Introduction, unmanned system description, different types of drones, different types of camera, sensor, network, applications, artificial intelligence.

2120614* Defense Industries and Dual Uses 3(3-0-9)

Meaning, history, case studies such as microwave, radar, nuclear, etc., defense industry development, Dual use application development, business potential and assessment.

2121670 Explosive Handling and Safety 3(3-0-9)

Basic handling and safety of explosives; laboratory handling; testing; manufacturing and storage of explosive instruments and weapons used in both the civil and the military sectors.

2121671 Blasting Design and Technology 3(2-3-7)

Advanced theory and application of explosives in excavation; detailed underground blast design; specialization in blasting, including blast casting, construction and pre-spliting; introduction to blasting research and examination of applications in other fields.

2121672 Demolition of Building and Structures 3(2-3-7)

Basic knowledge about the equipment, techniques and processes required for the demolition and remediation of mine plants and mining equipment sites and non-mining structures.

2121673 Scientific Instrumentation for Explosives Testing and Blasting 3(2-3-7)

Application of scientific principles, details of the equipment and the use of instruments for explosives including blasting; related topics: blast chamber design, equipment set up, high-speed photography, motion detection and measurement, explosives sensitivity testing, explosives properties testing, vibration measurement and analysis, destruction in both the civil and the military sectors.

2121674 Theory of High Explosive 3(3-0-9)

Applications of chemical thermodynamics and the hydrodynamics theory to determine properties of high explosives; kinetics and reaction rate; application of the above theory to the blasting of explosives.

2121675 Advanced Explosives Engineering 3(3-0-9)

Detonation of non-ideal explosives; equation of the state of porous media; explosively driven mechanical systems; shock compaction of powders and desensitization and experimental methods used in the evaluation of explosives and their applications.

2121676 Exterior Ballistics **3(3-0-9)**

Benefits and uses of exterior ballistics; related background theories; trajectory; forces and moments acted on the projectile; projectile coefficients; various trajectory models; wind effect; mass asymmetries and swerve motion.

2121677 Fundamental Principles of Explosive Engineering **3(2-3-7)**

Theory and application of explosives in the mining industry: explosives, initiating systems, characteristics of explosive reactions and rock breakage, fundamentals of blast design, drilling and blasting, regulatory and safety considerations.

2101535 Tunnel Engineering **3(3-0-9)**

History of tunneling; soil tunneling methods; types of linings and face support; stand-up times and tunnel man's ground classification; groundwater control and soil modification methods; lining behavior and design; ground movements and changes of pore water pressure caused by tunnel construction; field observations, monitoring, and instrumentation; building distortion/damage and relation to ground movements; fundamentals of tunnel engineering related to soil types and construction techniques; design of tunnel lining in various subsoil conditions; applications and techniques of tunnel construction for infrastructure system.

2101566 Dynamics of Structures **3(3-0-9)**

Condition: Consent of Faculty

Analysis of structural systems with single and multi-degree of freedom; equations of motions; free and forced vibrations; vibration natural frequencies and mode shapes of systems; numerical evaluation of dynamic response; response spectrum; modal response history and response spectrum analysis; response of inelastic SDF system; building codes on seismic design of structures.

2101567 Rail Transport System **3(3-0-9)**

This course covers the following topics: History of Rail Transport Development, Fundamental and Characteristics of Rail Operation, Rules of Safety, Composition of Rail System: Infrastructure, Rolling Stocks, Signaling and Communication, Case Studies of Rail Transport Development in Thailand and Neighboring Countries.

2101607 Advanced Mechanics of Materials **3(3-0-9)**

Stress, strain, and displacement relationship; energy theorems; equilibrium and compatibility conditions; plane stress and plane strain problems; beams on elastic foundation; beam-columns, flexure of curve members; torsion of non-circular and thin-walled members; shear center; shear flow; introduction to theorems of limit analysis.

2101615 Advanced Prestressed Concrete Structures **3(3-0-9)**

Prestressing systems; behavior of prestressed concrete beams; moment curvature relationship; load deflection curves, ductility and fatigue, analysis and design of composite members, continuous flexural members, prestressed frames and segmental bridges.

2101617 Structural Building Components **3(3-0-9)**

Analysis and design of structural components for buildings considering various types of construction materials: timber, metal, concrete and synthetics; the components include floor systems, roof member, tilt-up walls, sandwich panels, precast, precast member, bearing walls, shear walls and light-gauge steel members.

2101619 Seismic Design of Structures **3(3-0-9)**

Elementary engineering seismology; seismic waves; intensity and magnitude; response spectrum and design earthquakes; earthquake codes and analysis; response spectrum analysis; random vibrations; artificial generation of earthquake records; structural design and detailing for earthquake resistance; special structures: bridges, dams, nuclear power plants.

2102505 Introduction to Optimization Techniques **3(3-0-9)**

Condition: PRER 2102205 or Consent of Faculty

Review of linear algebra; solution of nonlinear equations; optimality conditions for unconstrained optimization; numerical methods for unconstrained optimization: steepest descent, Newton's, variable metric and conjugate gradient methods; optimality conditions for constrained optimization; numerical methods for constrained optimization: penalty and barrier function, and sequential quadratic; solutions of linear programming by the simplex method.

2102531 System Identification **3(3-0-9)**

Condition: PRER 2102332 or Consent of Faculty

Models for linear time-invariant and time-varying system; nonparametric time- and frequency-domain methods; parameter estimation methods; convergence and consistency; asymptotic distribution of parameter estimates; computing the estimate; recursive identification methods; experiment design; choice of dentification criterion; model structure selection and model validation.

2102544 Advanced Embedded Systems **3(3-0-9)**

Condition: Consent of Faculty

Hardware and software platforms for embedded systems; devices and buses; embedded programming; real

time operating system; hardware-software co-design in an embedded system; testing.

2102571 Multimedia Communication 3(3-0-9)
Condition: Consent of Faculty

Introduction to multimedia communication; image coding standards; video coding standards; audio coding standards; speech coding standards; IP networks; wireless networks; multimedia communication protocols; multimedia communication applications.

2102620 Electromagnetic Theory 3(3-0-9)

Maxwell's equations; theorem of electromagnetic energy and power; properties of materials in electromagnetic fields; boundary conditions; theorems of electromagnetic fields, duality principle, uniqueness, image theory, equivalence principle, induction theorem, reciprocity; potential functions; electromagnetic wave equations, plane wave functions, cylindrical wave functions, spherical wave functions mathematical tools for electromagnetic fields, separation of variables technique, transverse resonance method, perturbation and variational techniques, Green's functions, geometric algebra; solution methods for electrostatic, magnetostatic, for electrostatic, magnetostatic, and quasi-static fields problems; plane wave propagation problems, propagation in unbounded medium, multilayered medium, and anisotropic medium; wave guidance problems, field analysis in typical waveguides, modal expansion method; resonators and filters; radiation problems, radiation from current sources and apertures; scattering problems, scattering by cylinder, wedge, and sphere; optical waves, optical waveguides, optical wave propagation in photonic crystal.

2102627 Reliability and Survivability of Communication Networks and Systems 3(3-0-9)
Condition: Consent of Faculty

Fundamental probability; network reliability; approaches to calculating network reliability; generic reliability and maintainability concepts; network survivability; fiber transport system components and signals; APS; dual homing; self healing rings; SONET andlysis; DCS networks; survivable network design; IP and ATM network survivability.

2102635 Control System Theory 3(3-0-9)
Condition: Consent of Faculty

Review of linear algebra; least-squares methods and minimum norm methods; mathematical descriptions of dynamic systems; solutions of linear dynamic equations; stability, observability; internal stability of interconnected systems; state feedback; linear quadratic regulation; observers and observer-based compensation; introduction to nonlinear systems.

2102642 Computer Vision and Video Electronics 3(3-0-9)
Condition: Consent of Faculty

Human vision; geometric camera models; image segmentation; object recognition; video signals and standards; video input and output circuits; computer vision and digital video applications.

2102668 Biosensors 3(3-0-9)
Condition: Consent of Faculty

Necessary concepts relevant to the principle of measuring chemical and biological phenomena with emphasis on integrating these concepts of develop to apply and to construct novel instruments for observing, examing, and controlling various phenomena in the field of biotechnology, medical science, chemical engineering for both fundamental research and process development in industrial production.

2102676 Digital Image Processing 3(3-0-9)

Image perception; image digitization; image enhancement; image restoration; image segmentation; image compression; morphological image processing; image representation and description.

2103510 Mechanics of Composite Materials 3(3-0-9)

Basic concepts of fiber reinforced composite materials and their application, stress and strain analysis of continuous fiber composite materials; Hooke's law and hygrothermal behavior of orthotropic lamina; classical lamination theory, failure criterion, and design concepts, as applied to composite structures; analysis of composite beams and plates; introduction to material fabrication and testing.

2103511 Introduction to Continuum Mechanics 3(3-0-9)

Introduction to continuum mechanics; essential mathematics: notations, tensor and operations, transformation, equation and symbol presentation; Kinematics of motion and small deformation; engineering stress; governing equations; constitutive equations; applications: setting and interpretation of heat conduction, solid mechanics and fluid mechanics.

2103532 Computer Aided Design and Computer Aided Manufacturing 3(2-3-7)

Introduction to CAD/CAM; Basic Concept of CAD/CAM/CAE; Product Design and Strategy; 3D Modeling Concept; Techniques for Geometry Modeling; Surface Design, Design Analysis; Mechanism Design and Animation; Computer Aided Manufacturing Concept; The Design and Manufacturing Interface; The Total Approach to Product Development; NC Programming.

2103535 Mechatronics 3(3-0-9)

Introduction to mechanical system interfacing; combinational digital logic; industrial electronic components; industrial sensors; simple computer

structure; low level programming technique; embedded control computers; microcontroller; stepping motors; DC motors; Analog/Digital conversion; position and velocity measurement; amplifiers; project related to mechatronics.

2103540 Failure Analysis and Nondestructive Testing 3(2-3-7)

Stress at crack tip and related parameters; failure phenomena; crack propagation creep; corrosion; failure surface; life assessment; case studies; nondestructive testing; practice in NDT techniques.

2103566 Compressible Fluid Dynamics 3(3-0-9)

Thermodynamics of motion; physical acoustics; wave equation; speed of sound; quasi-one dimensional flow with friction and heat addition; shock dimensional steady flow; method of characteristics; nozzle design; linearized flow visualization using optical techniques.

2103571 Micro and Nano Electromechanical Systems 3(3-0-9)

Overview of MENS- NEMS, review of engineering mechanics and thermo- fluid engineering, electromechanics and light phenomena, micro system design, scaling of micromechanical devices, MEMS materials, review of micro fabrication, applications of MEMS, and future trends in technology development.

2103601 Advanced Engineering Mathematics 3(3-0-9)

Numerical and graphical methods of approximate solution; finite difference methods; calculus of variations, solution of classical partial differential equations of mathematical physics including application of conformal mapping and the Laplace transformation.

2103625 Advanced Finite Element Method 3(3-0-9)

Procedures of the finite element method for structural, thermal and fluid differential equations; nonlinear structural static and dynamic problems with discrete and continuum structures; transient nonlinear heat transfer problems with conduction, and radiation; and radiation; steady and unsteady nonlinear heat transfer problems with conduction, and radiation; steady and unsteady nonlinear incompressible and compressible fluid flow problems.

2103631 Control of Dynamic Systems 3(3-0-9)

Introduction; Mathematical Representation of Dynamic Systems; Response of Linear Systems; Stability of Linear Systems; System Theory, Control of Linear Systems: Root- Locus Design, Frequency Response analysis and design, State Variable Feedback, Observer Design; Multivariable Control Systems.

2103664 Design of Thermal Systems 3(3-0-9)

Engineering design, design of a workable system, consideration; Equation fitting and mathematical modeling, system simulation, optimization, Lagrange multipliers search methods, dynamic programming, linear programming.

2103665 Advanced Computational Fluid Dynamics 3(3-0-9)

Mathematical and numerical aspects of heat transfer and fluid mechanics, finite difference and finite volume methods for solving basic governing equations of fluid flow and heat transfer: continuity, momentum and energy, discretization methods for two and three dimensional problems, boundary conditions, numerical schemes and solvers, consistency stability and convergence, advanced numerical techniques for CFD, application of the methods to some engineering problems.

2107607 Environmental Analysis 3(3-0-9)

Procedures and details of environmental sample analysis; methods of sample collection, sample handling; analytical method selection; details of analysis and data presentation.

2107616 Air Quality Management 3(3-0-9)

Interaction among air, water and land pollutions, effects of air pollutants, standards and regulations, technical aspects of air pollution control programs, the organization and management of control programs in governmental and private sectors.

2107630 Treatment and Disposal of Industrial Wastes 3(2-3-7)

Industrial waste problems; categories of waste; nature and characteristics of liquid waste; effect of waste on environment; laws for disposal of waste in Thailand and other countries; method of treatment of various kinds of waste; preventive measures.

2107641 Air Pollution Control Technology 3(3-0-9)

Overview of air pollution control methods. Control of particulates and gaseous emissions by settling chambers, cyclones, scrubbers, filters and electrostatic precipitators. Design of equipment, maintenance and evaluation of control efficiency.

2107642 Engineering Practices for Solid Wastes Disposal 3(3-0-9)

Municipal and industrial solid wasters, their volume and characteristics; heat value, methods of handling, storage and disposal. Size and volume reduction. Separation of components. Landfill and leachate effects. Ocean disposal. Incineration.

2107657 Energy and Environment 3(3-0-9)

Energy resources and utilization in the global context and a case studies in Thailand; fossil- based energy, environmental impact of mining and fuel processing; air pollution, greenhouse gas, and global warming from fuel utilization; energy conservation and renewable energy technologies; hydro energy harnessing and its environmental impact and mitigation; other non-fossil fuel options: biomass, solar, and wind energy; synthetic fuel conversion technology including pyrolysis and

gasification; biogas from fermentation; prospect of hydrogen economy.

2107658 Theory and Design of Advanced Water Treatment Processes **4(3-3-10)**

Water sources; water chemistry and quality, aeration, coagulation, sedimentation, filtration, ion exchange, membrane processes, disinfection absorption, neutralization and stabilization; water conditioning for boiler and cooling system; design criteria for water sources, lines distribution and storage facilities, water treatment and softening, engineering design of water distribution system, functional and hydraulic design of complete water treatment.

2107659 Theory and Design of Advanced Wastewater Treatment Processes **4(3-3-10)**

Development of wastewater technology; wastewater collection and transportation; design of sewers and appurtenances; advanced wastewater treatment by microbial and biological control techniques, law related to effluent disposal; wastewater law relating to effluent disposal, wastewater treatment plant organization and management; combined and separate system pumping stations; functional and hydraulic design of complete wastewater treatment system.

2127675 Military Waste Management **3(3-0-9)**

Management of solid and hazardous wastes from military activities; waste reuse and recycling; characteristics of wastes from military activities; site remediation; site remediation; environmental impact assessment.

2107676 Management of Environmental Emergencies **3(3-0-9)**

Classification and identification of susceptible sites for environmental emergencies; protection of important infrastructures in industries, in industrial estates, in fuel distribution and storage and in water supply from terrorist activities in the form chemical or biological threats; planning for emergency handling; public handling; coordinating with various work units, and training related people.

2108532 Satellite Surveying and Modern Techniques **3(2-3-7)**

Satellite datum, coordinate systems, concept of satellite positioning, global positioning system, observable in GPS, errors in GPS measurements, survey planning, field procedures, data processing, principles of inertial navigation system (INS), practical applications of GPS, principles of electronics, electronic surveying systems and basic components, geometry of electronic surveying, instrumentation and modern surveying technology.

2108556 Online Spatial Information Technologies **3(2-3-7)**

Introduction to GIS; and internet GIS; fundamental of computer networking; client/server computing; technology evolutions of web GIS; standards for distributed geospatial services (ISO & OGC), XML, GML and SVG, mobile GIS case studies and web GIS applications.

2108557 Spatial Data Structure and Models **3(3-0-9)**

Conceptual model of space: entities and fields; vector data model, raster data model; data organization in raster: chain, block, run length, quadtrees, binary; data organization in vector: point, line, network, polygon, topology; comparisons of vector and raster data; database structure; file and data access; hierarchical structure; network structure, relational structure, object- oriented structure; introduction to geo-spatial relational database system, graph theory; optimal path.

2108558 Spatial Data Handling and Analysis **3(2-3-7)**

Data capture techniques, coordinate systems, data quality; intersections of lines and curves, calculation of length and area, coordinate adjustment, geometric searching; range searching; proximity searching; buffering; rubber sheeting, edge matching, image warping, conflation, feature editing; feature alignment; generalization; densification; topology construction; surface modeling; viewsheds; intervisibility; contouring.

2108627 Geoimage Processing **3(2-3-7)**

Concepts of digital image: air borne, space borne; electromagnetic wave; optical and microwave sensor; digital image processing; classification; image coordinate and photo coordinate; sensor orientation; stereo-photogrammetry; photogrammetric triangulation; orthorectification.

2108628 Radar Remote Sensing **3(2-3-7)**

Characteristics of microwave, microwave interaction with atmosphere and target, radar equation and radar section, principles of imaging radar, measureable phase/amplitude/polarization in radar imagery, geometric and radiometric properties of radar imagery, synthetic Aperture Radar, airborne/ spaceborne SAR systems, interferometric SAR, processing stages in inteferogram generation, differential interferometric SAR, In SAR/ DInSAR as measurement tools, geodetic and geophysical applications of InSAR/ DInSAR, polarimetric SAR, classification and analysis of polarimetric SAR, landuse/ landcover mapping applications using polarimetric SAR.

2108632* **Advanced GNSS Surveying** **3(2-3-7)**

GPS system, coordinate and reference system, GPS observations and equations, GPS error mitigation techniques, computation of GPS satellite positions, principles of least- squares estimation, mathematical models for GPS positioning, standard format of GPS data, GPS data processing by least- squares method, interpretation of baseline results, GPS network adjustment, quality control for GPS surveying, GPS heighting, trends and applications of GNSS technology.

2109509 Stainless Steel Technology **3(3-0-9)**

Stainless steel development; stainless steel grades; phase equilibrium diagram; microstructure and metallography; passive film; martensitic, ferritic, austenitic, duplex and precipitation hardening stainless steels; production technology; improvement of mechanical and corrosion properties and selection.

2109510 Instrumental Analysis **3(2-3-7)**

Operation principles of transmission electron microscopy and scanning electron microscopy, Xray diffraction, X- ray fluorescence, atomic absorption and spectro analysis, ESCA and Auger electron spectrometer; interpretation of instrumental results in terms of mechanical properties.

2109516 Advanced Topics in Physical Metallurgy **3(3-0-9)**

Advanced topics of current research interests in physical metallurgy.

2109517 Composite Materials I **3(3-0-9)**

Properties of engineering composite materials; types of composite materials; fiber and their interfaces; geometrical properties; elasticity; case studies.

2109518 Surface Technology **3(3-0-9)**

Carburizing, nitriding, flame hardening, diffusion hardening; chemical vapor deposition and physical vapor deposition; electro-plating; hot dip coating; metal spraying and ion implantation.

2109519 Solidification of Casting **3(3-0-9)**

Study of solidification of metal in molds; characteristics of liquid-solid phase transformations; Sand and metal thermal behavior; macroscopic structures; mechanical properties, and casting defects.

2109525 Welding Engineering **3(3-0-9)**

Type and process of welding; mass and heat flow during welding; metallurgical effects of heat thermal cycle; solid-phase welding and joining of ceramic; welding of ferrous and non-ferrous metals; behavior of welds in service.

2109527 High Temperature Materials **3(3-0-9)**

Theory of alloying and relationship among temperature, structure, and mechanical properties in nickel, cobalt, and iron base alloys; effect of thermomechanical processing; analysis of microstructures by transmission electron microscopy, scanning electron microscopy, X-ray diffraction, and X-ray microprobe.

2109533 Powder Metallurgy **3(3-0-9)**

Preparation and fabrication of metal powder; engineering properties and industrial uses; theory of compaction and sintering.

2109535 Cellular Metal **3(3-0-9)**

The structure, manufacturing methods, characterization techniques, mechanics. Physical and mechanical properties of cellular metals; energy absorption; sandwich structures and case studies.

2109536 Advanced Topics in Production Metallurgy **3(3-0-9)**

Advanced topics of current research interests in production metallurgy.

2109537 Tribology of Materials **3(3-0-9)**

Solid lubrication and surface treatment; fundamentals of contacts between solids; abrasive, erosive, and cavitation wear; adhesion and adhesive wear, corrosive and oxidative wear; fatigue wear; fretting and minor wear mechanism; wear of non-metallic materials; case study.

2110639 Computer System Security **3(3-0-9)**

Security system planning and administration; access control; data encryption; computer crime protection; disaster recovery planning; security models; including Orange book, and RACF.

2110661 Computer Network **3(3-0-9)**

Introduction to network and network components; transmission links and protocols; design and analysis of network; WAN; IMP; to pology; network protocols; flow control and routing techniques.

2110681 Computer Algorithm **3(3-0-9)**

Analysis and design of efficient algorithms; divide and conquer, recursion, dynamic programming and greedy algorithm; selection of appropriate data abstraction; analysis and correctness of algorithms; algebraic algorithms; combination problems; providing techniques for complexity analysis.

2110682 Embedded and Real-Time Systems 3(3-0-9)

Microcontroller architecture (RAM, ROM, CPU), I/O, and peripheral devices, I/O interfacing, real-time operating systems, real-time constraints, scheduling theory, real-time system design methodology, case studies.

2110743 Machine Learning 3(3-0-9)

Computing with logic; using logic set theory, number theory, algebras, graph theory, automata; language of first order logic, model theory and logic programming; problems of inductive inference in the framework of first-order predicate calculus and the probability calculus; introduction of computational learning theory.

2131501 Nuclear Technology for Military 3(3-0-9)

Radioactive and nuclear materials; measurement of nuclear radiation; principles of radiation safety, detection of radioactive and nuclear materials; radiation imaging; elemental analysis using nuclear techniques, nuclear techniques for explosive detection; other uses of radioactive and nuclear materials; nuclear non-proliferation.

2111610 Nuclear Security 3(3-0-9)

Nuclear security; overview of related legal framework; interrelationships between nuclear safety, security and safeguards; nuclear and radiation threat by non-State actors; counterterrorism; chemical biological, radiological and nuclear (CBRN) weapons; basic elements of nuclear security; planning nuclear security at the state level; planning nuclear security of nuclear and radiological facility; introduction to detection of and response to, crimes and unauthorized acts involving nuclear material and other radioactive material outside regulatory control; information security; security culture.

2111613 Radiation Safety and shielding 3(3-0-9)

Definition and basic concepts in radiation safety; biological effects of radiation; basic radiation protection, dose limits; regulation concerning radioactive materials; transportation of radioactive materials; accidents and emergency procedure; gamma radiation and x-ray shielding; radiation shielding from nuclear reactor.

2111642 Nuclear Reactor Engineering 3(3-0-9)

Production and characteristics of neutrons; the fission process; neutron diffusion theory; slowing-down theory; Fermi theory of the bare thermal reactor; one-and multi-group diffusion methods; basic principles of nuclear reactor reactor kinetics and nuclear reactor control.

2111646 Radioactive Waste Management 3(3-0-9)

Nature of radioactive wastes; origin of low- high radioactive wastes; characteristics, forms and quantity of radioactive wastes; storage and transportation; waste management technologies; radioactive waste management plans in various countries.

2111651 Weapon Mass Destruction Nonproliferation 3(3-0-9)

Issues concerning the proliferation of nuclear, chemical, and biological weapons; introduction to nuclear and radiological terrorism; international nuclear nonproliferation framework; weapon technologies of mass destruction; nuclear proliferation issues in South Asia.

2111653 Nuclear Safeguards 3(3-0-9)

Safeguarding nuclear material and facilities; monitoring principles and technologies; safeguards issues; international framework of nuclear material safeguard; nuclear material safeguard; nuclear proliferation threat; radiological threat; detecting nuclear and other radioactive materials; roles of intelligence; A Q. Khan's network; counter-proliferation of nuclear weapons; nuclear material safeguard in various countries.

2111654 Nuclear Fuel Cycle and Environmental Impacts 3(3-0-9)

Technology of nuclear fuel cycle; technologies used in manufacturing, safety handling, and disposing of nuclear materials and by-products; social environmental, and health impacts of materials used in each major step in the fuel cycle; potential of nuclear proliferation.

2111656 Physical Protection of Nuclear Materials and Facilities I 3(3-0-9)

Principles of physical protection of nuclear materials and facilities: detection, delay, response; threat identification and analysis; vital area analysis; international physical safeguard framework; internal threats.

2111657 Advanced Detection Technologies for Radioactive and Nuclear Material 3(3-0-9)

Detection and identification of the types of nuclear materials; chemical and radiological characteristics of nuclear materials from raw materials to various finished products; detection technologies; nuclear forensics.

2111658 Method and Instrumentation for Nuclear Security and Safeguards 3(3-0-9)

Counting statistics; radiation detectors; gamma detection; neutron detection; detection of charged particles; gamma spectroscopy; activation analysis; destructive analysis; non-destructive analysis; quantitative

nuclear material measurements; survey devices; use of detectors at port.

2111678 Nuclear Materials Engineering 3(3-0-9)

Nuclear fuel cycle; materials and thermal aspects of nuclear reactors; crystal structures of solids; point defects; diffusion in solids; elastic behavior of solids; dislocations in solid and creep deformation; grain and grain boundaries; cavities in solids; fission product behavior in nuclear fuel; radiation damage and fast-neutron irradiation effects in metals; introduction to the High-Temperature Gas-Cooled Reactor Technology.

2120602 Advanced Topics in Defense Engineering Technology 3(3-0-9)

Study of recent topic and technology development in various fields of defense and engineering technology.

2120813 Thesis 0(0-0-0)

2120816 Thesis 0(0-0-0)

Remarks

* New course

INNOVATIVE ENGINEERING FOR SUSTAINABILITY

This curriculum was created in response to the growing interest on sustainable development. By integrating the expertise of Faculty of Engineering, Chulalongkorn University on innovation and technology and sustainability, this program offers an approach to achieve sustainable development by merging knowledge on several fields of engineering and management as well as tools and up- to- date trends on innovation and sustainability.

HEAD:

Sawekchai	Tangaramvong	Ph.D. (The University of New South Wales, Australia)

PROFESSORS:

Pisut	Painmanakul	Ph.D. (INSA-Toulouse, France)
Viboon	Sangveraphunsiri	Ph.D. (Georgia Institute of Technology, Atlanta, USA)
Orathai	Chavalparit	Ph.D. (Wageningen University, Netherland)
Viboon	Sricharoenchaikul	Ph.D. (Georgia Institute of Technology, USA)
Chanathip	Pharino	Ph.D. (Massachusetts Institute of Technology (MIT), USA)
Chavalit	Ratanatamskul	Ph.D. (The University of Tokyo, Japan)

ASSOCIATE PROFESSORS:

Sawekchai	Tangaramvong	Ph.D. (The University of New South Wales, Australia)
Sittidaj	Pongkijvorasin	Ph.D. (University of Hawaii, USA)
Sutee	Anantsuksomsri	Ph.D. (Cornell University, USA)
Dao	Janjaroen	Ph.D. (University of Illinois at Urbana-Champaign, USA)
Natt	Leelawat	Ph.D. (Tokyo Institute of Technology, Japan)
Charusluk	Viphavakit	Ph.D. (Frederick University, Cyprus)
Ronnapee	Chaichaowarat	Ph.D. (Chulalongkorn University, Thailand)
Yan	Zhao	Ph.D. (Queen Mary University of London, UK)
Sutha	Khaodhiar	Ph.D. (Oregon State University, USA)
Sirima	Panyametheekul	Ph.D. (Imperial College, UK)
Tawan	Limpiyakorn	Ph.D. (University of Tokyo, Japan)
Benjaporn	Suwannasilp	Ph.D. (Stanford University, USA)
Jenyuk	Lohwacharin	Ph.D. (University of Tokyo, Japan)
Wiboonluk	Pungrasmi	Ph.D. (The University of Tokyo, Japan)
Patiparn	Punyapalakul	Ph.D. (The University of Tokyo, Japan)
Atiwong	Suchato	Ph.D. (Massachusetts Institute of Technology, USA)

ASSISTANT PROFESSORS:

Thitithep	Sitthiyot	Ph.D. (Claremont Graduate University, USA)
Supattra	Visessri	Ph.D. (Imperial College London, UK)
Sukree	Sinthupinyo	Ph.D. (Chulalongkorn University, Thailand)
Anurak	Sriariyawat	Ph.D. (The University of Nottingham, UK)
Pongsak	Suttinon	D.Eng. (Kochi University of Technology, Japan)
Piyatida	Ruangrassamee	Ph.D. (Massachusetts Institute of Technology, USA)
Unruan	Leknoi	Ph.D. (Kasetsart University, Thailand)
Sarun	Tejasen	Ph.D. (Oregon State University, USA)

INSTRUCTORS:

Pavisorn	Chuenchum	Ph.D. (Tsinghua University, China)
Nattawin	Chawaloesphonsiya	Ph.D. (Université Toulouse III - Paul Sabatier, France)
Tanawat	Tangjarusritaratorn	Ph.D. (Kyoto University, Japan)

Kritchart	Wongwailikhit	Ph.D. (Chulalongkorn University, Thailand)
Jing	Tang	D.Eng. (Tokyo Institute of Technology, Japan)
Pinunta	Rojratsirikul	Ph.D. (University of Bath, UK)
Porpin	Pungetmongkol	Ph.D. (Tokyo Institute of Technology, Japan)
Apipon	Methachittipan	Ph.D. (University of Cambridge, UK)
Sirin	Nitinawarat	Ph.D. (University of Maryland, USA)
Chee Keong	Ngaw	Ph.D. (Nanyang Technological University, Singapore)
Aung	Pyae	Ph.D. (Information Technology University of Turku, Finland)
Pitaakphong	Rattanagraikanakorn	Ph.D. (Delft University of Technology, Netherlands)
Prabhath	De Silva	Ph.D. (Arizona State University, USA)
Win	Trivitayanurak	Ph.D. (Engineering Carnegie mellon University, USA)
Ekapol	Chuangsuwanich	Ph.D. (Massachusetts Institute of Technology, USA)

NAME OF THE DEGREE

: Master of Science
: M.Sc.

FIELD OF STUDY

1. Innovative Engineering for Sustainability: **Sustainability and Innovation**
2. Innovative Engineering for Sustainability: **Environmental Technologies**
3. Innovative Engineering for Sustainability: **Artificial Intelligence Application with Impact**

ADMISSION

The applicants must hold a Bachelor degree in any fields and also passed the requirements of the Graduate School or got approval from the program committee for admission.

DEGREE REQUIREMENTS

3. ***Pattern 1 (1) (total 36 credits)*** program consists of
   1) Thesis 36 credits
   2) Seminar (1 credits) S/U

4. ***Pattern 1 (2) (total 36 credits)*** program consists of
   2. 1 Innovative Engineering for Sustainability: **Sustainability and Innovation**
   1) Compulsory elective course 6 credits
   2) Elective course 18 credits
   3) Thesis 12 credits
   4) Seminar (1 credits) S/U
   2. 2 Innovative Engineering for Sustainability: **Environmental Technologies**
   1) Compulsory elective course 12 credits
   2) Elective course 12 credits
   3) Thesis 12 credits
   4) Seminar (1 credits) S/U
   2. 3 Innovative Engineering for Sustainability: **Artificial Intelligence Application with Impact**
   1) Compulsory elective course 15 credits
   2) Elective course 9 credits
   3) Thesis 12 credits
   4) Seminar (1 credits) S/U

5. ***Pattern 2 (total 36 credits)*** program consists of
   3. 1 Innovative Engineering for Sustainability: **Sustainability and Innovation**
   1) Compulsory elective course 6 credits
   2) Elective course 24 credits
   3) Independent Study 6 credits
   4) Seminar (1 credits) S/U
   5) Comprehensive Examination S/U
   3. 2 Innovative Engineering for Sustainability: **Environmental Technologies**
   1) Compulsory elective course 12 credits
   2) Elective course 18 credits
   3) Independent Study 6 credits
   4) Seminar (1 credits) S/U
   5) Comprehensive Examination S/U
   3. 3 Innovative Engineering for Sustainability: **Artificial Intelligence Application with Impact**
   1) Compulsory elective course 15 credits
   2) Elective course 15 credits
   3) Independent Study 6 credits
   4) Seminar (1 credits) S/U
   5) Comprehensive Examination S/U

COURSES AND CREDIT

1. Seminar (Compulsory for all field of study) (Credit is not included in total 36 credits)

2120699 Seminar in Context of Innovative Engineering for Sustainability 1(1-0-3)

2. Compulsory elective course 0-15 credits (for Pattern 1 (2) and Pattern 2)

Innovative Engineering for Sustainability: ***Sustainability and Innovation***

2120501 Environmental Trends, Technology and Innovation 3(3-0-9)
2120502 Co-operate Environmental Management 3(3-0-9)

Innovative Engineering for Sustainability: ***Environmental Technologies***

2107616 Air Quality Management 3(3-0-9)
2107673 Principles for Environmental Engineering Management 3(3-0-9)
2107681 Water Management 3(3-0-9)
2107682 Waste Engineering 3(3-0-9)

Innovative Engineering for Sustainability: ***Artificial Intelligence Application with Impact***

2130501 Machine Learning and Time Series Analysis 4(4-0-12)
2130511 Abstraction of A.I. and Modern Digital Technologies 3(3-0-9)
2130512 Essential Skills and Thinking in the Age of A.I. 3(3-0-9)
2130513 Hands-on A.I. Experience 1(1-0-3)
2130531 Mathematics Foundations to Machine Learning I 2(2-0-6)
2130532 Mathematics Foundations to MachineL earning II 2(2-0-6)

3. Elective course 0-24 credits

Innovative Engineering for Sustainability: ***Sustainability and Innovation***

Pattern 1(2) 18 credits
Pattern 2 24 credits

2120511 Eco Industry 3(3-0-9)
2120512 Environmental Impact Management 3(3-0-9)
2120513 Environmental Economics and Policy 3(3-0-9)
2120521 Basic Concept of Urban Planning and Sustainable Infrastructure 3(3-0-9)
2120522 Sustainable Infrastructure Development Project 3(1-4-7)
2120531 Social Tools for Developing Sustainable Corporate 3(3-0-9)
2120532 Technology and Development of Social and Environmental-friendly Innovation 3(3-0-9)
2120533 Environmental Thinking 3(3-0-9)
2120541 Introduction to Complexity Science 3(3-0-9)
2120542 Behavioral Economics and Pro-environmental Behavior 3(3-0-9)
2120543 Sustainability Reporting and Disclosure 3(3-0-9)
2120590 Innovative Engineering for Sustainability - In Action 3(1-4-7)
2120591 Special Topics in Innovation for Sustainability I 3(3-0-9)
2120561 Climate Change Science 2(2-0-6)
2120562 Climate Change Adaptation 2(2-0-6)
2120563 Climate Change Mitigation 3(3-0-9)
2120564 Climate Change Management 3(3-0-9)
2124511 Fundamental Risk and Disaster Management 2(2-0-6)
2132571 Climate Change Mitigation 3(3-0-9)

Innovative Engineering for Sustainability: ***Environmental Technologies***

Pattern 1(2) 12 credits
Pattern 2 12 credits

2107683 Environmental Engineering Design I 3(1-6-5)
2107684 Environmental Engineering Design II 3(1-6-5)
2107626 Stream Sanitation 2(2-0-6)
2107633 Water Quality and Agricultural Practice 3(3-0-9)
2107638 Plumbing Design 3(3-0-9)
2107646 Chemistry for Water and Wastewater Treatment 3(3-0-9)
2107657 Energy and Environment 3(3-0-9)
2107663 Industrial Waste Management 3(3-0-9)
2107664 Anaerobic Wastewater Treatment Technology 3(3-0-9)
2107669 Environmental Impact Assessment 3(3-0-9)
2107672 Adsorption for Water and Wastewater Treatment 3(3-0-9)
2107674 Treatment of Wastewater Contaminated with Oil and Small Particles in Environmental Engineering 3(3-0-9)
2107677 Membrane Technology for Wastewater Reuse 3(3-0-9)

Innovative Engineering for Sustainability: ***Artificial Intelligence Application with Impact***

Pattern 1(2) 9 credits
Pattern 2 15 credits

2110524 Cloud Computing Technology 3(3-0-9)
2110572 Natural Language Processing Systems 3(3-0-9)
2110573 Pattern Recognition 3(3-0-9)
2130502 Practical IoT 2(2-0-6)
2130514 Crafting Impactful A.I. Strategies 3(3-0-9)
2130521 Python Programming for A.I. Application Development 3(3-0-9)
2130522 Web Development Foundations 4(4-0-12)
2130523 Data Analytics and Data Visualization 2(2-0-6)

2130591 Selected Topics for Learning Application Development Technology I 3(3-0-9)
2130592 Selected Topics for Learning Application Development Technology II 3(3-0-9)

In addition, students in all field of study may take other additional course which the curriculum allows or which is opened in graduate program in Chulalongkorn University. The course must be corresponding to the thesis and consented by the academic advisor.

4. Thesis

Pattern 1(1)

2120816 Thesis 36 credits

Pattern 1(2)

2120811 Thesis 12 credits

5. Independent Study

Pattern 2

2120791 Independent Study 6 credits

6. Comprehensive Examination

Pattern 2

2120896 Comprehensive Examination S/U

STUDY PROGRAM

Pattern 1(1) (All field of study)

The First Semester

2120699	Seminar in Context of Innovative Engineering for Sustainability (S/U)	1
2120816	Thesis	9
	Total	**10**

The Second Semester

2120816	Thesis	9
	Total	**9**

The Third Semester

2120816	Thesis	9
	Total	**9**

The Fourth Semester

2120816	Thesis	9
	Total	**9**

Pattern 1(2)

Innovative Engineering for Sustainability: ***Sustainability and Innovation***

The First Semester

2120699	Seminar in Context of Innovative Engineering for Sustainability (S/U)	1
2120501	Environmental Trends, Technology and Innovation	3
XXXXXXX	Elective course	9
	Total	**13**

The Second Semester

2120502	Co-operate Environmental Management	3
XXXXXXX	Elective course	9
	Total	**12**

The Third Semester

2120811	Thesis	6
	Total	**6**

The Fourth Semester

2120811	Thesis	6
	Total	**6**

Innovative Engineering for Sustainability: Environmental Technologies

The First Semester

2120699	Seminar in Context of Innovative Engineering for Sustainability (S/U)	1
2107616	Air Quality Management	3
2107673	Principles for Environmental Engineering Management	3
XXXXXXX	Elective course	6
	Total	**13**

The Second Semester

2107681	Water Management	3
2107682	Waste Engineering	3
XXXXXXX	Elective course	6
	Total	**12**

The Third Semester

2120811	Thesis	6
	Total	**6**

The Fourth Semester

2120811	Thesis	6
	Total	**6**

*Innovative Engineering for Sustainability: **Artificial Intelligence Application with Impact***

The First Semester

2120699	Seminar in Context of Innovative Engineering for Sustainability (S/U)	1
2130501	Machine Learning and Time Series Analysis	4
2130511	Abstraction of A.I. and Modern Digital Technologies	**3**
2130531	Mathematics Foundations to Machine Learning I	2
XXXXXXX	Elective course	3
	Total	**13**

The Second Semester

2130512	Essential Skills and Thinking in the Age of A.I.	3
2130513	Hands-on A.I. Experience	1
2130532	Mathematics Foundations to Machine Learning II	2
XXXXXXX	Elective course	6
	Total	**12**

The Third Semester

2120811	Thesis	6
	Total	**6**

The Fourth Semester

2120811	Thesis	6
	Total	**6**

Pattern 2

*Innovative Engineering for Sustainability: **Sustainability and Innovation***

The First Semester

2120699	Seminar in Context of Innovative Engineering for Sustainability (S/U)	1
2120501	Environmental Trends, Technology and Innovation	3
XXXXXXX	Elective course	6
	Total	**10**

The Second Semester

2120502	Co-operate Environmental Management	3
XXXXXXX	Elective course	9
	Total	**12**

The Third Semester

XXXXXXX	Elective course	9
	Total	**9**

The Fourth Semester

2120896	Comprehensive Examination	S/U
2120791	Independent Study	6
	Total	**6**

Innovative Engineering for Sustainability: Environmental Technologies

The First Semester

2120699	Seminar in Context of Innovative Engineering for Sustainability (S/U)	1
2107616	Air Quality Management	3
2107673	Principles for Environmental Engineering Management	3
XXXXXXX	Elective course	6
	Total	**13**

The Second Semester

2107681	Water Management	3
2107682	Waste Engineering	3
XXXXXXX	Elective course	6
	Total	**12**

The Third Semester

XXXXXXX	Elective course	6
	Total	**6**

The Fourth Semester

2120896	Comprehensive Examination	S/U
2120791	Independent Study	6
	Total	**6**

*Innovative Engineering for Sustainability: **Artificial Intelligence Application with Impact***

The First Semester

2120699	Seminar in Context of Innovative Engineering for Sustainability (S/U)	1
2130501	Machine Learning and Time Series Analysis	4
2130511	Abstraction of A.I. and Modern Digital Technologies	3
2130531	Mathematics Foundations to Machine Learning I	2
XXXXXXX	Elective course	3
	Total	**13**

The Second Semester

2130512	Essential Skills and Thinking in the Age of A.I.	3
2130513	Hands-on A.I. Experience	1
2130532	Mathematics Foundations to Machine Learning II	2
XXXXXXX	Elective course	6
	Total	**12**

The Third Semester

XXXXXXX	Elective course	6
	Total	**6**

The Fourth Semester

2120896	Comprehensive Examination	S/U
2120791	Independent Study	6
	Total	**6**

COURSE DESCRIPTIONS IN INNOVATIVE ENGINEERING FOR SUSTAINABILITY (M.SC.)

2107616 Air Quality Management 3(3-0-9)

In this course, students will learn the concepts and principles of air quality management with emphasis on analysis of key elements of Air Quality Management Process and exploring Air Quality Management scheme, both locally and internationally, through case studies. Fundamental topics taught in class include emission sources; meteorological phenomena and their impact on pollution dispersion; air pollution control technologies; air quality measurements and monitoring; effects of air pollutants; and regulatory standards. Along with these basic knowledge, actual case studies of both locally and internationally will be explored and brought to in-class discussion on the advantages and disadvantages of different types of air quality management practices, and students will be asked to develop and propose the effective and sustainable air quality management strategies related to the case of their interest.

2107673 Principles for Environmental Engineering Management 3(3-0-9)

In this study, students will learn the concepts and principles of making policies and plans for managing natural resources and the environment, as well as the organizing tools used to achieve the goals of environmental management policies and plans and performance analysis. Tools for analyzing the cost-effectiveness of each type of environmental management approach, such as laws and policies for environmental quality control and economics management, is used in conjunction with knowledge of environmental engineering to maximize efficiency. Along with the implementation of actual case study samples in today's society, both domestically and internationally are explained to help analyze and compare the advantages and disadvantages of different types of environmental management practices and offer appropriate management options to effectively solve each type of environmental problem.

2107681 Water Management 3(3-0-9)

In this course students will learn about basic theory of water and wastewater treatment technology and water reclamation. They will understand the principles and design criteria for water, wastewater treatment and water reclamation processes. This class includes water sources,

water chemistry, mass balances and reactor analysis, water and wastewater treatment processes including coagulation, flocculation, sedimentation, gravity filtration, membrane filtration, adsorption, ion exchange, membrane, advanced oxidation process and disinfection. Students will also learn about water distribution system as well as water, wastewater plant design.

2107682 Waste Engineering 3(3-0-9)

Global and Thailand situations, laws and regulations, functional elements, sources, physical, chemical, and biological characteristics, thermal processes for generation of renewable energy, fuel, and value-added products from solid waste including combustion, gasification, pyrolysis, and torrefaction, recycling, composting and landfill disposal. Landmark episodes involving hazardous waste mismanagement, definition, technology, health impacts, risk assessment and law and policy issues associated with hazardous materials and wastes are examined. Methods of managing hazardous waste are introduced and regulations presented where appropriate. Special cases on hazardous waste management technology, such as co-processing in cement industry will be discussed.

2107683 Environmental Engineering Design I 3(1-6-5)

In this course, students will learn about concept design practices used in developing efficient environmental engineering systems for water supply, wastewater treatment, air pollution control systems, greenhouse gases management system, and solid waste disposal facilities. This includes data survey and analysis, project planning, process design and step in design, as well as operation and maintenance of the systems. Students will learn basics of feasibility and sustainability.

2107684 Environmental Engineering Design II 3(1-6-5)

In this course, students will learn the principles and concepts of sustainable system design and develop skills to analyze components of system design, factors and elements essential to sustainability. Students will learn about utilizing data and analysis tools towards designing of sustainable environmental systems. Students will apply knowledge and experiences from the course Environmental Engineering System Design I for advanced design practice. The contents focus on learning and applying quantitative tool for assessing design alternatives and navigating tradeoffs between different sustainability dimensions.

2107626 Stream Sanitation 2(2-0-6)

Patterns of pollution and natural purifications; bacterial self purification; deoxygenation rate; reoxygenation rate; DO sag curve; detection and measurement of pollution; pollution of tidal & coastal waters; BOD loading of receiving waters.

2107633 Water Quality and Agricultural Practice 3(3-0-9)

Water pollution from agricultural practices; sediment, plant nutrients, pesticides, and animal waste; implications of agricultural pollution; control policy and methods.

2107638 Plumbing Design 3(3-0-9)

Plumbing systems, materials, and flow in pipes. Design of water supply systems, hot water supply systems, sanitary drainage and vent systems, storm drainage, fire protection system, public swimming pools, valves, pumps. Installation and testing a system.

2107646 Chemistry for Water and Wastewater Treatment 3(3-0-9)

Sampling of particulate and gaseous pollutants from source and atmosphere, flow measuring devices and their calibration techniques of pollutant identification and analysis, particle measurement, use of techniques in performance test of air control equipment.

2107657 Energy and Environment 3(3-0-9)

Energy resources and utilization in the global context and case studies in Thailand; fossil - based energy; environmental impact of mining and fuel processing; air pollution greenhouse gas, and global warming from fuel utilization; energy conservation and renewable energy technologies; hydro energy harnessing and its environmental impact and mitigation; other non-fossil fuel options: biomass solar, and wind energy; synthetic fuel conversion technology including pyrolysis and gasification; biogas from fermentation; prospect of hydrogen economy.

2107663 Industrial Waste Management 3(3-0-9)

Analysis of material and energy flow in industrial system to enhance eco-efficiency; relationships between industrial production and economic development; waste minimization, pollution prevention design for environment, life cycle analysis (LCA) and waste exchange; linkage of industrial activity with environment and social science; integration of environmental management and environmental ethics; environmental policies and laws.

2107664 Anaerobic Wastewater Treatment Technology 3(3-0-9)

Types of biological wastewater treatment; Theory and basic mechanism of anaerobic wastewater treatment; microbiology and biochemistry of anaerobic fermentation; Kinetics of anaerobic treatment system; various types of anaerobic wastewater treatment system; design and operation of anaerobic treatment processes; current status

of anaerobic technology; consideration and selection of anaerobic process in industrial, municipal and agricultural wastewater treatment.

2107669 Environmental Impact Assessment 3(3-0-9)

Selection of feasible projects by engineering, socio-economic and environment; environmental changes and its impact on communities, assessment methodology; environmental planning and decision making; risk assessment caused by chemical or hazardous waste; case studies.

2107672 Adsorption for Water and Wastewater Treatment 3(3-0-9)

Adsorption theory in aqueous phase; type of adsorbents; characterization adsorbents of physico-chemical adsorption phenomena; adsorption kinetics; adsorption isotherm; effects of water and wastewater characteristics on adsorption effciency; adsorption processes design for water production and wastewater treatment; adsorbent regeneration; case studies on adsorption phenomena of pollutants in aqueous phase.

2107674 Treatment of Wastewater Contaminated with Oil and Small Particles in Environmental Engineering 3(3-0-9)

Oil and small particles in environment; analysis of oil and small particles: overview of treatment and separation processes; fundamental knowledge of separation process; oil skimmer; gravity separation (decantation); coalescer; flotation; hydrocyclone; membrane processes; thermal processes; chemical treatment processes; electro-chemical processes; hybrid treatment processes; finishing process.

2107677 Membrane Technology for Wastewater Reuse 3(3-0-9)

Membrane technology in wastewater treatment; membrane biological reactor (MBR); filtering mechanism; modeling; design of bio-membrane system; operation and maintenance; biofouling and control; membrane cleaning; wastewater reuse; water recycling and reuse in industry; membrane application in wastewater treatment and reuse; state-of-the-art of novel bio- membrane system in environmental engineering; case studies in environmental engineering projects

2110524 Cloud Computing Technology 3(3-0-9)

Course Condition : COREQ 2110471, 2110313

Definition and benefits of cloud computing; cloud migration; infrastructure-as-a-service; platform-as-a-service; storage-as-a-service; auto-scaling and service availability; virtualization technologies and software-defined networks for cloud; cloud security; blockchain and innovative Internet-based distributed services.

2110572 Natural Language Processing Systems 3(3-0-9)

Natural language processing pipeline; tokenization; language model; word representation; part-of-speech tagging; parsing; text classification; machine translation; question answering; dialogue systems.

2110573 Pattern Recognition 3(3-0-9)

K-mean clustering; regression analysis; maximum likelihood estimation; maximum a posteriori; Naive Bayes; Gaussian mixture models; expectation maximization; dimensionality reduction; support vector machines; deep neural networks; reinforcement learning.

2120501 Environmental Trends, Technology and Innovation 3(3-0-9)

Innovation and management that result in sustainability, environmental trend and sustainable trends on a national and a global level, changes in technology and innovation for environmental management to yield sustainable development.

2120502 Co-operate Environmental Management 3(3-0-9)

Basic concepts of inclusive environmental management for organizations using technologies and innovations as one of strategies for promoting modern and sustainable organizations..

2120511 Eco Industry 3(3-0-9)

Concepts of industrial ecology, in which efficient resource utilization is focused for the development of sustainable industries and businesses with the balance of economy, society, and environment, as well as life cycle analysis of production activities towards pollution prevention and waste minimization.

2120512 Environmental Impact Management 3(3-0-9)

Learning environmental components, risk assessment, and how to make the right choice for managing environmental impacts caused by significant social and economic development activities.

2120513 Environmental Economics and Policy 3(3-0-9)

Basic theory of environmental economics; design and implementation of instruments to solve environmental problems; economic analysis of environmental policy; environmental economics and sustainable business and development.

2120521 Basic Concept of Urban Planning and Sustainable Infrastructure 3(3-0-9)

Basic concepts for eco-urban development regarding urban planning and infrastructure design in response to urbanization and improved quality of life.

2120522 Sustainable Infrastructure Development Project 3(1-2-9)

A project-based learning involving the analysis, design and problem- solving of the sustainable infrastructure development for urban and social expansion. The project requires various engineering disciplines, such as but not limited to civil engineering, sanitary and environmental engineering, and water resources engineering, together with effective teamwork and lifelong learning through the assigned project.

2120531 Social Tools for Developing Sustainable Corporate 3(3-0-9)

Social tools for understanding and analyzing social components relevant to sustainability; techniques and methodology for collecting and analyzing data on social sustainability; categorizing and analyzing stakeholders for building sustainable organization; and social impact assessment in business operations.

2120532 Technology and Development of Social- and Environmental-friendly Innovation 3(3-0-9)

Implementations of various technologies and concepts for developing innovations favorable to environment, society, and consumer' s need, as well as introducing the successful case studies.

2120533 Environmental Thinking 3(3-0-9)

Analyzing environmental paradigms as a tool for driving organization complying with the current circumstances, as well as promoting the inclusive and sustainable growth of organization with the engagement of all stakeholders.

2120541 Introduction to Complexity Science 3(3-0-9)

Concept of finite state machine, definitions and properties of complicated system and complex system, self- organization, linear, nonlinear, highly nonlinear networks, coupling effects, positive and negative feedbacks, emergence, power laws and fat- tails distribution, scale invariance in nature and society, phase transition, bifurcation, equilibrium, non- equilibrium and far from equilibrium concepts, forecasting complex adaptive system, the use of numbers vs. narratives, managing complex adaptive system.

2120542 Behavioral Economics and Behavior Pro-environmental 3(3-0-9)

Study components, factors, and related theories of behavioral change and environmental perception in order to understand the relationship between human behavior and the environment. The analysis for designing drivers of participation and sustainability in business that are consistent with current environmental and social conditions are studied in order to create sustainable and inclusive development in the corporate sector.

2120543 Sustainability Reporting and Disclosure 3(3-0-9)

The concepts of sustainable organizational development through the principle of environment, society, and governance (ESG), along with the process of sustainability disclosure preparation. These concepts could reflect the long- term business potential. In addition, it could help develop and improve the operations to achieve the organizational goals and move towards the sustainability.

2120590 Innovative Engineering for Sustainability In Action 3(1-2-9)

Integration of though process and practices for creating engineering-based innovation toward sustainable development, as well as making discussion with an experienced people.

2120591 Special Topics in Innovation for Sustainability I 3(3-0-9)

Lesson learned from case studies relating to attractive technology implementation and innovation development considering economic, social, and environmental dimensions to create ideas for modern and sustainable organizations.

2120561 Climate Change Science 2(2-0-6)

Climate change science; global climate models; economic measures and policies to manage greenhouse gases; impacts from greenhouse gas reduction measures.

2120562 Climate Change Adaptation 2(2-0-6)

Overview of Thailand climate change adaptation policy; cooperation of Thailand and International on climate change adaptation under Sendai framework; guidelines of Thailand climate change adaptation.

2120563 Climate Change Mitigation 3(3-0-9)

Overview of technologies and innovations related to climate change mitigation in various dimensions, including energy, buildings, transportation, industry, and agriculture. The principles and importance as well as the possibility of application for further development are discussed.

2120564 Climate Change Management 3(3-0-9)

The management for climate change adaptation and mitigation by applying appropriate concepts and tools to manage climate- related opportunities and risks. Case studies of climate change management in various sectors are discussed.

2120699 Seminar in Context of Innovative Engineering for Sustainability 1(1-0-3)

Attractive issues on engineering, innovation, and sustainability in different dimensions.

2120791 Study **6(0-24-0)**

An individual study of master's degree students on a chosen topic emphasizing on knowledge creation from case studies or actual problem-solving.

2120811 Thesis **12(0-48-0)**

Individual research project in a student's specialized field, involving new discovery of knowledge required for the Master's degree by in-depth research.

2120816 Thesis **3(3-0-9)**

Individual research project in a student's specialized field, involving new discovery of knowledge required for the Master's degree by in-depth research.

2120896 Comprehensive Examination **S/U**

2124511 Fundamental Risk and Disaster Management **2(2-0-6)**

Risk management; principles, policies, and procedures of risk management; types and sources of risk; tools and techniques in analyzing risk management; disasters; disaster risk management cycle; risk assessment; disaster management simulations and applications.

2130501 Machine Learning and Time Series Analysis **4(4-0-12)**

Methodology in the development of machine learning system, supervised machine learning, classification and regression models, linear models, support vector machine models, neural network models, tree- based models, unsupervised machine learning, dimensionality reduction, clustering methods, association rules, topic modeling, time series analysis, stationary property, time series smoothing, time series modeling.

2130502 Practical IoT **2(2-0-6)**

Introduction to embedded systems, IoT components, sensors, communication protocols and interfacing, automation.

2130511 Abstraction of A.I. and Modern Digital Technologies **3(3-0-9)**

Overview of artificial intelligence and digital technologies; core concepts in AI and digital technologies; interrelationships among technologies; data processing with computers; machine learning and AI paradigms; cloud computing and big data; internet of things (IoT); neural networks and deep learning; contemporary and latest applications in AI; ethical and responsible thinking: understanding of the ethical implications of AI; recognition and addressing of biases in AI; emphasis on fairness, accountability, and transparency in AI systems.

2130512 Essential Skills and Thinking in the Age of A.I. **3(3-0-9)**

Computational thinking; techniques for problem decomposition and pattern recognition; understanding of algorithmic design; basic coding and debugging; AI literacy; data literacy for AI: data interpretation and visualization, data quality, data collection, ethical considerations in data processing; no- code/ low- code application development; interactive coding in a notebook-based environment.

2130513 Hands-on A.I. Experience **1(1-0-3)**

Surveys of publicly accessible A.I. services; hands-on utilization of A.I. services: utilizing pre-trained models, custom model training; application design using A.I. services.

2130514 Crafting Impactful A.I. Strategies **3(3-0-9)**

Strategic integration of AI into business and product environments; AI applications in various industries; moral and societal impacts of AI; frameworks for successful AI implementation; case studies in AI deployment; key aspects of AI deployment: scalability, return on investment (ROI), optimization, stakeholder engagement, risk mitigation.

2130521 Python Programming for A.I. Application Development **3(3-0-9)**

Review of computer programming with Python; numerical Python (NumPy); data Manipulation with pandas; Python libraries for web applications; other advanced Python capabilities useful for A.I. development.

2130522 Web Development Foundations **4(4-0-12)**

Introduction to web development: understanding web application architecture, client-server interactions, role of browsers; HTML basics: elements, attributes, document structure; CSS Fundamentals: styling web pages, CSS rules, responsive design techniques; JavaScript essentials: variables, functions, events, DOM manipulation; back-end development: server- side programming, handling web requests and serving responses; basic database operations; full-stack integration.

2130523 Data Analytics and Data Visualization **2(2-0-6)**

Principles and processes of exploratory data analysis; importance of utilizing data; data import processes; data preparation; organizing data for analysis readiness; using contemporary applications for data management; single variable data analysis; multivariate data analysis; understanding perspectives in data analysis; considerations in data analysis; cautions in interpreting results from data analysis; using basic business intelligence applications; data visualization; basic dashboard design.

2130531 Mathematics Foundations to Machine Learning I **2(2-0-6)**

Fundamentals of differential and integral calculus; linear algebra: vectors, matrices, eigenvalues, and eigenvectors.

2130532 Mathematics Foundations to Machine Learning II **2(2-0-6)**

Probability and statistics; optimization; other mathematical foundations to learning more advanced machine learning topics.

2130591 Selected Topics for Learning Application Development Technology I **3(3-0-9)**

Explore current interests or the latest developments in various technologies for application development.

2130592 Selected Topics for Learning Application Development Technology II **3(3-0-9)**

Explore current interests or the latest developments in various technologies for application development.

2132571 Integrated Water Resources Management **3(3-0-9)**

Management of water resources which are the important basic resource for human activities through the concept of integrated water resources management through the linkages of water- energy- food dimensions, water security and water-related disaster management.

APPENDIX

FOUNDATION ENGLISH COURSES

5500111 Experiential English I **3(2-2-5)**

Practice in the four language skills for everyday communication; comparing, analyzing, and synthesizing information from different sources; giving oral and/ or written presentations.

5500112 Experiential English II **3(2-2-5)**

Condition : Prerequisite 5500111

Further practice in the four language skills for everyday communication; analyzing, synthesizing, summarizing, and evaluating information from different sources; giving oral and/or written presentations.

5500208 Communication and Presentation skills **3(2-2-5)**

Condition : Prerequisite 5500112

Practice using English for social communication and giving oral presentation on engineering-related topics.

5500308 Technical Writing for Engineering **3(2-2-5)**

Condition : Prerequisite 5500208

Practice in writing summaries, composing different types and styles of writing in the field of engineering, and writing reports of studies and experiments.

BASIC SCIENCES AND MATHEMATICES

2301107 Calculus I **3(3-0-6)**

Limit, continuity, differentiation and integration of real- valued functions of a real variable and their applications; techniques of integration; improper integrals.

2301108 Calculus II **3(3-0-6)**

Condition : Prerequisite 2301107

Mathematical induction; sequences and series of real numbers; Taylor series expansion and approximation of elementary functions; numerical integration; vectors, lines and planes in three dimensional space; calculus of vector valued functions of one variable; calculus of real valued functions of two variables; introduction to differential equations and their applications.

2301207 Calculus III **3(3-0-6)**

Condition : Prerequisite 2301108

Surfaces in three dimensional space; polar coordinate system; calculus of real-valued functions of several variables and its applications; line integrals.

2301208 Calculus IV **3(3-0-6)**

Condition : Prerequisite 2301207

Sequences and series of functions; uniform convergence; improper integrals; multiple integration; line integrals; surface integrals and integral theorems.

2301276 Engineering Mathematics I **3(3-0-6)**

Condition : Prerequisite 2301108

Linear algebra; surfaces in three dimensional spaces; polar coordinate system; real-valued functions of several variables; multiple integrals.

2301277 Engineering Mathematics II **3(3-0-6)**

Condition : Prerequisite 2301276

Differential vector calculus; integral vector calculus; tensors; functions of complex variables; improper integrals.

2301312 Differential Equations **3(3-0-6)**

Condition : Prerequisite 2301102 or 2301108 or 2301114 or 2301118

Differential equations with constant coefficients of second order and n-th order; linear differential equations with variable coefficient; system of linear differential equations; Laplace transforms and its application; Fourier series; boundary value problem; introduction to partial differential equations.

2301366 Numerical Analysis **3(3-0-6)**

Condition : Consent of Faculty

Numerical solutions of systems of linear equations, interpolation, approximation functions, least square approximation, numerical differentiation and integration; numerical solutions of algebraic and transcendental equations; numerical solutions of ordinary differential equations.

2301374 Applied Mathematical Methods **3(3-0-6)**

Condition : Prerequisite 2301207

Linear algebral; introduction to the theory of approximations; solution of algebraic and transcendental equations; solutions of linear systems; first and second order differential equations; Fourier transforms and Lap lace transforms; vector calculus.

2302127 General Chemistry **3(3-0-6)**

Stoichiometry; states of matters; solutions and colloids; thermodynamics; chemical equilibrium; acid-base equilibria; electrochemistry; Chemical kinetics; atomic structures; Chemical bonding; Periodic table; nuclear reactions.

2302163 General Chemistry Laboratory **1(0-3-0)**

Stoichiometry; gases; liquids; and solution; solids; thermochemistry; chemical kinetics; chemical equilibrium; electrochemistry; quantitative analysis; quanlitative analysis.

2304103 General Physics I 3(3-0-6)

Basic mathematics for general physics; mechanics and its applications; gases and kinetic theory; thermodynamics; transport phenomena and heat transfer; physical properties of matter.

2304104 General Physics II 3(3-0-6)

Electrostatic; direct current; alternating current; electrical circuits; electromagnetism and magnetic materials; mechanical and electromagnetic waves; modern physics; nuclear physics; relativity.

2304183 General Physics Laboratory I 1(0-3-0)

Measurement and precision; statistical analysis and accuracy; simple harmonic motion, rotational motion, wave, sound, heat, fluid.

2304184 General Physics Laboratory II 1(0-3-0)

Electrical measurements and basic Electrical equipment, ammeter and voltmeter, AC circuit, semiconductor devices, lense and spherical mirror, diffraction and interference of light, polarization, and radioactivity, Electromagnetic induction.

2307207 Physical Geology 3(3-0-6)

Basic principles and geological concepts; origin, evolution, and history of the Earth; geological processes; geological materials; earth's features and structures and their relationships in space and time.

2603284 Statistics for Physical Science 3(3-0-6)

The scope and uses of statistics in physical science; elementary principles of probability theory; random variables and some probability distributions; introduction to statistical inference; introduction to analysis of variance; regression and correlation; statistical quality control

AI-DIGITAL BIG DATA

2100201 Introduction to Artificial Intelligence 3(2-2-5)

Introduction to artificial intelligence related to scope, historial background; Comcept for design; knowledge representation; memory structures; probabilistic reasoning; decision making; fuzzy logic; genetic algorithm; chaotic.

2100202 Introduction to Data Science and Big Data 3(2-2-5)

Basic Knowledge related to definition of data science and big data; Knowledge and skill in exploratory data analysis; skill in data preparation; skill in data storage and retrivin; data anlysis using tools of data sciences; data visualization.

INTERDISCIPLINARY AND 21ST CENTURY SKILLS

2100223 Entrepreneurship and New Venture Creation 3(3-0-6)

Concept of entrepreneurship, concepts and processes of business opportunity analysis, design thinking for innovation business idea development, identifying target customers, analysis of customer's problem and need, developing unique value position for product and service, business models and revenue model, legal aspects for innovative entrepreneur, business idea presentation.

2100224 Technopreneurship 3(3-0-6)

Concept of technopreneurship, characteristics and motivation for technopreneurs, intrapreneurship, entrepreneurial mindset and process; opportunity analysis of technology business, technology business model design, sources of fund for technology business.

2100225 Design Thinking Principle 3(3-0-6)

Principle of Design Thinking method; Basic concept of prototype design; Basic concepts of self-assessment; Self-assessment based on knowledge, skill, people and working conditions; Research and analysis of information given by professional opinions; Development of action plan for sustainability.

2100226 Problem Solving Principle 3(3-0-6)

Principle of problem solving based on data; Assumption setting; Assumption verification; Problem prioritization; Application of statistics for correlation analysis; Planning for problem solving.

BASIC ENGINEERING PRACTICE

2100301 Engineering Practice 2(0-35-0)

Engineering practice in related areas under supervision of experience experienced engineers in private sectors or government agencies.

2100499 Senior Project 3(0-6-3)

An interesting project in a multidisciplinary field of engineering; project proposal; working on a project; project presentation and doing a complete written report.

GENERAL EDUCATION, SPECIAL

2100111 Exploring Engineering World 3(3-0-6)

Engineering, engineering disciplines and engineering works in daily life and relationship with other disciplines and current issues. Role, work, skills, professional advancement and ethics of engineers. Design thinking in the problem defining and problem solving.

2100311 Engineering Essentials 3(3-0-6)

Topics related to engineering: management, ethics, good governance, public responsibility, intellectual property, finance, investment, economics, and green technology.

ELECTIVE COURSES

2100310 Global Aware Tech 3(3-0-6)

Global awareness: Current mainstream technologies: Understanding of a variety of cultures, traditions, laws & regulations, bellefs, concepts, practices, values: Technology implementation in various societies: Success factora for technology implementation.

GROUP OF COURSES FOR OUTBOUND EXCHANGE STUDENT

2100324 Study Abroad I 2(2-0-4)

Study of a course offered by a university abroad according to the requirement of the program.

2100325 Study Abroad II 2(2-0-4)

Study of a course offered by a university abroad according to the requirement of the program.

2100326 Study Abroad I 3(3-0-6)

Study of a course offered by a university abroad according to the requirement of the program.

2100327 Study Abroad II 3(3-0-6)

Study of a course offered by a university abroad according to the requirement of the program.

2100624 Study Abroad I 1(1-0-3)

Study additional courses around according to the requirement of the program.

2100625 Study Abroad II 2(2-0-6)

Study additional courses around according to the requirement of the program.

2100626 Study Abroad III 3(3-0-9)

Study additional courses around according to the requirement of the program.

2100328 Study Abroad III 2(2-0-4)

Study of a course offered by a university abroad according to the requirement of the program.

2100329 Study Abroad IV 3(3-0-6)

Study of a course offered by a university abroad according to the requirement of the program.

DESCRIPTION OF GENERAL EDUCATION COURSES

in 5 fundamental areas

Humanities I Science and Maths I Interdisciplinary I Social Sciences I 21st Gened (S/U)

1. Humanities

Course Number	English Abbreviation of Course Title	Credit	Course Number	English Abbreviation of Course Title	Credit
0123101	PARAGRAPH WRITING	3(1-4-4)	2226001	INTRO VIET CULTURE	3(3-0-6)
0123104	UNIV THAI READING	3(1-4-4)	2232241	GER CH JU LIT	3(3-0-6)
0123105	THAI WRIT WORK	3(1-4-4)	2232253	GER-SPK CNTR TODAY	3(3-0-6)
0123106	TH COM SKIL	3(3-0-6)	2234482	INTRO ITAL CINEMA (EN/TH)	3(3-0-6)
0201105	CU SMART BUD GRAD	3(3-0-6)	2235320	CONTEMP PORT BRAZ	3(3-0-6)
0201211	MEDITAT LIFE DEV	3(2-2-5)	2236001	RUS BEGIN	3(3-0-6)
0201212	SP ETH ICS (EN/TH)	3(3-0-6)	2236003	COMM RUS	3(3-0-6)
0296110	HU ECO GLOBAL	3(3-0-6)	2236103	RUS LANG CULT (EN/TH)	3(3-0-6)
0296111	CRIT THINK SKIL	3(3-0-6)	2236222	MOD RUS	3(3-0-6)
0296112	LIFE SKILLS	3(3-0-6)	2244151	INTRO CAMBO CULT	3(3-0-6)
0296113	BSC TH COMM	3(3-0-6)	2245151	INTRO LAO CULT	3(3-0-6)
2200183	THAI CIV	3(3-0-6)	2296111	CREAT LRNG SPACE	3(2-3-4)
2200185	SURV ART ARCH THAI	3(2-4-3)	2296200	HUMAN LANG	3(3-0-6)
2200201	ACAD REPORT WRI (INTER)	3(2-2-5)	2296225	LIT FILM	3(3-0-6)
2200222	VERN ARCH TH SOC	3(3-0-6)	2296228	THAI FOLK ART	3(3-0-6)
2200223	PNTG TH SOC	3(3-0-6)	2296313	HUM LIT	3(3-0-6)
2200226	FOLK MUS TH SOC	3(3-0-6)	2296314	JUV LIT	3(3-0-6)
2200227	TH CL MUS DRAM	3(3-0-6)	2296315	LIT/ETHN IDEN	3(3-0-6)
2200330	TIPITAKA LIFE	3(3-0-6)	2296352	21C BUDDHISTS	3(3-0-6)
2200387	ARCHAEO THAI	3(2-3-4)	2501191	HIST ART ARCH	3(3-0-6)
2200389	ICONOGRAPHY	3(3-0-6)	2501192	ARCH THAI *	3(3-0-6)
2200390	FOR CULT TH ART	3(3-0-6)	2501292	INTRO HSE DSGN	3(3-0-6)
2200391	CONT ART TH SEA	3(3-0-6)	2501295	INTRO DESIGN	3(3-0-6)
2200392	ANC ART SIAM SEA	3(3-0-6)	2501296	THAI ARCH HERITAGE	3(3-0-6)
2200393	LANG / CULT ART	3(3-0-6)	2501297	ENJOY ARCH SKETCH	3(2-2-5)
2200394	CUST/FEST TH SOC	3(3-0-6)	2501298	UNDERST ARCH	3(2-3-4)
2200395	ROY TRAD/CERE	3(3-0-6)	2542001	ART DSGN FLD (INTER) *	3(0-9-0)
2200396	REL RIT TH SOC	3(3-0-6)	2502291	DESIGN EVERYDAY (EN/TH)	3(3-0-6)
2204180	CIVILIZATION	3(3-0-6)	2502292	CULTINARY DESIGN	3(2-2-5)
2206101	RES ACAD REP WRIT	3(3-0-6)	2502330	DSGN TH CULT HER *	3(3-0-6)
2207103	PHILOS LOGIC	3(3-0-6)	2502378	JWL APPRECIAT	3(3-0-6)
2207201	HIST WEST PHILOS	3(3-0-6)	2502379	APPRE CER	3(3-0-6)
2207203	PHILOS FILMS	3(3-0-6)	2502393	CONT JP DSGN	3(3-0-6)
2207341	SYMBOLIC LOGIC	3(3-0-6)	2503469	URBAN LIFE	3(3-0-6)
2207361	AESTHETICS	3(3-0-6)	2502430	DSGN ENTREPRN *	3(3-0-6)
2207363	ETHICS	3(3-0-6)	2504102	HEALG ART/LDSCP	3(3-0-6)
2207365	POLITICAL PHILOS	3(3-0-6)	2541151	SPARK CREAT (INTER)	3(1-4-4)
2207371	PHILOS LITERATURE	3(3-0-6)	2541152	C/C PROB SOLV (INTER)	3(1-4-4)
2207387	PHILOS WOMEN	3(3-0-6)	2541154	COLOR AESTHETICS (INTER)	3(1-4-4)
2207467	PHILOS LANG	3(3-0-6)	2541155	VIS CULT (INTER)	3(2-2-5)
2207472	JAPANESE PHILOS	3(3-0-6)	2541156	ARCH ENV FILM (INTER)	3(3-0-6)
2207474	CHINESE PHILOS	3(3-0-6)	2541157	PERSPEC EU ARCH (INTER)	3(3-0-6)
2207478	PS TOP ETHICS	3(3-0-6)	2541158	LAND/LANDSCAPE (INTER)	3(3-0-6)
2209212	HUMAN LANG	3(3-0-6)	2541159	UNDST/BSC IA DSGN (INTER)	3(2-2-5)
2209373	LANG CULTURE	3(3-0-6)	2541162	POSTMOD PHOTO (INTER)	3(3-0-6)
2209375	LANG ASEAN PLUS	3(3-0-6)	2541163	FML ANAL/PRES ARCH (INTER)	3(3-0-6)
2210214	LIT/ENVIRON	3(3-0-6)	2541168	DSGN ASIAN PESSP (INTER)	3(3-0-6)
2210215	LIT/WOMEN	3(3-0-6)	2541169	HIST ANIMATION (INTER)	3(3-0-6)
2210216	MAG REAL LIT	3(3-0-6)	2541171	CR ECON DSGN (INTER)	3(2-3-4)
2210217	CONTEM FICT	3(3-0-6)	2541176	JP DSGN CON (INTER) *	3(3-0-6)
2501299	BUDDHIST ART/ARCH (EN/TH)	3(3-0-6)	2541177	ARCH HOME (INTER)	3(3-0-6)
2210218	REL/SPIRIT LIT	3(3-0-6)	2542002	COMM DSGN PROJ (INTER) *	3(3-0-6)
2210219	MYSTERY FICTION	3(3-0-6)	2542003	DSGN THINL INNV (EN/TH)	3(3-0-6)
2210221	CRIME FICT/FILM	3(3-0-6)	2722272	DHAMMAVIDYA	2(2-0-4)

2210225	SCI TECH CONT FICT	3(3-0-6)	2722288	DHAMMA SELF	3(3-0-6)
2210226	LIT MARGIN	3(3-0-6)	2736106	ART APPRECIATION	2(2-0-4)
2210227	NONHUMAN SCI FICT	3(3-0-6)	2737110	MUS APPRECIATION	2(2-0-4)
2210235	LITERATURE AND FILM ADAPTATIONS	3(3-0-6)	2746105	LOC TALES MYTHS	3(1-6-2)
2210239	LIT/DISABILITY	3(3-0-6)	2796200	ART FOR LIFE QUAL *	3(3-0-6)
2210301	FUND LIT STUD	3(3-0-6)	2800210	ART APPRE COMM (INTER)	2(2-0-4)
2210313	HUMOUR/LIT	3(3-0-6)	3500303	ART HIST FILM	3(3-0-6)
2210314	JUVILE LIT	3(3-0-6)	3500304	FUND ART CULT MGT	3(3-0-6)
2210315	LIT/ETHN IDENTITY	3(3-0-6)	3500305	CUR STUD	3(3-0-6)
2210316	LIT/SOC-POL CONS	3(3-0-6)	3500111	INTRO FINE APP ART	3(3-0-6)
2210323	LIT/HUM RIGTHS	3(3-0-6)	3501120	HIST WEST ART I (EN/TH)	3(3-0-6)
2210335	INTRO CULT STUD	3(3-0-6)	3501214	THAI ARTS I	3(2-2-5)
2210420	MAJOR WRITER WORK	3(3-0-6)	3501217	EAR MOD ART	3(3-0-6)
2210423	LIT/PSYCHO	3(3-0-6)	3501222	HIST ORNTAL ART I *	3(3-0-6)
2221249	PALI DAILY LIFE	3(3-0-6)	3501224	HIST THAI ARTS	3(3-0-9)
2221316	IND MYTH TH CULT	3(3-0-6)	3502222	HIST CREAT ART	3(3-0-9)
2221390	IND CULT TH SOC	3(3-0-6)	3502271	HIST FASHION *	3(3-0-6)
2221433	BUDDHIST TEACHING	3(3-0-6)	3502272	HIST GRAPH DSGN *	3(3-0-6)
2221485	BUDDHIST CIV	3(3-0-6)	3503101	CL MUS SCRN (EN/TH)	3(3-0-6)
2223181	INTRO JP LIT	3(3-0-6)	3503111	INTRO CLASSIC (EN/TH)	3(3-0-6)
2223243	JAPAN TODAY	3(3-0-6)			

2. Science and Maths

Course Number	English Abbreviation of Course Title	Credit	Course Number	English Abbreviation of Course Title	Credit
0201287	MAP APPLN (INTER)	3(3-0-6)	3010101	DRUG DAILY LIFE (EN/TH)	3(3-0-6)
0201152	PROD PROMOTION SCI	3(3-0-6)	3011102	CA NONMED STUD	3(3-0-6)
0298111	IN PRO COMMUNITY	3(3-0-6)	3098101	DRUG DAILY LIFE	3(3-0-6)
0298112	GEN PRIN HAL PROD	3(3-0-6)	3101101	COMP APP PROF *	1(0-3-0)
0298114	INTR CLIN SEX	3(2-2-5)	3102114	ANL BEHAVIOR *	2(2-0-4)
0298115	SPREADSHEET SKILLS	3(2-2-5)	3107302	BIOSTAT STICS *	3(3-0-6)
0298116	DATA ANAL FOUND	3(2-2-5)	3200106	FUN ORAL BIO HLTH	3(3-0-6)
2100111	EXPL ENG WORLD	3(3-0-6)	3200109	CALCIUM HLTH	3(3-0-6)
2100225	DES THINK PRINC	3(3-0-6)	3200111	LIFE LRN SKIL DENT *	1(0-3-0)
2100311	ENG ESSENTIALS	3(3-0-6)	3200116	BIOMED SCI BIOETH *	1(0-2-1)
2101256	C E PROFESSION	3(3-0-6)	3200216	BIOMED SCI COMM *	1(0-2-1)
2102041	ICT TELECOM MGT	3(3-0-6)	3200314	BIOSTATISTICS *	2(2-0-4)
2102209	ELECT ENG ESSENT	3(3-0-6)	3200316	BIOMED SCI ANA *	1(0-2-1)
2110222	INTRO CEDT *	3(3-0-6)	3301102	COSMETICS DLY LIFE	3(3-0-6)
2103201	INTRO MECH DESIGN *	3(2-2-5)	3304102	DRUG EDUCATION (EN/TH)	3(3-0-6)
2104409	IND BUS MGT *	3(3-0-6)	3306101	USEFUL PLANTS	3(3-0-6)
2105261	CHEM PROD IND	3(3-0-6)	3307101	BASIC AROMATHERAPY	3(3-0-6)
2107219	URBAN ENVIRONMENTS	3(3-0-6)	3308100	MICRO ORGAN/LIFE	3(3-0-6)
2107220	ENV DAILY LIFE (INTER)	3(3-0-6)	3308101	HYG ENV MICROBIO	3(3-0-6)
2107221	ENV STUD	3(3-0-6)	3309101	LIFE/HEALTH	3(3-0-6)
2109101	ENG MATERIALS *	3(3-0-6)	3309102	OUR BODY	3(3-0-6)
2110191	INNOV THINK	3(3-0-6)	3310101	MAN & TOXIC SUBS	3(3-0-6)
2110221	COMP ENG ESS	3(3-0-6)	3600202	NUTRITION	2(2-0-4)
2111201	GEN RAD NUCLEAR	3(3-0-6)	3600204	HLTH SEXUALITY	3(3-0-6)
2111330	MOD MAP PROT RAD	3(3-0-6)	3600205	FAM HLTH CARE	3(3-0-6)
2112210	WATER / SOC	3(3-0-6)	3600206	COM HLTH DEV	3(3-0-6)
2142109	AUTO STUDIES (INTER)	3(3-0-6)	3600207	HLTH LIVING	3(3-0-6)
2140140	NANO101	3(3-0-6)	3600208	TOB ALC HLTH	3(3-0-6)
2140145	HOME IMPROVEMENT	3(3-0-5)	3600209	EMER DISAS CARE	3(2-2-5)
2147102	INTRO ROBOTICS (INTER) *	3(3-0-6)	3600301	NUTRI HLTH	3(3-0-6)
2182205	PROB STAT DATA (INTER) *	3(3-0-6)	3600302	WELLNESS SOCIETY	3(3-0-6)
2147111	EXPL ROBOTICS ENG (INTER) *	3(3-0-6)	3600303	DIS SURV EMER CARE	3(2-2-5)
2185101	INTRO CHE (INTER) *	3(3-0-6)	3600304	NEW GEN PAREN	3(3-0-6)
2300150	NATURAL SCIENCE	3(3-0-6)	3600305	EMPWRG TEENS	3(3-0-6)
2300152	SCIENCE TODAY	3(3-0-6)	3600306	ASIAN WISD HLTH	3(3-0-6)

2300200	SCI TECH SOC	3(3-0-6)	3640203	MTRNL CHILD HEALTH	2(2-0-4)
2301170	COMP PROG	3(3-0-6)	3700104	INI HC NEW GEN (INTER) *	3(3-0-6)
2301172	COMP PROG LAB	1(0-2-1)	3700105	FOOD SCI ART *	3(3-0-6)
2302190	CHEMISTRY FOR MODERN LIFE (INTER)	3(3-0-6)	3700107	SEXUAL DEVELOPMENT (EN/TH) *	3(3-0-6)
2303150	BIRDWATCH CONSERV	3(3-0-6)	3700108	HLTH PREV INFC DIS *	3(3-0-6)
2303165	MAN & ENVIRONMENT (EN/TH)	3(3-0-6)	3700109	IMMUNTY OF LIFE *	3(3-0-6)
2304274	PHYS BIO SYS	3(3-0-6)	3700110	GOOD HEALTH *	3(3-0-6)
2305103	PL BETTER LIFE	3(3-0-6)	3700113	BLOOD ESS LIFE	3(3-0-6)
2305107	PLANT WORLD	3(3-0-6)	3700114	INTRO ENVI TOX	3(3-0-6)
2305108	BIOTECH DAILY LIFE	3(3-0-6)	3700210	MOD TECH HLTH	3(3-0-6)
2305109	PL GROW TECH	3(3-0-6)	3705102	RADIA DAILY LIFE	3(3-0-6)
2305120	THAI NAT REFOR	3(3-0-6)	3741101	COMP HLTH SCI *	2(1-3-2)
2305151	ORGANIC GARDENING (INTER)	3(3-0-6)	3741102	LIVE SMART HLTHY *	2(2-0-4)
2305161	GENETICS FOR LIFE	3(3-0-6)	3741107	ROAD TO MT *	1(1-0-2)
2306416	MGT SYS TECH	3(3-0-6)	3741108	COMP HLTH SCI *	1(0-2-1)
2307205	INTRO GEM SCI	3(3-0-6)	3741207	MOD TECH *	2(2-0-4)
2307206	EARTH SCIENCES	3(3-0-6)	3741208	LIFE LEARN SKILLS *	2(1-2-3)
2307230	EARTH SURFACE	3(3-0-6)	3741329	PATIENT SAFETY *	1(1-0-2)
2308200	SCI LOGIST SYS	3(3-0-6)	3741341	SW PKG STATS ANLYS *	1(0-2-1)
2308303	HISTORY OF SCI (EN/TH)	3(3-0-6)	3741426	START-UP BUSIN MT *	1(1-0-2)
2308354	STRATEGY OF LIFE (EN/TH)	3(3-0-6)	3742100	PHY THR DAILY LIFE *	3(3-0-6)
2309201	GEN OCEANOLOGY	2(2-0-4)	3742102	EXERCISE THERAPY *	3(3-0-6)
2309202	ORNAMEN FISH AQUA	3(3-0-6)	3742106	BLC BODY MIND QOL *	3(3-0-6)
2309203	UNDER THE SEA	3(3-0-6)	3742107	LIFE KNOWLEDGE *)	3(3-0-6)
2310201	HEALTH/BEAUTY	3(3-0-6)	3743422	WEIGHT CONTROL *	3(3-0-6)
2310202	SMT BUY CONS PROD	3(3-0-6)	3900200	EX/PS HLTH (EN/TH)	3(2-2-5)
2311132	NEW TECH MAT SCI	3(3-0-6)	3900202	FUNC EX	3(2-2-5)
2312100	MICROB FRIEND	3(3-0-6)	3900203	THEK MTNG EX	3(2-2-5)
2313210	VISUAL MEDIA TECH	3(3-0-6)	4000105	INN MGT ORGAGR *	3(3-0-6)
2313213	DIGITAL PHOTO (EN/TH)	3(3-0-6)	4000205	ORG AGR	3(3-0-6)
2313221	PHOTO SCI	3(3-0-6)	4000210	QUAN ANAL AGRI BUS	3(3-0-6)
2313226	PRINS MEDIA TECH	3(3-0-6)	5600180	ENG FOUND INNO (INTER)	3(3-0-6)
2314255	ELEMENT FOOD TECH (EN/TH)	3(3-0-6)	5600191	SCI DAILY LIFE (INTER)*	3(3-0-6)
2314257	INTRO PACK TECH	3(3-0-6)	5609101	NUM METH INNO (INTER)*	3(3-0-6)
2398130	MUGGLE MECHANICS	3(3-0-6)	5698101	EMG TECH LLL (INTER)*	3(3-0-6)
2398131	PHYS IN FILMS	3(3-0-6)			

3. Interdisciplinary

Course Number	English Abbreviation of Course Title	Credit	Course Number	English Abbreviation of Course Title	Credit
0201102	THAI WISDOM	3(1-12-0)	0201281	TEAM/ORG DEV	3(3-0-6)
0201103	OUR CU	3(2-3-4)	0201282	NAT SKB JOUR	3(3-0-6)
0201106	ART SCI FIND HAP	3(3-0-6)	0201283	BEAUTIFUL DEATH	3(3-0-9)
0201107	LRN STUD ACT (EN/TH)	3(1-6-2)	0201284	JWL DES ENTRE (INTER)	3(3-0-6)
0201108	FAMILY RELATIONS	3(3-0-6)	0201285	ECON SOC PLAN	3(3-0-6)
0201109	INTRO EU INTEGRAT (EN/TH)	3(3-0-6)	0201286	LIFE DESIGN	3(3-0-6)
0201110	SICHANG STUDY	3(2-2-5)	0295100	EXPL BME WORLD	3(3-0-6)
0201111	WISDOM LIVING	3(3-0-6)	0295101	INTRO DATA SCI	3(3-0-6)
0201117	ART RATANAKOSIN	3(2-3-4)	0295102	AGRO WASTES MONEY	3(3-0-6)
0201121	LIFE REFL FILM	3(3-0-6)	0295104	GUARD WATER	3(2-2-5)
0201122	MGT PUB DISASTER	3(3-0-6)	0295105	PET LOVERS	3(2-3-4)
0201123	CULT TRAD TH LIFE (EN/TH)	3(2-2-5)	0295106	WELL LIFE EXT	3(3-0-6)
0201125	MGT DIFF CULT (INTER)	3(3-0-6)	0295107	PATIENT SAFETY	3(1-4-4)
0201127	QUAL WORK MGT (INTER)	3(3-0-6)	0295125	DESIGN THINK INNO	3(3-0-6)
0201130	IND BUS MGT	3(3-0-6)	2104181	HF ERGO DAILY LIFE	3(3-0-6)
0201131	THAI COAST COM DEV	3(2-3-4)	2305100	NATIONAL RESOURCES	3(3-0-6)
0201141	COAST ENV	3(2-3-4)	2305104	MAN/NATURE	3(3-0-6)
0201151	OUR ENVIRONMENT(EN/TH)	3(3-0-6)	2305106	PLANS/HUMANITY	3(3-0-6)
0201153	WASTE MANAGEMENT	3(3-0-6)	2502390	INTRO PACK DESIGN	3(3-0-6)
0201154	URB GLOB WRMG	3(3-0-6)	2503216	AMPHAWA STUDIES	3(2-2-5)
0201200	STUD PROC THAI SOC	3(2-3-4)	2504101	LA APPRECIATION	3(3-0-6)

0201201	IDEAL GRADUATE 1	3(3-0-6)	2506504	TRAD TAI SET HSG	3(2-3-4)
0201202	IDEAL GRADUATE 2	3(3-0-6)	2750178	LLL	3(1-4-4)
0201203	IDEAL GRADUATE 3	3(3-0-6)	3000106	DOCTOR AND SOCIETY *	2(1-2-3)
0201204	IDEAL GRADUATE 4	3(3-0-6)	3000257	CRIT THK ETH/LAW *	2(1-2-3)
0201205	IDEAL GRADUATE 5	3(3-0-6)	3000281	HUMAN LIFE *	1(1-0-2)
0201206	THAI IDEAL GRAD	3(3-0-6)	3000396	HLTH PROM *	1(0-3-0)
0201209	VALUE URB ENV	3(2-3-4)	3300100	HEALTH CONS PROT	3(3-0-6)
0201210	MAT MGT GREEN	2(2-0-6)	3303100	Q LIFE	3(3-0-6)
0201230	MAN/PEACE	3(3-0-6)	3303191	CHEM DRUG DAILY	3(3-0-6)
0201231	URB COMM STUD	3(2-3-4)	3305101	FOOD FOR HEALTH	3(3-0-6)
0201232	MULTI STUD RUR DEV (EN/TH)	3(3-0-6)	3800252	LEADER PER DEV	3(3-0-6)
0201234	LOCAL GLOB ISS (EN/TH)	3(2-3-4)	3800309	PSY CONSERV NATURE	3(3-0-6)
0201251	P2 CONTROL (EN/TH)	3(3-0-6)	3900204	REC BUS TOUR	3(3-0-6)
0201252	ALT ENGY CONS	3(3-0-6)	3914101	REC QUAL LIFE DEV (EN/TH)	3(3-0-6)
0201254	GLOB WARM ADAP	3(3-0-6)	4000101	AGR PROD DEV CONS (EN/TH)	3(3-0-6)
0201255	ICT STRATEGIC MGT (EN/TH)	3(3-0-6)	5695101	DES DEV PROD PROT (INTER) *	3(3-0-6)
0201256	LIV DIGI WORLD(EN/TH)	3(3-0-6)	5695102	PROF COMM SKL INNO (INTER) *	3(3-0-6)
0201270	NAT SECURITY DEV	3(3-0-6)			

4. Social Sciences

Course Number	English Abbreviation of Course Title	Credit	Course Number	English Abbreviation of Course Title	Credit
0201170	MILITARY SCIENCE	3(3-0-6)	2894100	FASN COMM	3(3-0-6)
0201171	EFFECT CAREER MGT (INTER)	3(3-0-6)	2900151	FOUNDATION ECON	3(3-0-6)
0201172	SELF/CAREER MGT (INTER)	3(3-0-6)	2900152	INTRO THAI ECON	3(3-0-6)
0201173	RETHINK JUST INNO (INTER)	3(3-0-6)	3401102	TAX LAW DLY LIFE	3(3-0-6)
0294455	PROF PRESENTATION	3(3-0-6)	3401105	LAW ENTREPRENEUR	3(3-0-6)
0294456	DESIGNING LIFE	3(1-5-3)	3401124	INTRO IP LAW	3(3-0-6)
0294460	INTR SUST DEV	3(2-2-5)	3402103	INTRO CRIM LAW	3(3-0-6)
0294461	STARTUP ENTREPRN	3(2-2-5)	3404103	LAW LAND MGT	3(3-0-9)
0294463	RDMAP LT NEW GEN	3(3-0-6)	3404109	LAW COMP TECH	3(3-0-6)
0294464	CONT INDIA	3(3-0-6)	3404113	INTRO WTO LAW	3(3-0-6)
0294465	BSC E TPR	3(2-2-5)	3404115	INTRO PUBLIC LAW	3(3-0-6)
0294466	ESS CAR EER SKIL	3(2-2-5)	3404117	INTRO TO LAW (EN/TH)	3(3-0-6)
0294467	APRU SDG GC (INTER)	3(2-3-4)	3404122	LEGAL LOGICS *	2(2-0-4)
2400104	GOVT POL THAI	3(3-0-6)	3404123	LEGAL HISTORY *	2(2-0-4)
2403183	SOCIETY & CULTURE (EN/TH)	3(3-0-6)	3404124	LAW AND SOCIETY *	2(2-0-4)
2403184	SOC DIVER JUS THAI (EN/TH)	3(3-0-6)	3404128	LEGAL LOGIC LANG *	2(2-0-4)
2403185	JUV DEL (EN/TH)	3(3-0-6)	3404129	LEGAL ETHICS *	2(2-0-4)
2403284	CROSS CULT MGT (EN/TH)	3(3-0-6)	3404130	LAW ECON *	2(2-0-4)
2403471	ANTH RSRCH METH	3(3-0-6)	3404131	FREE ASM LAW	3(3-0-6)
2404300	IT/SOC (EN/TH)	3(3-0-6)	3404201	LAW ACCTG *	2(2-0-4)
2404301	SEL TOP PAX DIGI	3(3-0-6)	3404202	LAW ECON ANAL *	2(2-0-4)
2541160	CREAT URB LIVING (INTER)	3(3-0-6)	3404307	LEGAL RES *	2(2-0-4)
2601111	BUS ACCTG	3(3-0-6)	3404405	LEGAL ETHICS *	2(2-0-4)
2602121	INTRO BUSINESS	3(3-0-2)	3404450	UNDSTG CHIN	3(3-0-6)
2602171	BUS CPTS/ETHICS (INTER)	3(3-0-6)	3404500	ENV LAW SOC	3(3-0-6)
2602241	INTRO IT/IS (EN/TH)	3(3-0-6)	3405102	INTRO INTL LAW	3(3-0-6)
2603244	GEN PRIN INSURANCE	3(3-0-6)	3494101	LAW HUM RES MGT	3(3-0-6)
2604362	PERSONAL FINANCE	3(3-0-6)	3800105	INTRO PSY (EN/TH)	3(3-0-6)
2605311	PRINC MKTG	3(3-0-6)	3800130	SOC PSY EVERY LIFE (INTER)	3(3-0-6)
2722178	THAI CULTURE	2(2-0-4)	3800202	PSY LIFE WORK (EN/TH)	3(3-0-6)
2722221	TH CULT GLOB	3(3-0-6)	3800250	HUMAN RELATIONS	3(3-0-6)
2737201	MUSIC FOR ESTHE *	3(3-0-6)	3800251	MENTAL HEALTH	3(3-0-6)
2746104	KHAM PHOR SORN	3(1-6-2)	3800351	PSY THINK CREAT	3(3-0-6)
2746292	EDU SUS DEV *	3(3-0-6)	3900205	WORLD SPT IND	3(2-2-5)
2747406	LEAD ED PRO 21STCE *	3(3-0-6)	4000104	INTRO AGRIBUS *	3(3-0-6)
2800118	COMM ETHICS	3(2-2-5)	4000203	INTRO SUFF ECON	3(3-0-6)
2800119	MEDIA LAW REG *	3(3-0-6)	4000204	INTRO AGRO FOOD CH (EN/TH)	3(3-0-6)
2800211	THAI CULT/COMM (INTER)	3(3-0-6)	4000206	HIST THAI AGR	3(3-0-6)
2800212	HUMAN COMM (INTER)	3(3-0-6)	4000208	INTRO AGR ECON (EN/TH)	3(3-0-6)

2800218	VIS MED STUDIES (INTER)	3(3-0-6)	4000209	INTRO AGR RES MGT	3(3-0-6)
2800219	CROSS CULT COMM (INTER)	3(3-0-6)	5100101	POP/DEV	3(3-0-6)
2800221	INTER COMM ETI PRO (INTER)	3(3-0-6)	5600160	IP DATA SECUR MGT	3(3-0-6)
2800314	ART PUB SPKG (INTER)	3(3-0-6)	5600161	SE INNO	3(3-0-6)
2800381	GEN CULT/COMM (INTER)	3(3-0-6)	5600170	ETHICS GOVERN TECH (INTER)	3(3-0-6)
2801321	NEWS INFO/SOC	3(3-0-6)			

5. 21st GENED (S/U)

Course Number	English Abbreviation of Course Title	Credit	Subject matter
0294455	PROF PRESENTATION	3(3-0-6)	Social Sciences
0294456	DESIGNING LIFE	3(1-5-3)	Social Sciences
'0294460	INTR SUST DEV	3(2-2-5)	Social Sciences
0294461	STARTUP ENTREPRN	3(2-2-5)	Social Sciences
0294463	RDMAP LT NEW GEN	3(3-0-6)	Social Sciences
0294464	CONT INDIA	3(3-0-6)	Social Sciences
0294465	BSC ETPR	3(2-2-5)	Social Sciences
0294466	ESS CAR EER SKIL	3(2-2-5)	Social Sciences
0294467	APRU SDG GC (INTER)	3(2-3-4)	Social Sciences
0295100	EXPL BME WORLD	3(3-0-6)	Interdisciplinary
0295101	INTRO DATA SCI	3(3-0-6)	Interdisciplinary
0295102	AGRO WASTES MONEY	3(3-0-6)	Interdisciplinary
0295103	LRNG LIFE	3(3-0-6)	Interdisciplinary
0295104	GUARD WATER	3(2-2-5)	Interdisciplinary
0295105	PET LOVERS	3(2-3-4)	Interdisciplinary
0295106	WELL LIFE EXT	3(3-0-6)	Interdisciplinary
0295107	PATIENT SAFETY	3(1-4-4)	Interdisciplinary
0295108	STEM ROBOT	3(2-2-5)	Interdisciplinary
0295109	INNO SRD	3(2-2-5)	Interdisciplinary
0295110	WINE EDUCATION	3(2-2-5)	Interdisciplinary
0295111	KNOW ACCUM I	1(1-0-2)	Interdisciplinary
'0295112	KNOW ACCUM II	2(2-0-4)	Interdisciplinary
0295113	KNOW ACCUM III	3(3-0-6)	Interdisciplinary
0295114	KNOW ACCUM IV	1(0-3-0)	Interdisciplinary
0295115	KNOW ACCUM V	2(0-6-0)	Interdisciplinary
0295116	KNOW ACCUM VI	3(0-9-0)	Interdisciplinary
0295117	CLI DISAS RESIL	3(2-2-5)	Interdisciplinary
0295125	DESIGN THINK INNO	3(3-0-6)	Interdisciplinary
0295126	DIGIT PROD SERV	3(2-2-5)	Interdisciplinary
0295127	URBAN FILM	3(3-0-6)	Interdisciplinary
0295128	SAFE WORK	3(3-0-6)	Interdisciplinary
0295129	ART RATANAKOSIN	3(2-3-4)	Interdisciplinary
0296110	HU ECO GLOBAL	3(3-0-6)	Humanities
0296111	CRIT THINK SKIL	3(3-0-6)	Humanities
0296112	LIFE SKILLS	3(3-0-6)	Humanities
0296113	BSC TH COMM	3(3-0-6)	Humanities
0298111	IN PRO COMMUNITY	3(3-0-6)	Science and Maths
0298112	GEN PRIN HAL PROD	3(3-0-6)	Science and Maths
0298114	INTR CLIN SEX	3(2-2-5)	Science and Maths
0298115	SPREADSHEET SKILLS	3(2-2-5)	Science and Maths
0298116	DATA ANAL FOUND	3(2-2-5)	Science and Maths
2296111	CREAT LRNG SPACE	3(2-3-4)	Humanities
2296200	HUMAN LANG	3(3-0-6)	Humanities
2296225	LIT FILM*	3(3-0-6)	Humanities
2296228	THAI FOLK ART	3(3-0-6)	Humanities
2296313	HUM LIT*	3(3-0-6)	Humanities
2296314	JUV LIT*	3(3-0-6)	Humanities
2296315	LIT/ETHN IDEN*	3(3-0-6)	Humanities
2296352	21C BUDDHISTS	3(3-0-6)	Humanities
2398130	MUGGLE MECHANICS	3(3-0-6)	Science and Maths

2398131	PHYS IN FILMS	3(3-0-6)	Science and Maths
2796200	ART FOR LIFE QUAL*	3(3-0-6)	Humanities
2894100	FASN COMM	3(3-0-6)	Social Sciences
3098101	DRUG DAILY LIFE	3(3-0-6)	Science and Maths
3494101	LAW HUM RES MGT	3(3-0-6)	Social Sciences
5695101	DES DEV PROD PROT (INTER)*	3(3-0-6)	Interdisciplinary
5695102	PROF COMM SKL INNO (INTER)*	3(3-0-6)	Interdisciplinary
5698101	EMG TECH LLL (INTER)*	3(3-0-6)	Science and Maths

* General Education, Special

Information as of May 17, 2024
For the latest information, please visit: https://gened.chula.ac.th/

IMPORTANT

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