BULLETIN 2016

Faculty of Engineering
Chulalongkorn University

FOR USE BY
ENGINEERING STUDENTS
HAVING ID.NO.59X XXXXX XX
UNTIL THEIR GRADUATION

TABLE OF CONTENTS

Appendix

UNIVERSITY CALENDAR
ACADEMIC YEAR 2016

First Semester

First day of classes	Monday, August 8.2016
Midterm Examinations (if any)	Monday, September 26 - Friday, September 30, 2016
Close of first semester activities	Sunday, October 30, 2016
Last day of classes	Saturday, November 26, 2016
Final Examinations	Monday, November 28 - Tuesday, December 13, 2016
Close of first semester	Wednesday, December 14, 2016

Second Semester

First day of classes	Tuesday, January 3, 2017
Midterm Examinations (if any)	Monday, February 27 - Friday, March 3, 2017
Close of second semester activities	Sunday, April 9, 2017
Last day of classes	Saturday, May 6, 2017
Final Examinations	Monday, May 8 - Tuesday, May 23, 2017
Close of second semester	Wednesday, May 24, 2017

Summer Session

First day of classes	Monday, June 5, 2017
Last day of classes and Examinations	Friday, July 21, 2017
Close of summer session	Saturday, July 22, 2017
Last day of Academic Year	Friday, August 11, 2017

ADMINISTRATION
FACULTY BOARD

Dean of the Faculty :

Assoc. Prof. Dr. Supot   Techavorasinskun

Associate Dean
Assoc. Prof. Dr. Kasem   Choocharukul
Assist. Prof. Dr. Jirawat   Chewaroungroaj
Assoc. Prof. Dr. Tawatchai Charinpanitkul
Assoc. Prof. Dr. Anongnat Somwangthanaroj
Assist. Prof. Dr. Manop   Wongsaisuwan
Assist. Prof. Dr. Sanphet   Chunithipaisan
Assoc. Prof. Dr. Atiwong   Suchato
Assist. Prof. Dr. Manoj   Lohatepanont
Assist. Prof. Dr. Pisut   Painmanakul

Assistant Dean
Assoc. Prof. Dr. Thanyarat Singhanart
Assist. Prof. Dr. Charnchai Pluempitiwiriyawej
Assist. Prof. Dr. Chaiyachet Saivichit
Assist. Prof. Dr. Niphon   Wansophark
Assist. Prof. Dr. Sukree   Sinthupinyo
Dr. Falan   Srisuriyachai
Dr. Phannee   Saengkaew
Dr. Sirikanya   Singcuna

Head of Department of Civil Engineering

Prof. Dr. Teerapong Senjuntichai

Head of Department of Electrical Engineering

Assist. Dr. Komson Petcharaks

Head of Department of Mechanical Engineering

Assist. Prof. Dr.Witaya Wannasuphoprasit

Head of Department of Industrial Engineering

Assist.. Prof. Dr.Paveena Chaovalitwongse

Head of Department of Chemical Engineering

Prof. Dr. Paisan   Kittisupakorn

Head of Department of Mining and Petroleum Engineering

Dr. Thitisak Boonpramote

Head of Department of Environmental Engineering

Assist. Prof. Dr.Khemarath Osathaphan

Head of Department of Survey Engineering

Prof. Dr.Chalermchon Satirapod

Head of Department of Metallurgical Engineering

Assoc. Prof. Dr.Gobboon Lothongkum

Head of Department of Computer Engineering

Assist. Prof. Dr.Natawut   Nupairoj

Head of Department of Nuclear Engineering

Assoc. Prof. Dr. Sunchai   Nilsuwankosit

Head of Department of Water Resources Engineering

Assist. Prof. Dr.Anurak Sriaiyawat

Elected Members of the Board:

Assoc. Prof. Dr. Sirima   Panyametheekul
Assoc. Prof. Dr. Jaroon   Rungamornrat
Assist. Prof. Dr. Wanchalerm Pora
Assist. Prof. Dr. Napassavong   Osotssilp
Assist. Prof. Dr. Thanyaatorn Mekumpornpong
Assist. Prof. Dr. Somchai Kriengkraiwasin
Dr. Phannee Saengkaew
Dr. Somboon Rassame
Dr. Piyatida Ruangrassamee
Mr. Chate   Patanothai

Program Director of International School of Engineering

Mrs. Kaewja Nacaskul

Program Director of The Regional Centre for Manufacturing Systems Engineering

Prof. Dr.Parames   Chutima

Acting Director of Biomedical Engineering Program

Assoc. Prof. Dr.Siriporn Damrongsakkul

Acting Director of Defense Engineering and Technology

Assoc. Prof. Dr.Withit Pansuk
Col.Assist. Prof. Dr.Chuan Chuntavan

Director of Center for Engineering Research and Technical Services

Assoc. Prof. Dr. Thanyawat Pothisiri

Registrar :

Assiat. Prof. Dr.Charnchai Pluempittiwiriyawej

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 and 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.	G.Dip.	M.Eng.	M.Sc.	D.Eng./Ph.D.
- Civil Engineering	√	-	√	-	√
- Electrical Engineering	√	-	√	-	√
- Mechanical Engineering	√	-	√	-	√
- Industrial Engineering	√	-	√	-	√
- Chemical Engineering	√	-	√	-	√
- Mining and Petroleum Engineering	√	-	√ (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)	√	-	-	-	-
- Biomedical Engineering	-	-	√	√	√
-Defense Engineering and Technology	-	-	√	-	-

Details of the graduate degrees in Engineering can be found in the handbook 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 compliment 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

The Library, located on the third floor and the fourth floor of the Engineering Building No.3, 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. Computer online searching service and internet are available.

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 Engineering Network (ENGINET), which is linked to the Chulalongkorn University Network (CHULANET). The networking enables users to access to the facilities from anywhere at any time and to link to many other networks around the world.

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 Health Care

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 :

Regular Undergraduate Programs
Regular semester	21,000	baht per semester
Summer session :	5,250	baht per session

Regular Graduate Programs
Regular semester	31,000	baht per semester
Summer session	7,750	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)

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.

Common Fundamental Subject   (55 - 61 Credits)

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
2100311 Engineering Essentials (optional)	3 credits

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

Basic Science and Mathematics (21 - 24 Credits)

Mathematics (2301107 -108, and/or 2301207, and/or 2603284)	6-12 credits
Chemistry (2302127,2302163)	4 credits

Physics (2304103 - 104,2304183 - 184)
8 credits

Basic Engineering   (14 -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
2102391	Elec Eng I	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 74 - 84 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.

FIRST YEAR CURRICULUM
COMMON TO ALL ENGINEERING STUDENTS

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 CREDITS FOR COMMON TO ALL ENGINEERING STUDENTS = 35
(Except international program)

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 so as to broaden their outlooks in their future careers.

Laboratories in various divisions and research units of the Department are set up to supplement classroom works 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 :

Teerapong Senjuntichai,   Ph.D. (Manitoba)

PROFESSORS :

Teerapong Senjuntichai, Ph.D. (Manitoba)
Suched   Likitlersuang, D.Phil. (Oxford)

ASSOCIATE 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)
Jittichai	Rudjanakanoknad,	Ph.D. (UC Berkeley)
Kasem	Choocharukul,	Ph.D. (Purdue)
Phoonsak	Pheinsusom,	D.Eng. (Tokyo)
Saksith	Chalermpong,	Ph.D. (UC Irvine)
Sorawit	Narupiti,	Ph.D. (Michigan State)
Supot	Techavorasinskun,	D.Eng. (Tokyo)
Tanit	Tongthong,	Ph.D. (Maryland)
Thanyawat	Pothisiri,	Ph.D. (UI Urbana-Champaign)
Tospol	Pinkaew,	D.Eng. (Tokyo)
Tirawat	Boonyatee,	D.Eng. (Kyoto)
Visuth	Chovichien,	Ph.D. (UI Urbana-Champaign)
Veerasak	Likhitruangsilp,	Ph.D. (Michigan)
Wanchai	Teparaksa,	D.Eng. (Kyoto)
Wisanu	Subsompon,	Ph.D. (Carnegie Mellon)
Withit	Pansuk,	Ph.D. (Hokkaido)

ASSISTANT PROFESSORS :

Boonchai	Sangpetngam,	Ph.D. (Florida)
Chatpan	Chintanapakdee,	Ph.D. (UC Berkeley)
Manoj	Lohatepanont,	Sc.D. (MIT)
Noppadon	Jokkaw,	Ph.D. (Chula)
Tanate	Srisirirojanakorn,	Ph.D. (UI Urbana-Champaign)
Vachara	Peansupap,	Ph.D. (RMIT)
Watanachai	Smittakorn,	Ph.D. (Colorado State)

CIVIL ENGINEERING CURRICULUM

FIRST YEAR CURRICULUM
COMMON TO ALL ENGINEERING STUDENTS

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER			**SIXTH SEMESTER**	
2101252	STAT CE	3	2101307	RC DESIGN	4
2101256	CE PROFESSION	3	2101312	STRUCT ANAL II	3
2103213	ENG MECH I	3	2101335	CONS SUPVN	2
2301207	CALCULUS III	3	2101338	HIGHWAY ENG	3
5500208	COM PRES SKLL	3*	2101421	GEO ENG DES CONS	3
xxxxxxx	GENERAL EDUCATION	3	2112440	HYDRAULIC ENG	3
		18	2108306	FLD PRAC TOPO SURV	1
					19
	FOURTH SEMESTER			**SUMMER SEMESTER**	
2101202	MECH MAT I	3	2100301	ENG PRACTICE	2
2101253	APP MATH CE	3			**2**
2101254	GEOL CE	2			
2101302	MAT TESTING LAB	1			
2108298	SURVEYING	3		**SEVENTH SEMESTER**	
2112346	HYDRAULICS I	3			
XXXXXXX	GENERAL EDUCATION	3	2101406	STL/TIMBER DSGN	4
		18	2101455	CONS ENG COST EST	3
			2101490	PRE-PROJECT	1
			xxxxxxx	FOREIGN LANGUAGE	3
	FIFTH SEMESTER		xxxxxxx	GENERAL EDUCATION	3
			xxxxxxx	ELECTIVE COURSES	3
2101310	STRUCT ANAL I	3	xxxxxxx	FREE ELECTIVES	3
2101311	CIV ENG MAT	4			**20**
2101321	SOIL MECHS	3			
2101322	SOIL MECHS LAB	1			
2101337	TRANS ENG	3		**EIGHTH SEMESTER**	
2112342	PRIN OF HYDROLOGY	3			
2112344	HYDRAULIC LAB I	1	2101454	CONST MANAGEMENT	3
		18	2101499	CIVIL ENG PROJECT	3
			xxxxxxx	GENERAL EDUCATION	3
			xxxxxxx	APPROVED ELECTIVES	3
			xxxxxxx	FREE ELECTIVES	3
					15

TOTAL CREDITS FOR GRADUATION = 146

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 9 credits

A. Structural Engineering

2101601	Advanced Structural Theory	3(3-0-9)
2101607	Advanced Mechanics of Materials	3(3-0-9)
2101680	Applied Mathematics I	3(3-0-9)

B. Geotechnical Engineering

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

C. Transportation Engineering

2101660	Transportation Systems	3(3-0-9)
2101661	Transportation Planning and Policy	3(3-0-9)
2101662	Methods for Transportation Analysis	3(3-0-9)

D. Construction Engineering and Management

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 15 credits

A. Structural Engineering

2101510	Computer Methods for Civil Engineering	3(3-0-9)
2101512	Advanced Concrete Technology	3(3-0-9)
2101603	Theory of Elasticity	3(3-0-9)
2101604	Shell Structures	3(3-0-9)
2101605	Stability of Structures	3(3-0-9)
2101606	Dynamics and Vibrations	3(3-0-9)
2101608	Plate Structures	3(3-0-9)
2101609	Plastic Design of Steel Structures	3(3-0-9)
2101611	Matrix Analysis of Structures	3(3-0-9)
2101614	Behavior of Steel Structures	3(3-0-9)
2101615	Advanced Prestressed Concrete Structures	3(3-0-9)
2101616	Long Span Structural Systems	3(3-0-9)
2101617	Structural Building Components	3(3-0-9)
2101618	Finite Element Method for Civil Engineers	3(3-0-9)
2101619	Seismic Design of Structures	3(3-0-9)
2101654	Engineering for Disaster Mitigation	3(3-0-9)
2101656	Disaster Damage Mitigation and Recovery Management	3(3-0-9)
2101681	Applied Mathematics II	3(3-0-9)
2101794	Graduate Seminar in Civil Engineering	3(3-0-9)
2101800	Advanced Solid Mechanics	3(3-0-9)
2101801	Fracture Mechanics	3(3-0-9)
2101802	Inelastic Behavior of Materials	3(3-0-9)
2101803	Nonlinear Analysis in Structural Mechanics	3(3-0-9)
2101804	Behavior of Reinforced Concrete Structure	3(3-0-9)
2101805	Limit State Design of 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)
2101817	Structural Testing and Evaluation	3(2-3-7)
2101818	Life Cycle of Concrete Structures	3(3-0-9)

B. Geotechnical Engineering

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 (2-3-7)
2101639	Special Study in Soil Engineering	3(3-0-9)
2101793	Graduate Seminar in Civil Engineering	S/U
2101820	Geo-environment Engineering	3(3-0-9)
2101821	Deep Foundation Design	2(2-0-6)
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)
2101834	Earth and Retaining structures	3(3-0-9)

C. Transportation Engineering

2101551	Pavement Design	3(3-0-9)
2101553	Public Transit Systems Planning and Operations	3(3-0-9)
2101554	Traffic and Parking Studies for Site Development	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)
2101560	Sustainable Transportation	3(3-0-9)
2101562	Train Control and Operation	3(3-0-9)
2101567	Rail Transport System	3(3-0-9)
2101644	Urban Transportation Planning	3(3-0-9)
2101649	Probability Statistics and Decision for Civil Engineering	3(3-0-9)
2101653	Computer Model in Transportation	3(3-0-9)
2101664	Transportation Operations	3(3-0-9)
2101665	Highway Design	3(3-0-9)
2101666	Intelligent Transportation Systems	3(3-0-9)
2101667	Logistics System Analysis	3(3-0-9)
2101668	Evaluation of Transportation Project and Policy	3(3-0-9)
2101669	Transport Policy	3(3-0-9)
2101793	Graduate Seminar in Civil Engineering	S/U
2101840	Traffic Modeling and Simulation	3(3-0-9)
2101841	Special Studies in Transportation Engineering	3(3-0-9)
2101842	Advanced Transportation and Logistics System Optimization	3(3-0-9)
2101844	Road Safety	3(3-0-9)
2101845	Advanced Pavement Design	3(3-0-9)
2101846	Railway Engineering	3(3-0-9)

2101535	Tunnel Engineering	3(3-0-9)
2101550	Civil Engineering Project Planning	3(3-0-9)
2101618	Finite Element Method for Civil Engineers	2(2-0-6)
2101621	Foundation Engineering	3(3-0-9)
2101635	Earth and Retaining Structures	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	S/U
2101697	Infrastructure Planning and Management	3(3-0-9)
2101698	Construction Business Management	3(3-0-9)
2101793	Graduate Seminar in Civil Engineering	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)
2604501	Financial Management	3(3-0-9)

3) Thesis

2101811	Thesis	12 credits
2101828	Dissertation	48 credits
2101894	Doctoral Dissertation Seminar	0(0-0-0)
2101897	Qualifying Examination	0(0-0-0)

D. Construction Engineering and Management

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 9 credits Elective Courses 3 credits	Dissertation 12 credits	Elective Courses 12 credits	- Core Courses 9 credits - Elective Courses 3credits
	2	Elective Courses 12 credits	Dissertation 12 credits		Elective Courses 12 credits
2	1	Thesis 12 credits	Dissertation 12 credits	Dissertation 12 credits	Dissertation 12 credits
	2		Dissertation 12 credits	Dissertation 12 credits	Dissertation 12 credits
3	1			Dissertation 12 credits	Dissertation 12 credits
	2			Dissertation 12 credits	Dissertation 12 credits

2101202   Mechanics of Materials I   3(3-0-6)
Condition : Prerequisite 2103213 or 2103211
Fundamental concepts of stress and strain; axially loaded members; torsion; shear force and bending moment in beams; deflection of beams; stresses in beams; composite beams; unsymmetrical bending; combined stresses; buckling of column.

**2101251   Civil Engineering Professional
              Conduct   3(3-0-6)**
Development of concepts, methodology and processes of civil works since the ancient times; relationship between civil engineering and other engineering professions, and society; roles and contributions of civil engineering to world civilization; process of engineering design; fundamental of construction techniques; professional ethics; safety; sustainable development.

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)**
Introduction to linear algebra, matrices and matrix operations, linear equations, linear operators, eigen value problems; introduction to vector analysis, vector fields and operations, line integrals, surface integrals, volume integrals, integral theorems; Fourier and Laplace transforms, series representation of functions; basic concept of optimization; Ordinary Differential Equation (ODE), Initial Value Problem (IVP), Boundary Value Problem (BVP), introduction to Partial Differential Equation (PDE); Introduction to numerical techniques, some interesting topics of numerical methods for 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.

**2101255   Introduction to Electrical, Mechanical
              and Environmental Engineering   2(2-0-4)**
Basic concepts of electrical, mechanical and environmental engineering; fundamentals of structures, components and processes of each discipline; interrelationship between these engineering systems; practical application in buildings and civil works.

2101302   Materials Testing Laboratory   1(0-3-0)
Condition : Co-requisite 2101202
Behavior and testing of most construction materials such as metals, timber, brick, glass and synthetics.

2101307   Reinforced Concrete Design   4(3-3-6)
Structural behavior in thrust, flexure, torsion, shear, bond and interaction among these forces; analysis and design of reinforced concrete structural components by working stress and strength design methods; design calculations and construction drawings; application of graphs, tables, and computer software in design of reinforced concrete structures.

2101308   Mechanics of Materials II   3(3-0-6)
Condition: Prerequisite 2101202
Analysis flexural and shearing stresses in beams; composite beams; unsymmetrical bending; combined stresses and strains; buckling of columns; introduction to structural dynamics.

2101310   Structural Analysis I   3(3-0-6)
Condition: Prerequisite 2101202
Introduction to structural analysis; degree of statical indeterminacy and stability of structures; reactions, shears and bending moments in beams and rigid frames including deflected shapes; analysis of determinate plane trusses; responses of plane structures under moving loads by using influence lines; deflection analysis by method of moment-area and conjugate structures; deformation analysis of structures by virtual work and related energy methods; analysis of indeterminate structures by force method or flexibility method.

2101311   Civil Engineering Materials   4(3-3-6)
Condition: Prerequisite 2101202
Properties, behavior, and testing of civil engineering materials such as materials for concrete, materials for highway, steel, metal, wood, brick, tile, glass, plastic, rubber, composite materials, and other synthetic materials.

2101312   Structural Analysis II   3(3-0-6)
Condition : Prerequisite 2101310
Methods of structural analysis; slope-deflection method; moment distribution method; introductory plastic structural analysis; matrix structural analysis; introduction to finite element method in structural analysis.

2101321   Soil Mechanics   3(3-0-6)
*Condition : Prerequisite 2101254 or
              2106296*
Formation of soils; soil classification; soil exploration; flow through porous media; stresses in a soil mass; stress-strain and strength properties of cohesionless soils; stress-strain and strength properties of cohesive soils; Terzaghi's bearing capacity formula settlement; consolidation theory.

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.

2101335   Construction Supervision   2(2-0-4)
Construction methods; construction standards; components, methods, and procedures of construction supervision and inspection check list in foundation construction, structural and architectural works as well as infrastructure construction.

2101336   Reinforced Concrete Design   3(2-3-4)
Condition : Prerequisite 2101310
Structural behavior in thrust, flexure, torsion, shear, bond and interaction among these forces; analysis and design of reinforced concrete structural components by working stress and strength design methods; design calculations and construction drawings.

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
Road and traffic systems; highway planning and development; traffic consideration; roadway design; road materials; highway construction and maintenance; highway safety management.

2101403   Timber and Steel Design   3(2-3-4)
Condition : Prerequisite 2101310
Design of timber and steel structures; tension and compression members; beam-columns; built-up members; plate girders; connections.

**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
Construction industry; principles of management; construction organization; contracts and tendering; planning and control tools; feasibility study; cash-flow analysis; construction laws and regulations; safety in construction; construction finance and accounting; construction claims and disputes; arbitration.

**2101455   Construction Engineering and cost
Estimating   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.

2101460   Structural Steel Design   3(2-3-4)
Condition : Prerequisite 2101310
Design of steel structures; tension and compression members; beams and beam-columns; plate girders; bolted and welded connections and composite members.

2101461   Building Design   3(2-3-4)
Condition : Prerequisite 2101307 or 2101336
Design of reinforced concrete buildings of various types; structural systems; slab systems; frame analysis; interaction of frames and walls; walls; footings.

2101462   Prestressed Concrete Design   3(2-3-4)
Condition : Co - requisite 2101307 or 2101336
Concept and principles of prestressing; properties of relevant materials; prestressing systems; loss of prestress; analysis and design of statically determinate members; flexure, shear, bond, anchorage and bearing; moment-curvature analysis; deflections and camber; design for anchorage zone reinforcement prestressed concrete piles; introduction to post-tensioned concrete floor systems; construction site visit.

2101464   Bridge Design   3(2-3-4)
*Condition : Prerequisite 2101307 and
2101336*
Theories of load distribution and application; simply supported bridges in reinforced concrete, steel and prestressed concrete; statically indeterminate bridges; ultimate load method; bridge economy.

**2101468   Reinforced Concrete Design Problems
1(1-0-3)**
Condition: Co-requisite 2101336
Problems in design of reinforced concrete structures; application of graphs, tables and computer software in design of reinforced concrete structures.

**2101495   Advanced Topics in Civil
Engineering I   3(3-0-6)**
Topics of current interest or new developments in various fields of civil engineering; A complete written report is required by the Department. A final oral examination is optional.

2101499   Civil Engineering Project   3(0-6-3)
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; elimination methods for linear equations; various decomposition and storage schemes, partial pivoting, errors and ill-conditioning; iterative methods for linear equations: iteration, Gauss-Seidel iteration and successive over-relaxation methods; interpolations and curve fitting; numerical integration; methods of successive approximations for buckling of columns and beam-columns; numerical solution of differential equations; finite difference solution of beams, plates and grids; solution of nonlinear equations; computer graphic; The emphasis is put on civil engineering application.

2101512   Advanced Concrete Technology   3(3-0-9)
Review of concrete technology; improvement of the quality of concrete 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.

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

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 tunnelman'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.

2101536 Underground Construction 3(3-0-9)
Condition : Consent of Faculty
Soil investigation plans; soil profile; selection of soil properties; construction of shallow foundation construction of deep pile foundation; pile load test; pile integrity test; pilot pile test; blow count test; construction of basement by sheet pile bracing system; construction of deep basement by diaphragm wall system; caisson sinking in soft clay.

2101546 Introduction to Finite Element Method 3(3-0-9)
Condition : Consent of Faculty
Concepts of weak form of governing differential equation, weight residual method, minimization principle, equivalence between weak and strong forms, weak 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 finite element programs to various boundary value problems in civil engineering.

2101550 Civil Engineering Project Planning 3(3-0-9)
Concepts of civil engineering project planning; analysis; technical requirement; financial and economic feasibility; capital budgeting techniques; social and political impact considerations and environmental concern; multi-objective objective decision making.

2101551 Pavement Design 3(3-0-9)
Principles of highway and airport pavement including pavement types and wheel loads; stresses in flexible and rigid pavements; consideration of properties of pavement components including the design test; methods of design of flexible and rigid pavement for highways and airports; methods of construction and maintenance.

2101553 Public Transit Systems Planning and Operations 3(3-0-9)
Condition : Consent of Faculty
Components of public transportation system; public transportation planning procedure; technological evolution of mass transit; selection of transit mode; transit station planning; basic operation elements; date collection and analysis; scheduling of service; fare policies; financing and cost structure of transit service.

2101554 Traffic and Parking Studies for Site Development 3(3-0-9)
Condition : Consent of Faculty
Survey and data collection for traffic studies; traffic forecasting methods; traffic impact studies; point of access studies; vehicular circulation analysis; parking studies; planning and design of parking facilities; legal requirements.

2101555 Travel Behavior Survey and Analysis 3(3-0-9)
Condition : Consent of Faculty
Dimensions and characteristics of urban travel; travel demand; theories of travel behavior; methodologies of travel survey; experimental design; theory of sampling; analytical methods in travel behavior research.

2101556 Air Transportation System 3(3-0-9)
Condition : Consent of Faculty
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 Planning and Management of Airport System 3(3-0-9)
Condition : Consent of Faculty
Preparation of a layout and design of an airport system including studies of a proposed site; surface and subsurface drainage; runway and taxiway; grading plane and earthwork estimates; design of base courses and runway surfaces; accessory structures and lighting; airport operations.

2101558 Transportation and Logistics System Optimization 3(3-0-9)
Condition : Consent of Faculty
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.

2101559 Traffic Engineering 3(3-0-9)
Condition : Consent of Faculty
Theory of traffic flow, traffic studies, highway capacity analysis, traffic control devices, signal system, traffic system design and operations.

2101560　Sustainable Transportation　3(3-0-9)
Principles of sustainable transportation; social, economic, and environment components; planning; planning for sustainable transportation system; measures-public transport, non-motorized transport, and other innovative measures; mobility management; evaluation; institutional and regulatory issues.

2101562　Train Control and Operation　3(3-0-9)
Principles of sustainable transportation; social, economic, and environment components; planning; planning for sustainable transportation system; measures-public transport, non-motorized transport, and other innovative measures; mobility management; evaluation; institutional and regulatory issues.

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)
Condition : Consent of Faculty
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.

2101580　Construction Information Management
**　　　　　　　　　　　　　　　　　3(3-0-9)**
Condition : Consent of Faculty
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)**
Condition : Consent of Faculty
Construction Processes, materials, tools, equipment; construction productivity; modern construction techniques; equipment in building and infrastructure works.

COURSE DESCRIPTIONS IN CIVIL ENGINEERING (M.ENG, PH.D.)

2101601　Advanced Structural Theory　3(3-0-9)
Analysis of trusses; frames and arches; influence lines; continuous frame with non-prismatic members: building frames subjected to lateral loads; introduction to matrix analysis of structures.

2101602　Behavior of Reinforced Concrete
**　　　　　　Members　　　　　3(3-0-9)**
The behavior and strength of reinforced concrete members; beams subjected to pure bending, combined bending, and shear; columns under axial compression and eccentric loading; deflections; bond and cracking; review of research and pertinent literature; emphasis is placed on background, use and limitations of present design specifications.

2101603　Theory of Elasticity　　3(3-0-9)
Equations of equilibrium and continuity in elastic solid; two dimensional solutions of beams, wedges, disks and rings under various conditions of loading, strain concentration; strain energy methods of solution.

2101604　Shell Structures　　　3(3-0-9)
Membrane theory of shells; rotation and translational shells; general theory of shells; axisymmetrical bending of shells of revolution; cylindrical shell roofs; prismatic shell roofs.

2101605　Stability of Structures　3(3-0-9)
Buckling of concentrically and eccentrically loaded columns; lateral buckling of beams; built-up columns; stability of frameworks.

2101606　Dynamics and Vibrations　3(3-0-9)
Analysis of system with single and multi degree of freedom; free and forced vibration; determination of natural frequencies of structures; distributed mass system; longitudinal and lateral vibration of flexural members; problems involving nonlinear force-displacement relation and damping.

2101607　Advanced Mechanics of Materials 3(3-0-9)
Stress, strain, and displacement relationships; energy theorems; equilibrium and compatibility conditions; problems of plane stress and plane strain, 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.

2101608　Plate Structures　　　3(3-0-9)
Differential equation for bending of plates; axisymmetrical bending of circular plates; orthotropic plates; combined action of lateral loads and in-plane forces; finite element method.

2101609　Plastic Design of Steel Structures 3(3-0-9)
Ultimate load capacity of steel structures; method of analysis for structures in the plastic rang; plastic design of continuous beams, frames, and connections. Secondary design problems to include the effect of shear and axial force upon plastic moment capacity.

2101610　Numerical and Approximate Methods
**　　　　　　of Structural Analysis　3(3-0-9)**
Numerical methods for system of linear equations; moments and deflections of beams, reciprocal relationship; buckling of axially loaded bars; approximate differentiation and integration; vibrations problems.

2101611　Matrix Analysis of Structures　3(3-0-9)
Review of matrix algebra; matrix procedures for analysis of continuous beams, plane frames, space frames under static and quasi-static loading; stiffness and flexibility methods; techniques for solving large linear equation system; computer application.

2101612　Experimental Structural Analysis　3(2-3-7)
Laboratory studies of structural models and components; experimental stress analyss; photoelastic method; electrical strain gauge and brittle lacquer methods.

2101614　Behavior of Steel Structures　3(3-0-9)
Researches which relate the basic behavior of structural steel members and frames to present design approximations. Discussions ate emphasized on background, use and limitations of the current specifications.

**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.

2101616　Long Span Structural Systems　3(3-0-9)
Analysis and design of two-hinge ribbed and lamella arches, ribbed domes, two-way grid systems, space frames, and cable suspended systems.

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 members, tilt-up walls, sandwich panels, precast members, bearing walls, shear walls and light-gauge steel members.

**2101618　Finite Element Method for Civil
　　　　　　Engineers　3(3-0-9)**
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 requirement; 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 problems; application in civil engineering problems.

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 of special structures: bridges, dams, and nuclear power plants.

2101620　Advanced Soil Mechanics I　3(3-0-9)
Soil formation; the nature of soil; stress within a soil mass; effective stress concept; stress-strain behavior; shear strength of cohesionless soil; one dimensional and two dimensional flow; theories of compressibility and consolidation; undrained and drained shear strength of cohesive soil; creep in soft soil.

2101621　Foundation Engineering　3(3-0-9)
Application of soil mechanics principles to stress distribution in earth masses; settlement analysis; bearing capacity of piles and caissons; lateral pressure for design of retaining walls, open cuts anchored bulkheads, cofferdams and culverts.

2101623　Field Exploration and Soil Testing　2(1-3-4)

Site investigation by conventional and geophysical methods; laboratory and field work in soil sampling, classification, and testing.

2101624　Elasticity in Soil Mechanies　3(3-0-9)
Vector and tensor analysis, Eigenvalue problem, introduction to continuum mechanics, stress-strain definition for small strain, equilibrium and compatigility equations, stress-strain relationship, stress-strain relationship, stress-strain parameters and invariants, stress function method, energy method and variational principle, Hooke's law, simple elastic model, anisotropic and non-linear elastic model.

2101625　Soil Dynamics　2(2-0-6)
Vibration theory related to soils, soil structures and foundations, application to engineering design; foundations for dynamic loading including impact, pulsating and blast load.

2101626　Soil Stabilization　3(3-0-9)
Engineering properties of soils to be used as foundation and construction materials; the art of altering engineering properties of soils by means of mechanical, chemical, electrical and thermal stabilization, including dewatering, pile sinking techniques, underpinning and other special problems.

2101627　Engineering Geophysics　2(2-0-6)
Theory and application geophysics and geophysical methods as applied to civil engineering. Study of seismology, earth magnetic and electrical fields, gravity, and radioactivity. Conventional and geophysical methods of subsurface exploration and testing and identification of earth materials.

2101628　Advanced Soil Mechanics II　3(3-0-9)
Settlement analysis; shallow foundations; earth retaining structures structure and stability of slopes; normalized soil behavior concepts, measurement and selection of soil parameters for evaluation of stability of structures and predictions of pore pressure and untrained deformations.

2101629　Theoretical Soil Mechanics　3(3-0-9)
Stress and strain concepts; principal stresses and strains; invariants; octahedral stresses and strains; special matrices; plane stress; plan strain; stresses and displacements in soil mass as elastic body; yield criterion, theories of failure; plasticity; effect of wall movement surcharge on lateral earth pressures; bearing capacity and stability of slopes.

**2101630　Physical and Mineralogical Properties
　　　　　　of Soils　3(3-0-9)**
Aspects of soil mineralogy and its composition applied to soil engineering problems; origin and occurrence of soils; nonclay minerals in soil; structures and properties of the clay minerals; classification and nomenclature of clay minerals; mineral identification; relations between soil composition engineering behavior.

2101631　Geomechanics　3(3-0-9)
General concept of numerical methods of soil mechanics.; flow though porous media; finite element approaches to the problems of shallow foundation and deep foundation; one, two and three dimensional theories of consolidation.

2101632　Rock Mechanics　　　　　3(3-0-9)
　　　Rock formation; mechanical properties of rock; stability of rock slopes, underground rock chambers; rock falls, ruptures of rock and methods of improving the properties of rock mass.

2101633　Advanced Engineering Geology　2(2-0-6)
　　　Advanced study of soil and rock mechanics related to geological structures, site investigation by geological and geophysical methods, surveying of construction materials for civil engineering work.

2101634　Plasticity in Soil Mechanics　　3(3-0-9)
　　　General stress-strain behavior; yield criterion; limiting equilibrium equations; intergration of a system of two partial differential equations; solution of Christianovitch on the weightless and purely cohesive soil; determination of stress exerted on the wall.

2101636　Interpretation of Field Exploration　and
　　　　　　Soil Testing　　　　　　3(2-3-7)
　　　Fundamentals of field exploration; necessity of field exploration, scope of exploration and related field tests, interpretation of field exploration report, concepts and methodologies of soil testing; tests for basic soil properties, advanced soil testing, selection of proper testing methods, interpretation of test results.

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 soil engineering.

2101640　Highway Planning and Economics　3(3-0-9)
　　　Principle of highway planning, finance, economics, and programming of improvements; highway need studies and highway sufficiency studies for regional highway planning.

2101641　Traffic Engineering　　　　3(2-3-7)
　　　Analysis of traffic problems including filed studies; surveys and the interpretation of survey data; regulation and control methods and equipment's

2101642　Geometric Design of Highways　3(3-0-9)
　　　Design control and criteria: design speed, horizontal alignment, vertical alignment, cross section, geometric design of intersections at grades and interchanges.

2101644　Urban Transportation Planning　3(3-0-9)
　　　Transportation systems and characteristics of traffic flow in urban areas; planning of urban transportation facilities; mathematical models for prediction of traffic flow; interrelationship of landaus and transportation.

2101645　Traffic Flow Theory　　　　3(3-0-9)
　　　Application of theoretical approaches to traffic engineering; integration mathematics, probability, control theory, experimental psychology and physical analogies as a means of describing vehicular traffic flow

and providing an insight into contemporary　traffic research procedures.

2101647　Public Transportation Planning　2(2-0-6)
　　　Engineering problem in the mass movement of people in metropolitan areas; demand in relation to level of service, equipment, routes; running time and station spacing.

2101648　System Transportation Modeling　2(2-0-6)
　　　An indepth study of data gathering and processing, trip general model using regression theory, trip distribution model using gravity model and abstract mode model; modal split, traffic assignment and evaluation process.

2101649　Probability Statistics and Decision
　　　　　　for Civil Engineering　　　3(3-0-9)
　　　Elements of probability theory; common probability model; probabilistic model and observed data; elementary Baysian decision theory; analysis of independent random process.

2101650　Transportation Technology　　3(3-0-9)
　　　Multimodal transportation planning and facilities design; discussion of topics of special interest in transportation planning, including evaluation techniques, social and environmental problems in system design, and technology of transportation.

2101651　Traffic Characteristics and
　　　　　　Operations　　　　　　3(3-0-9)
　　　Driver and vehicle characteristics affecting traffic flow; flow and capacity characteristics; statistical properties of traffic; safety analysis; headway and speed measurement; signing and signal control for efficient intersection control; parking characteristics and capacity analysis.

2101653　Computer Models in Transportation
　　　　　　　　　　　　　　　　　　3(2-3-7)
　　　Analytical models and practical tools for planning and analysis of transportation supply; computer application in design and analysis of transportation networks; planning and analysis of transportation facilities. And routing and scheduling of transportation resources.

2101654　Computer Models in Transportation
　　　　　　　　　　　　　　　　　　3(2-3-7)
　　　Introduction to engineering for disaster management and resilience: earthquake disasters-case studies and lessons from earth quake disasters learnt; seismic design concept; tsunami disaster-modeling, early warning system, and preparedness: field trips to disaster prone areas.

2101655　Civil Engineering and Disaster Recovery
　　　　　　　　　　　　　　　　　　2(2-0-6)
　　　Problems and remedy measures of civil works after natural disaster, case studies from various countries, disaster management related to structures damaged by natural disaster, recovery of landslide induced by natural disaster, field trip to some organizations related to disaster recovery management or sites under.

**2101656   Disaster Damage Mitigation and Recovery
                    Management   2(2-0-6)**
Mitigation of disaster damage; hazard maps; crisis control: basic principles and management learning for business continuity: structural and non-structural mitigation measures from the viewpoint of the government to that of local communities: disaster recovery: communication and recovery technologies; case studies.

2101660   Transportation Systems   3(3-0-9)
Introduction to transportation; importance of transportation in the economy; development of transportation technology; roles of public and private sectors; transportation organizations; transportation system components and functions; types of transportation; modes of transportation; key characteristics of transportation modea; intermodal transportation; general and mode-specific policy issues; social, economic, and political issues; careers in transportation sector.

**2101661   Transportation Planning and Policy
                                            3(3-0-9)**
Policy context and transportation planning; decision making tools in transportation planning; modeling techniques in transportation; introduction to transportation economics; the four-step planning process and its limitation; alternative modeling approaches; transportation planning ethecs.

**2101662   Methods for Transportation Analysis
                                            3(3-0-9)**
Mathematical and statistical methods for transportation analysis; basic probability models and statisticl analysis; introduction to mathematical programming; decision analysis, decision analysis, optimization and simulation.

2101664   Transportation Operations   3(3-0-9)
Techniques in transportation operational analysis, space-time diagram, cumulative plots, queuing theory, traffic flow theory, traffic control, transportation scheduling, operations of transportation terminals.

2101665   Highway Design   3(3-0-9)
Highway design procedures; basic design policies; geometric design and structure standards; cross section; design of traffic interchanges and intersections; highway capacity analysis; analysis of freeway and highway facilities; design of traffic control devices.

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 technology to monitoring, analysis, evaluation, and prediction of transportation system performance and behavior, feasibility studies; human factors and institutional issues.

2101667   Logistics System Analysis   3(3-0-9)
Fundamentals of logistics management, framework for logistics system analysis, logistics system modeling, logistics network design, distribution planning and

management, transportation system and operation analysis.

**2101668   Evaluation of Transportation Project
                    and Policy   3(3-0-9)**
Basic microeconomics; Applications of microeconomic principles for transportation policy analysis; Evaluation of transportation projects and financing alternative.

2101669   Transport Policy   3(3-0-9)
Major policies concerning the transportation-related aspects of the environment, energy, economic development, community mobility/accessibility, freight transportation, advanced transportation systems, transportation safety and social justice; basic concepts in transportation policy formulation, research design and evaluation of legislation analysis and tracking, decision-making methods, public participatory techniques, transportation policy evaluation principles and methods.

2101680   Applied Mathematics I   3(3-0-9)
Ordinary equations; Fourier series; introduction to Fourier and Laplace trasforms and some applications to boundary value problems; vector analysis; matrices and linear equations.

2101681   Applied Mathematics II   3(3-0-9)
Partial defferential equations and boundary value problems; special functions; integral transform, calculus of variations and complex variables with emphasis on civil engineering applications.

**2101683   Experimental Problems in Civil
                    Engineering   3(2-3-7)**
A variety of experimental and analytical techniques applied to problems in civil engineering; field and laboratory observation employing strain gauges, mechanical and electrical equipment, static and dynamic instrumentation.

2101685   Structural Limit Design   3(3-0-9)
Limit analysis theory. Application to continuous beams and frames; control of deflection and cracking; yield line analysis by virtual work and equilibrium methods; application to slab of various types; Hillerbor's strip method.

**2101690   Construction Methods and
                    Equipment   3(3-0-9)**
Preparation of construction schedules; various types of construction; earth; concrete; underground, foundation; job facilities.

2101691   Special Studies   3(3-0-9)
Basic knowledge of research methodology in construction engineering and management; development of research topics and statement of research problem; techniques for literature review; academic and research writing; research methods and techniques; data collection; analysis of data and presentation; qualitative and quantitative research.

**2101692   Analytical Methods in Construction
                    Management   3(3-0-9)**
Analytical method used in modern construction management from both builders' and owners' view;

techniques and methods applied from cost engineering, optimization techniques and work improvement; the use of modeling techniques as a tool for rational decision-making in construction environment from project conception to completion.

2101693   Problem Analysis in Construction Industry   3(2-3-7)
Various levels of management problems in construction industry; organization; planning and control of construction's production process, marketing, labor, and legal issues; investigation and practice of problem-solving by participating in real-world problems of construction industry.

2101694   Contracting in Construction Business   3(3-0-9)
Basic principle of civil law; contracting law; various types of construction contracts; contract clauses affecting construction performances; FIDIC standard contract; standard method of measurement; criminal law related to construction.

2101695   Computer Applications in Construction   3(3-0-9)
A broad range of computer applications in construction with emphasis on engineering management, computer hardware and software components; operating, operating systems, programming language, and information technology; analysis, design, development and implementation of microcomputer-based system including spreadsheet, database and CAD for CM; the effective utilization's of various construction management software; conception of decision support system.

2101696   Project Planning and Control   3(3-0-9)
Analytical techniques for planning and controlling the design and construction of project with emphasis on scheduling techniques and quality management system including planning with charts, critical path methods (CPM), resource allocation and leveling, time/cost trade offs, cash flow analysis, and quality control/quality assurance.

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 cuch 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.

2101699   Construction Systems Optimization and Simulation   3(3-0-9)
Systems analysis applied to modern construction engineering and management from both owner's and contractor's views; civil systems modeling and optimization

techniques; applications of decision analysis and risk analysis; simulation techniques; computer programs for

2101721   Offshore Structural Engineering   3(3-0-9)
Physical environmental aspects of marine and offshore construction; wave, wind and current forms and conditions; geotechnical aspects of offshore construction; offshore site investigation; material and fabrication for marine structures; offshore structure and foundation design; prouduce, methods and equipment offshore construction .

2101790   Seminar in Civil Engineering I   1(0-3-1)
Review and discussion of problems and progresses in civil engineering by staff members, students, and participants.

2101791   Seminar in Civil Engineering II   3(0-9-3)
Discussion special topics related to advanced civil engineering; analysis of data, conclusion, and report presentation.

2101792   Seminar in Civil Engineering III   3(0-9-3)
Discussion of special topics related to advanced civil engineering concerning research projects; analysis of data, conclusion, and report presentation.

2101793   Graduate Seminar in Civil   0(0-0-0) Engineering
Self studies on the topics provided by the Division; oral presentation of the study outcome in conjunction with technical papers as wall as answers to technical questions and comments from the audience; special lectures by guest speakers.

2101800   Advanced Solid Mechanics   3(3-0-9)
Review of basic principles of solid mechanics; plane problems in linear elasticity, green's functions for point loads on surface of semi-infinite plane; rigid punch problems; green' s function for point load in infinite plane; edge dislocations and cracks, Wiliams asymptotic expansion, stress intensity factors; complex variable representations for anti-plane shear and plane problems; three dimensional linear elasticity, stress functions; representations of displacement field; green's functions of infinite and semi-infinite spaces, rigid punch problem, Hertz problem, Eshelby's equivalent method; introduction to composite media, macroscopic measures of stress and strain, averaging theorem, overall properties of multi-phase media; Somigliana's identity, boundary integral equations for two and three-dimensional linear elasticity.

2101801   Fracture Mechanics   3(3-0-9)
Introduction to fracture mechanics, stress analysis of linear elastic cracked bodies, the stress field theory of fracture, the energy concepts on fracture, numerical and experimental determination of fracture properties, effects of variables on fracture toughness, fracture mechanics design, and elasto-plastic fracture; analysis of simple two-dimensional fracture problems; introduction to fatigue, fatigue crack growth, fracture criteria, and fracture control plans.

2101802   Inelastic Behavior of Materials   3(3-0-9)
Review of basic principles of solid mechanics; introduction to inelastic behavior of materials, aspects of material behavior and evidences from experiments;

nonlinear elasticity, total deformation theory for plasticity, J2 total deformation theory; incremental theory of plasticity, concept of yield surface, plastic flow rule, consistency condition, J2 flow theory, isotropic hardening; plasticity with nested yield surfaces, plasticity with a bounding surface; formulation of boundary value problems in plasticity, minimum principles, solutions of simple BVPs in plasticity; pressure-sensitive materials, time dependent materials; application of inelastic material behavior in finite element analysis, radial return method.

2101803 Nonlinear Analysis in Structural Mechanics 3(3-0-9)
Finite strain mechanics; total Lagrangian and updated Lagrangian finite element formulation, nonlinear solution methods, large displacement behavior of structures and large displacement analysis of structural problems, finite element formulation of inelastic problems.

2101804 Behavior of Reinforced Concrete Structure 3(3-0-9)
The behavior and strength of reinforced concrete structures subjected to frexure shear, torsion, axial and eccentric loading; determination of deflections, bond and cracking, review of research and pertinent literature, with emphasis on background, structural models, the performance and criteria approach of present design codes and specifications.

2101805 Limit State Design of Concrete Structures 3(3-0-9)
Limit state design criteria; structural reliability, structural behavior in flexure, shear, torsion, compression and bond; structural design for slab, frame, column, footing, and others; determination of serviceability limit states for structural performance.

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; properties of materials at elevated temperatures; design and detailing of structural elements for fire safety; design of frames for fire safety; assessment and repair of fire-damaged structures.

2101817 Structural Testing and Evaluation 3(3-0-9)
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; date analysis and evaluation of structural performance.

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)
Application of elastic wave and electricity for ground prospecting, Reflection survey, Refraction survey, Surface wave method, down-hole, up-hole and cross hole; Resistivity method for ground prospecting; Electro-magnetic prospecting.

2101831 Engineering Ground Modification 3(3-0-9)
Revision of mathematics and continuum mechanics, principle 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 problem.

2101832 Engineering Geophysics 3(3-0-9)
Aspects of soil mineralogy and its composition applied to soil engineering problems; origin and occurrence of soils; non-clay minerals in soil; structure and properties of the clay minerals; classification and nomenclature of the clay minerals; mineral identification; relation between soil composition engineering behaviors; Soil compaction, lime/cement-soil mixing behavior, preloading and prefabricated vertical drain (PVD) technique, cement grouting, cement columns, geotextile and geosynthetic.

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.

2101834 Earth and Retaining Structure 3(3-0-9)
Slope stability problems, methods of slope stability analysis; Slope stability analysis under drained/undrained conditions and with/without ground water seepage; field stability observations using geotechnical instrument; introduction to earth pressures; lateral earth pressure theories; analysis and design of retaining wall.

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 inatruments; introduction to earth pressures; lateral earth pressures; lateral earth pressure theories; analysis and design of retaining wall.

2101840　Traffic Modeling and 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.

**2101841　Special studies in Transportation
　　　　　　Engineering　　　　　　　　3(3-0-9)**
　　Individual's problem solving in transportation engineering.

**2101842　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.

2101844　Road Safety　　　　　　　3(3-0-9)
　　Accident characteristics; sources of road traffic accidents; road safety indicators; statistical methods in traffic safety analysis; safety management system; road safety audit; counter measures; current research in road safety.

2101845　Advanced Pavement Design　3(3-0-9)
　　Advanced theorem of pavement design and method for evaluation of damage caused by heavy wheel load impacts on pavement containing excess water.

2101846　Railway Engineering　　　　3(3-0-9)
　　Historical development of railways; principles of railway planning; geometric design; track structure; rolling stocks; signaling and operating system; financing and economics of railway development project; construction and maintenance of railway.

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 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
　　　　　　Engineering and Management　3(3-0-9)**
　　Advanced topics in construction engineering and management; lean construction; advanced construction estimating;

2101811	**Thesis**	**12**	**Credits**
2101828	**Dissertation**	**48**	**Credits**
2101896	**Comprehensive Examination**		**0(0-0-0)**
2101897	**Qualifying Examination**		**0(0-0-0)**
2101894	**Doctoral Dissertation Seminar**		**0(0-0-0)**
2101896	**Comprehensive Examination**		**0(0-0-0)**

　　Comprehensive examination in Infrastructure in Civil Engineering; writing and oral examination.

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 practioner 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 3 are required core courses in applied mathematics, 9 are major requirement, 6 required elective courses in related fields , and 18 are thesis:

The major requirement consists of 12 strategic research areas (SRA) namely:

1. Advanced Control and Optimization
2. Biomedical Engineering
3. Embedded Systems and Robotics
4. High Voltage Engineering
5. Industrial Instrumentation
6. Microwave and Lightwave Communications
7. Multimedia and Signal Processing
8. Nanoelectronics and Photonics
9. Optoelectronics
10. Power Electronics
11. Power and Energy Systems
12. Telecommunications and Information Networking

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 student has to pass the following requirements in order to achieve his or her study :

1. For the applicant who holds a Master's Degree with more than 3.5 grade point average, 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.

2. For 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.

3. 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 :

Komson Petcharaks, Dr.Sc. Techn.
(Swiss Federal Inst.
of Tech Zurich)

PROFESSORS :

Bundhit Eua-arporn, Ph.D. (London)
David Banjerdpongchai, Ph.D. (Stanford)
Somsak Panyakeow, D.Eng. (Osaka)
Boonchai Techaumnat, D.Eng. (Kyoto)

ASSOCIATE PROFESSORS :

Chedsada Chinrungrueng, Ph.D.
(U.C.Berkeley)
Chaodit Aswakul, Ph.D. (London)
Duang-rudee Wonglumsom, Ph.D. (Stanford)
Kulyos Audomvongseree, D.Eng. (Tokyo)
Lunchakorn Wuttisittikulkij, Ph.D. (Essex)
Mana Sriyudthsak, D.Eng. (T.I.T.)
Nisachon Tangsangiumvisai, Ph.D. (London)
Prasit Teekaput, Ph.D. (VPI & Su)
Somchai Ratanathammaphan, D.Eng. (Chula)
Songphol Kanjanachuchai, Ph.D.(Cambridge)
Thavatchai Tayjasanant, Ph.D.(Alberta)
Watit Benjapolakul, D.Eng. (Tokyo)
Watcharapong Khovidhungij, Ph.D. (UCLA)

ASSISTANT PROFESSORS :

Arporn Teeramongkonrasmee, Ph.D. (Chula)
Cherdkul Sopavanit, M.Eng. (Chula)
Chaiyachet Saivichit, Ph.D. (London)
Charnchai Pluempitiwiriyawej, Ph.D. (Carnegie
Mellon)
Chanchana Tangwongsan, Ph.D. (Wisconsin)
Chanin Wissawinthanon, Ph.D. (Minnesota)
Komson Petcharaks, Dr.Sc. Techn.
(Swiss Federal Inst.
of Tech Zurich)
Manop Wongsaisuwan, D.Eng. (T.I.T.)
Naebboon Hoonchareon, Ph.D. (Purdue)
Pasu Kaewplang, Ph.D. (Chula)
Jitkomut Songsiri Ph.D. (UCLA)
Hadsakoon Boriphonmongkol, M.Eng. (Chula)
Supavadee Aramvith, Ph.D. (Washington)
Sotdhipong Phichaisawat, Ph.D. (Brunel, UK)
Surachai Chaitusaney Ph.D. (Tokyo)
Suchin Arunsawatwong, Ph.D. (Manchester)
Suree Pumrin, Ph.D. (Washington)
Supatana Auethavekiat Ph.D. (Tokyo)
Surapong Suwankawin, Ph.D. (Chula)

Suvit Nakpeerayuth, M.Eng. (Chula)
Somboon Sangwongwanich, D.Eng. (Nagoya)
Taptim Angkaew, D.Eng. (Osaka)
Wanchalerm Pora, Ph.D. (London)
Weerapun Rungseevijitprapa, Dr.-Ing. (Hannover)
Widhyakorn Asdornwised, D.Eng.(Chula)

LECTURERS :

Apiwat Lek-Uthai Dr.Ing. (Karlsruhe)
Bunchauy Supmonchai, M.Eng. (Chula)
Channarong Banmongkol, D.Eng. (Nagoya)
Jakapan Lee, M.Eng. (T.I.T)
Somboon Chongchaikit, Dr.Ing. (Paris XI)
Panuwat Janpugdee Ph.D. (USA)

ELECTRICAL ENGINEERING CURRICULUM
FIRST YEAR CURRICULUM
COMMON TO ENGINEERING STUDENTS

COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER	
2102201	ELECTRICAL ENGINEERING MATHEMATICS I	3
2102203	PROBABILITY AND STATISTICS FOR ELECTRICAL ENGINEERING	3
2102209	ELECTRICAL ENGINEERING ESSENTIALS	3
2102213	CIRCUIT THEORY I AND LABORATORY	4
2103213	ENGINEERING MECHANICS I	3
2301207	CALCULUS III	3
		19
	FOURTH SEMESTER	
2102202	ELECTRICAL ENGINEERING MATHEMATICS II	3
2102214	CIRCUIT THEORY II AND LABORATORY	3
2102222	ENGINEERING ELECTROMAGNETICS	3
2102253	ELECTRICAL MACHINES I AND LABORATORY	4
5500208	COMMUNICATION AND PRESENTATION SKILLS	3
xxxxxxxx	GENERAL EDUCATION II	3
		19
	FIFTH SEMESTER	
2102311	ELECTRICAL MEASUREMENT AND INSTRUMENTATION	3
2102333	LINEAR CONTROL SYSTEMS I AND LABORATORY	4
2102360	ELECTRICAL POWER SYSTEM I	3
2102385	SEMICONDUCTOR DEVICES I	3
2102387	FUNDAMENTALS OF DIGITAL SYSTEMS AND LABORATORY	3
xxxxxxxx	GENERAL EDUCATION II	3
		19

COURSE NO.	SUBJECT	CREDITS
	SIXTH SEMESTER	
2102308	PROPERTIES OF ELECTRICAL ENGINEERING MATERIALS	3
2102371	PRINCIPLES OF COMMUNICATIONS AND LABORATORY	3
2102386	ELECTRONIC CIRCUITS AND LABORATORY	4
2102xxxx	APPROVED ELECTIVES GROUP I	6
xxxxxxxx	GENERAL EDUCATION III	3
		19
	SUMMER SEMESTER	
2100301	ENGINEERING PRACTICE	2
	SEVENTH SEMESTER	
2102490	ELECTRICAL ENGINEERING PRE-PROJECT	1
2102xxxx	APPROVED ELECTIVES GROUP I	6
2102xxxx	APPROVED ELECTIVES GROUP I (LAB)	3
2102xxxx	APPROVED ELECTIVES GROUP II	3
5500308	TECHNICAL WRITING FOR ENGINEERING	3
		15
	EIGHTH SEMESTER	
2102499	ELECTRICAL ENGINEEING PROJECT	3
xxxxxxxx	APPROVED ELECTIVES GROUP II	3
xxxxxxxx	GENERAL EDUCATION IV	3
xxxxxxxx	FREE ELECTIVES	6
		15

TOTAL CREDITS FOR GRADUTATION = 144

Approved elective courses

Category	Power	Control	Communications	Electronics
(At least 15 Breadth group 1 credits)	2102356 Electrical Machines II (3) 2102446 Fundamental of Power Electronics (3) 2102458 High Voltage Engineering I (3) 2102461 Electrical Power Systems II (3) 2102459 High Voltage Engineering Laboratory (3) 2102465 Electrical Power Laboratory (1)	2102401 Random Processes for EE (3) 2102432 Linear Control Systems II (3) 2102433 Digital Control Systems (3) 2102435 Industrial Automation (3) 2102436 Control and Instrumentation Laboratory (1)	2102322 Telecommunication Transmission (3) 2102423 Digital Signal Processing (3) 2102425 Data Communications (3) 2102472 Fundamental of Digital Communication(3) 2102473 Communication Engineering Laboratory (1)	2102444 Introduction to Embedded Systems (3) 2102446 Fundamental of Power Electronics (3) 2101447 Electronic Engineering Laboratory (1) 2102488 *Semiconductor Devices II (3)* 2102489 Principle of Analog Circuit Design (3)
Depth group 2 (At least 6 Credits)	*See the list of Approved elective Group II form the Electrical Department announced must, in which it can be update annually*			

Notes

A student must select 2 fields in the approved elective courses from Breadth group 1, with a minimum of 2 subjects in each selected field.
The total credits for approved elective group 1 must be at least 15.
In case, the student selects 2102401 RANDOM PROCESSES FOR EE and/or 2102446 FUNDAMENTAL of POWER ELECTRONICS, and/or 2102307 SIGNALS AND SYSTEMS he or she can declare them only in one field.
A student must select courses from Depth group 2 with a total of at least 6 credits.
The approved elective courses groups 1 and 2 can also be selected as free elective course(s).

NAME OF THE DEGREE

: Master of Engineering
: M. Eng.

PROFESSORS :

Bundhit	Eua-arporn,	Ph.D. (London)
Boonchai	Techaumnat,	D.Eng. (Kyoto)
David	Banjerdpongchai,	Ph.D. (Stanford)
Somsak	Panyakeow,	D.Eng. (Osaka)

ASSOCIATE PROFESSORS :

Chedsada	Chinrungrueng,	Ph.D. (U.C.Berkeley)
Chaodit	Aswakul,	Ph.D. (London)
Duang-rudee	Wonglumsom,	Ph.D. (Stanford)
Kulyos	Audomvongseree,	D.Eng. (Tokyo)
Lunchakorn	Wuttisittikulkij,	Ph.D. (Essex)
Mana	Sriyudthsak,	D.Eng. (T.I.T.)
Nisachon	Tangsangiumvisai,	Ph.D. (London)
Prasit	Teekaput,	Ph.D. (VPI & Su)
Somchai	Ratanathammaphan,	D.Eng. (Chula)
Songphol	Kanjanachuchai,	Ph.D.(Cambridge)
Thavatchai	Tayjasanant,	Ph.D.(Alberta)
Watit	Benjapolakul,	D.Eng. (Tokyo)
Watcharapong	Khovidhungij,	Ph.D. (UCLA)

ASSISTANT PROFESSORS :

Arporn	Teeramongkonrasmee,	Ph.D. (Chula)
Cherdkul	Sopavanit,	M.Eng. (Chula)
Chaiyachet	Saivichit,	Ph.D. (London)
Charnchai	Pluempitiwiriyawej,	Ph.D. (Carnegie Mellon)
Chanchana	Tangwongsan,	Ph.D. (Wisconsin)
Chanin	Wissawinthanon,	Ph.D. (Minnesota)
Jitkomut	Songsiri	Ph.D. (UCLA)
Komson	Petcharaks,	Dr.Sc. Techn. (Swiss Federal Inst. of Tech Zurich)
Manop	Wongsaisuwan,	D.Eng. (T.I.T.)
Hadsakoon	Boriphonmongkol,	M.Eng. (Chula)
Naebboon	Hoonchareon,	Ph.D. (Purdue)
Pasu	Kaewplang,	Ph.D. (Chula)
Supavadee	Aramvith,	Ph.D. (Washington)
Sotdhipong	Phichaisawat,	Ph.D. (Brunel, UK)
Suchin	Arunsawatwong,	Ph.D. (Manchester)
Suree	Pumrin,	Ph.D. (Washington)
Supatana	Auethavekiat	Ph.D. (Tokyo)
Surapong	Suwankawin,	Ph.D. (Chula)
Suvit	Nakpeerayuth,	M.Eng. (Chula)
Surachai	Chaitusaney	Ph.D. (Tokyo)
Somoon	Sangwongwanich,	D.Eng. (Nagoya)
Taptim	Angkaew,	D.Eng. (Osaka)
Wanchalerm	Pora,	Ph.D. (London)
Weerapun	Rungseevijitprapa,	Dr.-Ing. (Hannover)
Widhyakorn	Asdornwised,	D.Eng.(Chula)

LECTURERS :

Apiwat	Lek-Uthai	Dr.Ing. (Karlsruhe)
Bunchauy	Supmonchai,	M.Eng. (Chula)
Channarong	Banmongkol,	D.Eng. (Nagoya)
Jakapan	Lee,	M.Eng. (T.I.T)
Somboon	Chongchaikit,	Dr.Ing. (Paris XI)
Panuwat	Janpugdee	Ph.D. (USA)

COURSE REQUIREMENTS

1. Required Courses

(1.1) Core Course   3 credits   from

2102502	Random Signals and Systems	3(3-0-9)
2102504	Introduction to Mathematical Analysis	3(3-0-9)
2102505	Introduction to Optimization Techniques	3(3-0-9)
2102507	Computational Techniques For Engineers	3(3-0-9)

(1.2) 2102790 Electrical Engineering Seminar   2(2-0-6)

2) Elective Courses   9 credits   from

- Advanced Control and Optimization

2102531	System Identification	3(3-0-9)
2102536	Nonlinear Control Systems I	3(3-0-9)
2102631	Optimal Control Systems	3(3-0-9)
2102632	Stochastic Control Systems	3(3-0-9)
2102635	Control System Theory	3(3-0-9)
2102637	Multivariable Control Systems	3(3-0-9)
21026 38	Nonlinear Control Systems II	3(3-0-9)
2102731	Infinite-Dimensional Control Systems	3(3-0-9)
2102732	Convex Optimization and Engineering Applications	3(3-0-9)

- Biomedical Engineering

2102523	Statistical Signal Processing in Biomedical Engineering	3(3-0-9)
2102547	Cognitive Engineering	3(3-0-9)
2102585	Biomaterial Science	3(3-0-9)
2102588	Biomedical Electronics	3(3-0-9)
2102668	Biosensors	3(3-0-9)
2102675	Pattern Recognition	3(3-0-9)
2102676	Digital Image Processing	3(3-0-9)
2102785	Advanced Sensor Theory	3(3-0-9)
2102876	Adaptive Signal Processing	3(3-0-9)

- Embedded Systems and Robotics

2102540	Microcomputer Systems	3(3-0-9)
2102544	Advanced Embedded Systems	3(3-0-9)
2102545	Digital Integrated Circuits	3(3-0-9)
2102546	Analog Integrated Circuits	3(3-0-9)
2102581	Digital Circuit Design	3(3-0-9)
2102641	Computer-Aided Analysis of Electronic Circuits	3(3-0-9)
2102642	Computer Vision and Video Electronics	3(3-0-9)
2102645	Embedded System Design	3(3-0-9)

- High Voltage Engineering

2102553	Fundamentals of Electromagnetic Compatibility	3(3-0-9)
2102558	Insulation Coordination	3(3-0-9)
2102650	Electrical Transients in Power Systems	3(3-0-9)
2102656	Power System Protection	3(3-0-9)
2102754	Electric Field Analysis in High Voltage Engineering	3(3-0-9)
2102755	Power System Electromagnetic Transient Simulation	3(3-0-9)

- Industrial Instrumentation

2102540	Microcomputer Systems	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)
2102581	Digital Circuit Design	3(3-0-9)
2102616	Advanced Industrial Measurement	3(3-0-9)
2102645	Embedded System Design	3(3-0-9)
2102668	Biosensors	3(3-0-9)
2102675	Pattern Recognition	3(3-0-9)
2102676	Digital Image Processing	3(3-0-9)

- Microwave and Lightwave Communications
2102520	Optical Fiber Transmissions and Networks	3(3-0-9)
2102521	Access Networks	3(3-0-9)
2102620	Electromagnetic Theory	3(3-0-9)
2102625	Computational Electromagnetics for Microwave and Photonics	3(3-0-9)
2102674	Optical Communication	3(3-0-9)

- Multimedia and Signal Processing
2102571	Multimedia Communication	3(3-0-9)
2102573	Digital Communications	3(3-0-9)
2102574	Information Theory	3(3-0-9)
2102605	Fourier Transforms and its Applications	3(3-0-9)
2102675	Pattern Recognition	3(3-0-9)
2102676	Digital Image Processing	3(3-0-9)
2102874	Speech Processing	3(3-0-9)
2102875	Digital Video Processing	3(3-0-9)
2102876	Adaptive Signal Processing	3(3-0-9)

- Nanoelectronics and Photonics
2102549	Semiconductor Fabrication Technology	3(3-0-9)
2102582	Photonic Devices in Optical Communication Systems	3(3-0-9)
2102583	Introduction to Quantum Mechanics	3(3-0-9)
2102584	Introduction to Nanoelectronics	3(3-0-9)
2102589	Laser Engineering	3(3-0-9)
2102663	Solar Cell Technology	3(3-0-9)
2102680	Semiconductor Lasers	3(3-0-9)
2102682	Solid-State Physics for Electronics Engineers	3(3-0-9)
2102684	Guided-Wave Optics and Nanophotonics	3(3-0-9)

- Optoelectronics
2102580	Optoelectronics	3(3-0-9)
2102582	Photonic Devices in Optical Communication Systems	3(3-0-9)
2102589	Laser Engineering	3(3-0-9)
2102680	Semiconductor Lasers	3(3-0-9)

- Power Electronics
2102543	Advanced Electric Motor Drives	3(3-0-9)
2102548	Switched-Mode Electrical Power Processing I	3(3-0-9)
2102686	Switched-Mode Electrical Power Processing II	3(3-0-9)

- Power and Energy Systems
2102550	Power Electronics in Electrical Power Systems	3(3-0-9)
2102551	Computational Methods for Power System Analysis and Design	3(3-0-9)
2102552	Introduction to Distributed Generation	3(3-0-9)
2102554	Power System Harmonics	3(3-0-9)

2102555	Fundamentals of Power Quality	3(3-0-9)
2102556	Power System Economics	3(3-0-9)
2102559	Lighting System Design and Simulation	3(3-0-9)
2102651	Power System Stability	3(3-0-9)
2102656	Power System Protection	3(3-0-9)
2102757	Power System Reliability	3(3-0-9)

- Telecommunications and Information Networking
2102525	Internet and Network Security	3(3-0-9)
2102577	Telecommunication Network	3(3-0-9)
2102578	Satellite Communications	3(3-0-9)
2102627	Reliability and Survivability of Communication Networks and Systems	3(3-0-9)
2102628	Graph Theory and Combinatorial Optimization	3(3-0-9)
2102629	Traffic Engineering and Queuing Theory	3(3-0-9)
2102677	Broadband Network and Design	3(3-0-9)
2102770	Wireless Communications and Networking	3(3-0-9)
2102774	Telecommunications Switching, Transmission and Signaling	3(3-0-9)

3) Approved Courses   6 credits
2102598	Special Problems in Electrical Engineering I	3(3-0-9)
2102697	Special Problems in Electrical Engineering II	3(3-0-9)

4) THESIS
2102813	THESIS	18	credits
2102816	THESIS	36	credits

NAME OF THE DEGREE

: Doctor of Philosophy
: Ph.D.

PROFESSORS :

Bundhit	Eua-arporn,	Ph.D. (London)
David	Banjerdpongchai,	Ph.D. (Stanford)
Somsak	Panyakeow,	D.Eng. (Osaka)

ASSOCIATE PROFESSORS :

Boonchai	Techaumnat,	D.Eng. (Kyoto)
Chedsada	Chinrungrueng,	Ph.D. (U.C.Berkeley)
Duang-rudee	Wonglumsom,	Ph.D. (Stanford)
Ekachai	Leelarasmee,	Ph.D. (U.C. Berkeley)
Lunchakorn	Wuttisittikulkij,	Ph.D. (Essex)
Mana	Sriyudthsak,	D.Eng. (T.I.T.)
Nisachon	Tangsangiumvisai,	Ph.D. (London)
Prasit	Teekaput,	Ph.D. (VPI & Su)
Somchai	Ratanathammaphan,	D.Eng. (Chula)
Songphol	Kanjanachuchai,	Ph.D.(Cambridge)
Watit	Benjapolakul,	D.Eng. (Tokyo)
Watcharapong	Khovidhungij,	Ph.D. (UCLA)

ASSISTANT PROFESSORS :

Arporn	Teeramongkonrasmee,	Ph.D. (Chula)
Chaodit	Aswakul,	Ph.D. (London)
Chaiyachet	Saivichit,	Ph.D. (London)

Charnchai	Pluempitiwiriyawej,	Ph.D. (Carnegie Mellon)
Chanchana	Tangwongsan,	Ph.D. (Wisconsin)
Kulyos	Audomvongseree,	D.Eng. (Tokyo)
Komson	Petcharaks,	Dr.Sc. Techn. (Swiss Federal Inst. of Tech Zurich)
Manop	Wongsaisuwan,	D.Eng. (T.I.T.)
Naebboon	Hoonchareon,	Ph.D. (Purdue)
Pasu	Kaewplang,	Ph.D. (Chula)
Supavadee	Aramvith,	Ph.D. (Washington)
Sotdhipong	Phichaisawat,	Ph.D. (Brunel, UK)
Somboon	Sangwongwanich,	D.Eng. (Nagoya)
Suchin	Arunsawatwong,	Ph.D. (Manchester)
Suree	Pumrin,	Ph.D. (Washington)
Supatana	Auethavekiat	Ph.D. (Tokyo)
Surapong	Suwankawin,	Ph.D. (Chula)
Taptim	Angkaew,	D.Eng. (Osaka)
Thavatchai	Tayjasanant,	Ph.D.(Alberta)
Wanchalerm	Pora,	Ph.D. (London)
Weerapun	Rungseevijitprapa,	Dr.-Ing. (Hannover)
Widhyakorn	Asdornwised,	D.Eng.(Chula)

LECTURERS :

Apiwat	Lek-Uthai	Dr.Ing. (Karlsruhe)
Channarong	Banmongkol,	D.Eng. (Nagoya)
Chanin	Wissawinthanon,	Ph.D. (Minnesota)
Jitkomut	Songsiri	Ph.D. (UCLA)
Somboon	Chongchaikit,	Dr.Ing. (Paris XI)
Surachai	Chaitusaney	Ph.D. (Tokyo)

COURSE REQUIREMENTS

1) *Required Courses*
2102791	Electrical Engineering Seminar I	2(2-0-6)
2102792	Electrical Engineering Seminar II	2(2-0-6)
2102793	Electrical Engineering Seminar III	2(2-0-6)
2102794	Electrical Engineering Seminar IV	2(2-0-6)

2) *Core Course*   *3 credits   from*
2102502	Random Signals and Systems	3(3-0-9)
2102504	Introduction to Mathematical Analysis	3(3-0-9)
2102505	Introduction to Optimization Techniques	3(3-0-9)
2102507	Computational Techniques for Engineers	3(3-0-9)

3) *Elective Course*   *9 credits   from*

- Advanced Control and Optimization
2102531	System Identification	3(3-0-9)
2102536	Nonlinear Control Systems I	3(3-0-9)
2102631	Optimal Control Systems	3(3-0-9)
2102632	Stochastic Control Systems	3(3-0-9)
2102635	Control System Theory	3(3-0-9)
2102637	Multivariable Control Systems	3(3-0-9)
2102638	Nonlinear Control Systems II	3(3-0-9)
2102731	Infinite-Dimensional Control Systems	3(3-0-9)
2102732	Convex Optimization and Engineering Applications	3(3-0-9)

- Biomedical Engineering
2102523	Statistical Signal Processing in Biomedical Engineering	3(3-0-9)
2102547	Cognitive Engineering	3(3-0-9)
2102585	Biomaterial Science	3(3-0-9)
2102588	Biomedical Electronics	3(3-0-9)
2102668	Biosensors	3(3-0-9)
2102675	Pattern Recognition	3(3-0-9)
2102676	Digital Image Processing	3(3-0-9)
2102785	Advanced Sensor Theory	3(3-0-9)
2102876	Adaptive Signal Processing	3(3-0-9)

- Embedded Systems and Robotics
2102540	Microcomputer Systems	3(3-0-9)
2102544	Advanced Embedded Systems	3(3-0-9)
2102545	Digital Integrated Circuits	3(3-0-9)
2102546	Analog Integrated Circuits	3(3-0-9)
2102581	Digital Circuit Design	3(3-0-9)
2102641	Computer-Aided Analysis of Electronic Circuits	3(3-0-9)
2102642	Computer Vision and Video Electronics	3(3-0-9)
2102645	Embedded System Design	3(3-0-9)

- High Voltage Engineering
2102553	Fundamentals of Electromagnetic Compatibility	3(3-0-9)
2102558	Insulation Coordination	3(3-0-9)
2102650	Electrical Transients in Power Systems	3(3-0-9)
2102656	Power System Protection	3(3-0-9)
2102754	Electric Field Analysis in High Voltage Engineering	3(3-0-9)
2102755	Power System Electromagnetic Transient Simulation	3(3-0-9)

- Industrial Instrumentation
2102540	Microcomputer Systems	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)
2102581	Digital Circuit Design	3(3-0-9)
2102616	Advanced Industrial Measurement	3(3-0-9)
2102645	Embedded System Design	3(3-0-9)
2102668	Biosensors	3(3-0-9)
2102675	Pattern Recognition	3(3-0-9)
2102676	Digital Image Processing	3(3-0-9)

- Microwave and Lightwave Communications
2102520	Optical Fiber Transmissions and Networks	3(3-0-9)
2102521	Access Networks	3(3-0-9)
2102620	Electromagnetic Theory	3(3-0-9)
2102625	Computational Electromagnetics for Microwave and Photonics	3(3-0-9)
2102674	Optical Communication	3(3-0-9)

- Multimedia and Signal Processing
2102571	Multimedia Communication	3(3-0-9)
2102573	Digital Communications	3(3-0-9)
2102574	Information Theory	3(3-0-9)
2102605	Fourier Transforms and its Applications	3(3-0-9)
2102675	Pattern Recognition	3(3-0-9)
2102676	Digital Image Processing	3(3-0-9)
2102874	Speech Processing	3(3-0-9)
2102875	Digital Video Processing	3(3-0-9)
2102876	Adaptive Signal Processing	3(3-0-9)

- Nanoelectronics and Photonics

2102549	Semiconductor Fabrication Technology	3(3-0-9)
2102582	Photonic Devices in Optical Communication Systems	3(3-0-9)
2102583	Introduction to Quantum Mechanics	3(3-0-9)
2102584	Introduction to Nanoelectronics	3(3-0-9)
2102589	Laser Engineering	3(3-0-9)
2102663	Solar Cell Technology	3(3-0-9)
2102680	Semiconductor Lasers	3(3-0-9)
2102682	Solid-State Physics for Electronics Engineers	3(3-0-9)
2102684	Guided-Wave Optics and Nanophotonics	3(3-0-9)

- Optoelectronics

2102580	Optoelectronics	3(3-0-9)
2102582	Photonic Devices in Optical Communication Systems	3(3-0-9)
2102589	Laser Engineering	3(3-0-9)
2102680	Semiconductor Lasers	3(3-0-9)

- Power Electronics

2102543	Advanced Electric Motor Drives	3(3-0-9)
2102548	Switched-Mode Electrical Power Processing I	3(3-0-9)
2102686	Switched-Mode Electrical Power Processing II	3(3-0-9)

- Power and Energy Systems

2102550	Power Electronics in Electrical Power Systems	3(3-0-9)
2102551	Computational Methods for Power System Analysis and Design	3(3-0-9)
2102552	Introduction to Distributed Generation	3(3-0-9)
2102554	Power System Harmonics	3(3-0-9)
2102555	Fundamentals of Power Quality	3(3-0-9)
2102556	Power System Economics	3(3-0-9)
2102559	Lighting System Design and Simulation	3(3-0-9)
2102651	Power System Stability	3(3-0-9)
2102656	Power System Protection	3(3-0-9)
2102757	Power System Reliability	3(3-0-9)

- Telecommunications and Information Networking

2102525	Internet and Network Security	3(3-0-9)
2102577	Telecommunication Network	3(3-0-9)
2102578	Satellite Communications	3(3-0-9)
2102627	Reliability and Survivability of Communication Networks and Systems	3(3-0-9)
2102628	Graph Theory and Combinatorial Optimization	3(3-0-9)
2102629	Traffic Engineering and Queuing Theory	3(3-0-9)
2102677	Broadband Network and Design	3(3-0-9)
2102770	Wireless Communications and Networking	3(3-0-9)
2102774	Telecommunications Switching, Transmission and Signaling	3(3-0-9)

4) Approved Course   *12 credits*
Select form any 21026xx, 21027xx and 2108xx in item 3), and the following course

2102697	Special Problems in Electrical Engineering II	3(3-0-9)
2102796	Advanced Topics in Electrical Engineering I	3(3-0-9)
2102797	Advanced Topics in Electrical Engineering II	3(3-0-9)

5) Dissertation

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

COURSES DESCRIPTIONS IN ELECTRICAL ENGINEERING (B.ENG.)

2102201   Electrical Engineering Mathematics I   3(3-0-6)
Condition : Prerequisite 2301108
First-order and higher-order ordinary differential equations; series solutions of ordinary differential equations; Fourier series; Fourier integral and transform; Laplace transform; partial fraction expansion; partial differential equations; boundary-value problem; applications in Electrical Engineering.

2102202   Electrical Engineering Mathematics II   3(3-0-6)
Condition : Prerequisite 2301108
Systems of linear equations; elementary row operations; rank; matrix algebra; inverse of a matrix; LU factorization; determinants; vector spaces and subspaces; bases and dimensions; linear transformation and matrix representation; coordinate vectors; change of basis; eigenvalues and eigenvectors; diagonalization and similarity transformation; functions of a square matrix; Cayley-Hamilton theorem; infinite series, matrix exponentials; applications to differential equations; functions of a complex variable; analytic functions and derivatives; elementary functions; integration in the complex plane; Cauchy's integral theorem; Taylor and Laurent series; residue theorem and applications; conformal mapping.

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.

2102206 Introduction to Electrical Engineering   1(0-3-0)
Basic knowledge and understanding of present trends of electrical engineering technology in various fields, i.e., electrical power, electronics, control, and communication, based on which the students can grasp the whole picture of electrical engineering. The course is composed of lectures, hands-on laboratories in basic applications and MATLAB, and study trip. The lectures will be given by the Department staffs and invited experts from the industries, and will cover the topics ranging from basic researches to state-of-the-art technologies of each field.

2102210   Circuit Theory I   3(3-0-6)
Condition : Prerequisite 2304108
Elementary concepts; resistive circuits; node and mesh equations; circuit theorems; first-order and second-order circuits; periodic waveforms; sinusoidal waveforms; steady-state AC circuits; electric power; three-phase circuits.

2102211   Electric Circuit Laboratory   1(0-3-0)
Condition : Prerequisite 2102210 or Consent of faculty
A laboratory work on electric circuits and measurements: multimeter; oscilloscope; dc circuits ac circuits; three-phase circuits; resonance; first-order and secomd-order transient responses.

2102212   Circuit Theory II   3(3-0-6)
Condition : Prerequisite 2102210 Corequisite 2102201
Network graphs; network equations in matrix forms; node and mesh analysis; definitions of loop and cut-set; state equations; transient responses; complete responses; impulse response; unit-step response; natural frequency; network functions; sinusoidal steady-state responses; frequency response; two-ports networks; small signal analysis.

2102222   Engineering Electromagnetics   3(3-0-6)
Condition: Prerequisite 2102201 or 2102204
Vector analysis; electrostatic fields in free space; electrostatic fields in dielectrics and conductors; Laplace equation and simple solution method; energy in electrostatic fields; convection current and conduction currents; magnetostatic fields; magnetic forces; energy in magnetostatic fields; elestromagnetic induction and Maxwell's equations; time-harmonic electromagnetic fields and their phasors; plane waves in an unbounded medium; free-space, dielectric and conductor; electromagnetic power transmission, Poynting's theorem.

2102252   Electrical Machines I   3(3-0-6)
Condition: Prerequisite 2102210
Basic principles of electromechanical energy conversion: electromagnetic forces, Faraday's law, Ampere'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.

2102300   Electrical Engineering Technology for Better Community   1(0-18-0)
Practice applying knowledge in electrical engineering through a project for the betterment of a community, developing teamwork skills, and raising awareness of public service mindset and social responsibility.

2102307   Signals and Systems   3(3-0-6)
Condition : Prerequisite 2102202,2102212
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.

2102308   Properties of Electrical Engineering Materials   3(3-0-6)
Condition : Prerequisite 2304108
Fundamentals; structures of solids; determination of structures; preparation of materials; mechanical, thermal, electrical, magnetic and optical properties of materials; dielectrics; superconductivity.

2102311   Electrical Measurements and Instrumentation   3(3-0-6)
Condition : Prerequisite 2102210
Units and standard instruments; shielding; safety; precision; voltage, current and power measurements; impedance measurement at low and high frequencies; transducers; magnetic measurements; digital techniques in measurement; noises; signal-to-noise ratio enhancement techniques.

2102322   Telecommunication Transmission 3(3-0-6)
Condition: Prerequisite 2102222
Transmission line theory; Smith chart and impedance matching techniques by using stubs transmission lines in telecommunication system, coaxial line and twin leads; plane wave transmission, polarization and reflection and refraction; waveguide principle; microwave waveguides; optical waveguides; principle of radiation and antennas; basic antenna parameters; free-space point-to-point transmit-receive systems; calculation of link budget; introduction to wave propagation in wireless systems.

2102331   Feedback Control Systems Laboratory   1(0-3-0)
Condition : Prerequisite 2102332
A Laboratory work on control systems; computer simulation of dynamic systems; position control and speed control of servomotor; PID tuning and computer control of industrial processes.

2102332　Linear Control Systems I　3(3-0-6)
Condition : Prerequisite 2102207 or 2102212
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; Nichols charts; control system design by frequency response method.

2102355　Electrical Machines Laboratory　1(0-3-0)
Condition: Prerequisite 2102252, 2102211
Basic laboratory concerning electromechanical energy conversion: experimental topics related with the contents of the lecture course on electrical machines I: experiments on basic instruments and equipments in electrical power engineering, characteristics of various apparatus, i.e., magnetic cores, transformers, dc generators, dc motors, synchronous generators, induction motors and magnetic contactors.

2102356　Electrical Machines II　3(3-0-6)
Condition: Prerequisite 2102252
Magnetic energy and coenergy; forces and torques in electromagnetic systems; transient behaviors of dc motors; starting and speed control methods of dc motors; structure and connection of three-phase transformers; parallel connection of transformers; characteristics of salient-pole synchronous generators; parallel operation of synchronous generators; transient behaviors of synchronous generators; synchronous motors; permanent magnet synchronous motors; brushless dc motors; characteristics and starting methods of synchronous motors; structure and operating principles of stepping motors; starting and braking methods of three-phase induction motors; speed control of induction motors; operating principles of induction generators; characteristic of single-phase induction motors.

2102360　Electrical Power Systems I　3(3-0-6)
Condition : Prerequisite 2102252
Introduction to power systems; sources of electric energy; power system structure; load characteristics; basic power system calculation; electric power plants; transmission line parameters; transmission line model and performance analysis; power transformer model and per-unit system; electrical power distribution system; power system equipment.

2102370　Principles of Communications　3(3-0-6)
Condition : Prerequisite 2102207 or (2102201 and 2102203)
An overview of signals, linear systems and Fourier transform; analog modulation: AM, DSB, SSB, VSB, FM and PM; random process and noise in communication systems; digital baseband transmission and power spectrum analysis; Nyquist's sampling theorem and quantization; pulse code modulation, delta modulation and time division multiplexing; digital modulation: ASK, PSK, FSK and QAM; information theory and source coding.

2102382　Electronic Circuits　3(3-0-6)
Condition : Prerequisite 2102210
Current-voltage characteristics of electronic devices and their models; basic transistor amplifier circuits; transistor biasing; analysis of small-signal transistor amplifiers; frequency response of small-signal linear amplifiers; feedback amplifiers; operational amplifiers and their applications in linear and nonlinear circuits; oscillators; power amplifiers; power supplies; introduction to power electronics.

2102383　Fundamentals to Digital Systems 3(3-0-6)
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; combinational circuit design; sequential circuits: latch, flip-flop; register, and counter; analysis of clocked sequential circuits: Moore and Mealy machines; circuits for arithmetic operations: adder, subtractor, and multiplier; MOS and CMOS logic; VHDL for digital system design; logic simulation and FPGA programming.

2102384　Electronics Laboratory　1(0-3-0)
Condition : Prerequisite 2102211 or 2110261
Corequisite 2102382
A laboratory work on basic properties of semiconductors and electronic devices: charge carriers in semiconductors, diodes, transistors, triggering devices, thyristors, optoelectronic devices and ultrasonic sensors; electronic circuits: transistor biasing, amplifiers, feedback amplifiers, linear and nonlinear application of op-amps, dc power supplies and digital circuits.

2102385　Semiconductor Devices I　3(3-0-6)
Crystal properties and growth of semiconductors; atoms and electrons; energy band and charge carriers in semiconductors; excess carriers in semiconductors; junctions; field-effect transistors; bipolar junction transistors; optoelectronic devices; power devices

2102391　Electrical Engineering I　3(3-0-6)
Condition : Prerequisite 2304104 and 2304108
DC circuit analysis; ac single-phase and three-phase circuit analysis; Kirchhoff's laws; complex power; basic principles, efficiency and connections of transformers; characteristics, operation, speed control and applications of dc motors, single-phase and three-phase induction motors; introduction to low-voltage electrical system design and protection.

2102392　Electrical Engineering Laboratory I 1(0-3-0)
Condition : Corequisite 2102391
A laboratory work on electric circuits and machines: dc and ac circuits; three-phase circuits; transformers; dc generators; dc motors; induction motors.

2102401　Random Processes for Electrical Engineering　3(3-0-6)
Condition: Prerequisite 2102203
Basic concepts of probability theory; random variables; stochastic processes; mean, covariances, and correlations; stationary random processes; analysis of random signals; power spectral density; response of linear systems to random signals; amplitude modulation by random signals; optimum linear estimators.

2102420 Principles of Antennas 3(3-0-6)
Condition : Prerequisite 2102322
Fundamental parameters of antennas; linear wire antennas; loop antennas; antenna arrays; linear array'planar array; antenna synthesis; calculation of self and mutual impedances by method of moment; broadband antennas; aperture antennas; horn antennas; microstrip antennas; reflector antennas; introduction to antenna measurements.

2102421 Principles of Microwave Engineering 3(3-0-6)
Condition : Prerequisite 2102322
Microwave network analysis; impedance matching and tuning circuits; microwave resonators; power divides and directional couplers; microwave filters; design of microwave filters; ferrimagnetic microwave components; active microwave circuits; microwave oscillators and amplifiers; introduction to microwave systems, communication systems, radar systems, and microwave heating ; microwave biological effects and safety.

2102422 Principles of Telecommunication 3(3-0-6)
Condition: Prerequisite 2102370
Introduction to telecommunications; layered communication architectures; transmission medium: wired and wireless; data link layer protocols: flow control and error control; medium access control; circuit switching and packet switching; throughput and delay performance analysis of communication link; introduction to network topology, flows and graph theory; routing principles in circuit-switched and packet-switched networks; introduction to queuing theory and basic simulation techniques; Overviews of cellular mobile phone networks, optical networks, Internet and satellite systems..

2102423 Digital Signal Processing 3(3-0-6)
Condition: Prerequisite 2102201
Signals; linear time-invariant system; z-transform and its inverse; convolution theorem; difference equation; group delay; some applications using discrete-Fourier transform (DFT) and fast Fourier transform (FFT); finite impulse response (FIR) filtering; infinite impulse response (IIR) filtering; transversal filters; lattice filters; sampling theory; sampling rate conversion; decimation; interpolation; polyphase filters; aliasing; word length effects; quantization error effects; roundoff noise effects in digital filters.

2102425 Data Communications 3(3-0-6)
Condition: Prerequisite 2102422 or Consent of faculty
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 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); system design considerations.

2102426 Traffic Engineering in Communication Networks 3(3-0-6)
Conduction: Prerequisite 2102422 or Consent of faculty
Traffic engineering overview; traffic characteristics; performance evaluation by computer simulation; introduction to traffic models in non-queuing/queuing systems; application of traffic engineering in communication networks.

2102427 Multimedia Compression Technology 3(3-0-6)
Condition: Prerequisite (2102207 and 2102423) or 2102307 or Consent of faculty
Introduction to multimedia compression technology; statistical methods: Huffman coding, facsimile compression, arithmetic coding; dictionary methods: LZ77 , LZSS , LZ78, LZW; image compression methods: progressive image compression, JPEG, JPEG-LS; wavelet methods: subband, filter banks, DWT: video compression methods:MPEG; audio compression methods: U-law and A-law companding, ADPCM audio compression, MPG-1 audio layers.

2102428 Introduction to Image Processing 3(3-0-6)
Condition: Prerequisite 2102203, 2102307 o r Consent of faculty
Fundamentals of image processing; image enhancement and restoration; image segmentation; line and edge detection; morphology; optical flow; stereo vision; image representations; chain code; convex hull; boundary and area descriptors; pyramid and multiresolution image representations.

2102432 Linear Control Systems II 3(3-0-6)
Condition: Prerequisite 2102332
State-space representation of dynamic systems; mathematical modeling of complex engineering systems at level of details compatible with the design and implementation of modern control systems; system characteristics; controllability and stability; modifications of system characteristics using feedback, state feedback, optimal regulation and observers; extensive case study emphasizing computer-aided analysis and design.

2102433 Digital Control Systems 3(3-0-6)
Condition: Prerequisite 2102332
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.

2102434 Industrial Control and Instrumentation 3(3-0-6)
Condition : Prerequisite 2102332
Industrial instrumentation: analog and digital devices; industrial control techniques in actual industrial systems; analysis, design, selection and maintenance of industrial control systems; applications to electromechanical, pneumatic, and hydraulic systems.

2102444 Introduction to Embedded Systems 3(3-0-6)
Condition : Prerequisite 2102383
Embedded system architecture; microprocessor/ microcontroller; memory; I/O and peripherals; embedded C programming; interrupt; DMA and embedded system networks.

2102446　Fundamentals of Power Electronics
3(3-0-9)
Condition : Prerequisite 2102210
Fundamental theories of power electronics for electrical power processing and control; basic converter and inverter topologies and their operations; static and dynamic characteristics as well as control techniques of semiconductor power devices: diodes. Transistors and thyristors; characteristics and models of passive components: inductors, transformers, capacitors and resistors; converter and inverter applications: switching power supplies, dc and ac motors drives, high voltage dc transmission.

2102456　Electrical System Design　3(3-0-6)
Condition : Corequisite 2102360
Types of electrical systems; system design concept and criteria; electrical devices, installation materials, symbol and circuit diagrams; load characteristics; power supplies; power distribution and wiring design; infrastructural system design: lighting, heating, air conditioning, grounding; motor load and motor control; specifications and cost estimations; residential and commercial electrical system design; power factor correction.

2102457　Fundamentals of Light and Lighting 3(3-0-6)
Condition: Consent of faculty
Light, eyes, vision, health and productivity; application of light in nonvisual processes; definition and terminology in light and lighting; photometry and colorimetry; principles of light generation; daylight, light sources and control gears; optical properties of material; construction, classification and characteristics of luminaries; principles of lighting calculation; indoor and outdoor lighting applications; lighting quality, energy efficiency and pollution impacts.

2102458　High Voltage Engineering I　3(3-0-6)
Condition: Consent of faculty
Generation and measurement of high voltages and currents; electric fields in homogeneous and heterogeneous materials; gaseous discharges; electric arcs; breakdown in liquid and solid dielectrics; high voltage test of electric apparatuses; lightning discharges and protections.

2102459　High Voltage Engineering Laboratory I　1(0-3-0)
Condition : Prerequisite 2102458
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; over-voltage in power systems; electrical insulation; protective devices and power system protection; power system stability.

2102463　Electrical Power System Protection
3(3-0-6)
Condition : Prerequisite 2102360
Introduction and philosophies of power system protection; phasor and polarity; symmetrical components revision; input sources for relay; key principles of system protection; system grounding principles; generator, transformer, reactor, shunt capacitor, bus, motor and line protection.

2102464　Fundamentals of Electric Motor Drives　3(3-0-6)
Condition: Prerequisite 2102356
Moments of inertia of various components in electrical drive systems; operating region of drives; braking methods of motors; calculation of motor ratings for various loads; torque-speed characteristics of dc motors used in drive systems; control circuits and control methods of dc motors; torque-speed characteristics and equivalent circuits of induction motors used in drive systems; control circuits and control methods of induction motors; servo drive systems.

2102473　Communication Engineering Laboratory　1(0-3-0)
Condition : Prerequisite 2102370
Hands-on laboratory in three major areas related to communication engineering, namely, telecommunications, electromagnetic waves and digital signal processing.

2102474　Communication System Design　3(3-0-6)
Condition : Prerequisite 2102422
Trends of telecommunication; wiring (twisted pair, coaxial, optical fiber and standard interfaces such as RS-232); switching, PABX and call center; architectures, characteristics and standards of local area network (LAN); metropolitan area network (MAN) and wide area network (WAN); intelligent buildings; Internet and intranet; cable and security management; design of intelligent buildings; design of MAN and WAN; economic consideration; traffic and future planning for expansion; applications and case studies.

2102479　Optical Fiber Communication　3(3-0-6)
Condition : Prerequisite 2102322
Overview of optical fiber communications; wave guiding in optical fibers, mode theory for dielectric circular waveguides; signal distortion in optical fibers due to loss and dispersion; optical sources, laser diodes; modulation techniques; photodetector, optical receiver operation; digital transmission systems, power budget analysis; dispersion management; optical fiber amplifiers; principle and components in WDM systems.

2102487　Industrial Electronics　3(3-0-6)
Condition : Prerequisite 2102382
Industrial sensors and their characteristics; signal conditioning; signal transmission; sequence control; programmable sequence controller and PLC; process control; distributed control system (DCS); man-machine-interface (MMI) software.

2102488　Semiconductor Devices II　3(3-0-6)
Condition : Prerequisite 2102385
Review of physics and properties of semiconductors; compound semiconductor; P-N

junction; metal-semiconductor junctions; heterojunctions; MESFET; heterojunction transistor (HEMT and HBT); microwave devices; high speed photonic devices and integrated circuits.

2102489　Principles of Analog Circuit Design　3(3-0-6)
Condition : Prerequisite 2102382

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.

2102490　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.

2102491　Electrical Engineering II　3(3-0-6)
Condition : Prerequisite 2102391

Conduction in metals and semiconductors; P-N junctions; characteristics of semiconductor devices; transistor ampilfiers; operational amplifier circuits and applications; digital circuits: basic gates, Boolean algebra, combinational circuits and sequential circuits; relay sequential circuits; industrial instrumentation; power electronics: phase controlled recifiers and motor speed controls.

2102499　Electrical Engineering Project　3(0-6-3)
Condition : 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.)

2102502　Random Signals and Systems　3(3-0-9)

Statistical independence and conditional probability; Hilbert space of 2nd-order random variables; conditional mean and covariance of multidimensional Gaussian distribution; Bayesian estimator; stationary discrete-time random signals; discrete-time linear systems with random signals input-output relation; rational spectral densities factorization; continuous-time stationary Gaussian processes and spectral factorization; ergodic processes; Hilbert space of square integrable functions on a time interval; karhunen-Loeve vs. Fourier series expansion of random signals; discrete-time Kalman filtering problem formulation; innovation sequence and update formula; propagate formula; Kalman filter equations.

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.

2102505　Introduction to Optimization Techniques　3(3-0-9)
Condition : Prerequisite 2102202 or

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 methods, sequential quadratic programming; solution of linear programs by the simplex method.

2102507　Computational Techniques for Engineers　*3(3-0-9)*
Condition : Prerequisite 2102202 or 2102205 or Consent of Faculty

Mathematical preliminaries; computer arithmetics; solutions of nonlinear equations; solving system of linear equations; approximating functions; numerical differentiation and integration; numerical solutions of ordinary differential equations.

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

Overview of optical fiber telecommunication; enabling technologies for optical fiber transmissions; standard for optical fiber transmission; signal propagation in optical fiber; design of optical fiber point-optical fiber telecommunication; enabling technologies for optical fiber transmissions; standard for optical fiber transmission; signal propagation in optical fiber; design of optical fiber point-to-point link; dispersion compensation methods and their optimum design rules; wavelength division multiplexed(WDM) transmission systems; Dense WDM (DWDM); long-haul EWDM transmission design; enabling technologies for optical fiber networks; standard for optical fiber networks; first generation optical networks; access networks; FTTx; SONET and SDH optical ring network; FTTx; SONET and SDH optical ring network; DWDM networks: ring, mesh, and broadcast-and-selective topologies; design of DWDM optical local-area-network (LAN), DWDM optical metropolitan-area network (MAN), and DWDM optical wide-area network (WAN); engineering DWDM network; fiber system installations; fiber system tests and measurements; recent trends in fiber-optic transmissions and networks.

2102521　Access Networks　3(3-0-9)
Condition : Consent of Faculty

Overview of access networks, access networks and core networks, xDSL: Variety of DSL versions; Standards of xDSL systems and components; Transmission of DSL signal in twisted pair and limitations; xDSL system design; business models in xDSL, HFC: standards of HFC and Docsis; HFC systems and components; transmission of video and data in HFC and limitations; HFC system design; business model in HFC, FTTx: variety of FTTx versions; standards of FTTx; FTTx systems and components; transmission of optical signals in FTTx system and

limitations; FTTx system design; business models in FTTx, PLC: standards of PLC system; PLC systems and components; transmission of PLC signals in power system; PLC system design WiMAX : standards of WiMAX; WiMAX systems and components; of PLC signals in power system; PLC system, PLC system design, WiMAX: standards of WiMAX; WiMAX systems and components; transmission of WiMAX signals WiMAX system design; business models in WiMAX, WiFi: standards of WiFi; WiFi systems and components; transmission of WiFi signals; WiFi system design, other minor access nerworks: Bluetooth UWB; FSO; comparison of access networks nature of access networks; future trends.

2102523   Statistical Signal Processing in
Biomedical Engineering   3(3-0-9)
Condition : Prerequisite 2102207 or
Consent of Faculty
   Characterization of signals and linear time-invariant systems; conversion of continuous-time signals to discrete-time signals; modeling of stochastic signals from white noise; energy and power signals; the principles of autocorrelation for discrete-time signals; linear prediction and optimum linear filtering; Least-Squares methods for system modeling and filtering design; all topics focused on biomedical engineering perspective.

2102525   Internet and Network Security   3(3-0-9)
Condition : Consent of Faculty
   Overview of internet TCP/IP protocol and multimedia traffics; medium access controls protocols; wireless LAN networks; gigabit Ethernet; dynamic routing protocols (RIP and OSPF), LAN switching transport layer protocols: UDP and TCP, IP multicast, NAT, DHCP, DNS, SNMP; routing mechanism and congestion control algorithms; future broadband networks: WDM technology, advanced network architecture, network simulation, performance analysis, and measurement; network security; basic concept of cryptography: secret-key, public-key, digital signatures; authentication and identification schemes; intrusion detection: viruses; security of electronic mail and the World Wide Web; electronic commerce: payment protocols, electronic cash and firewalls.

2102531   System Identification   3(3-0-9)
Condition : Prerequisite 2102332 or
Consent of Faculty
   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.

2102536   Nonlinear Control Systems I   3(3-0-9)
Condition: Prerequisite 2102432 or
Consent of Faculty
   Introduction to nonlinear control systems; state-space and phase-plane analyses; describing functions; Lyapunov stability; circle and Popov criteria; nonlinear control systems design.

2102540   Microcomputer Systems   3(3-0-9)
Condition : Prerequisite 2102444 or
Consent of Faculty
   Microcomputer hardware: CPU, bus, memory, I/O units; interfacing techniques and programming; interfacing peripherals; software design techniques; real time systems and programming; microcomputer operating systems; high-level languages; microcomputer applications in control and instrumentation.

2102543   Advanced Electric Motor Drives   3(3-0-9)
Condition: Prerequisite 2102356 or
Consent of Faculty
   Modeling and dynamic equations of dc motors; control principles of motor drives; semiconductor devices used in motor drive systems; various converter topologies for dc motor drives; modeling and dynamic equations of induction and synchronous motors; control principles of induction and synchronous motors; various inverter topologies for ac motor drives.

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.

2102545   Digital Integrated Circuits   3(3-0-9)
Condition : Consent of Faculty
   Internal circuits of different families of gates; TTL, ECL, NMOS and CMOS; internal configuration of large scale integrated circuits including ROM, RAM, PAL, PLA and FPGA; dynamic digital circuits such as domino and clocked circuits.

2102546   Analog Integrated Circuits   3(3-0-9)
Condition : Consent of Faculty
   MOS transistor models; operational amplifier design; stability and frequency compensation of feedback amplifiers; switched-capacitor circuits; effect of nonlinearity and mismatch; oscillators and phase lock loops.

2102547   Cognitive Engineering   3(3-0-9)
   Introduction to cognitive science from Descartes concepts to Informatics; Psychophysics: visual system, auditive system and somatosensory system; human cognitive function: sensory-motor system, perception, memory, learning, reasoning, decision making and problem solving, instrumentation and cognitive process: signal detection, image perception, speech recognition; applications of sensors and actuators in cognitive process; examples of computational modeling and brain process: artificial intelligence, neural network.

2102548   Switched-Mode Electrical Power
Processing I   3(3-0-9)
Condition : Prerequisite 2102382 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 converter and

inverters; analysis of resonant inverters using fundamental frequency approximation and their applications.

2102549 Semiconductor Fabrication Technology 3(3-0-9)
Condition : Prerequisite 2102385 or Consent of Faculty

Integrated circuit fabrication technologies: crystal growth, vapor phase epitaxy, liquid phase epitaxy, molecular beam epotaxy, thermal oxidation, thermal diffusion, ion implantion, chemical vapor deposition, metallization, lithography, annealing, assembly and packaging, future trends.

2102550 Power Electronics in Electrical Power Systems 3(3-0-9)
Condition : Consent of Faculty

Basic structure of electrical power system networks; fundamentals of power flow in power systems; basic characteristics of transmission systems; compensation in transmission systems; interconnection of power systems through FACTS and HVDC; active and reactive power flow control; voltage and current compensation for power quality; power electronic circuits for conversion of renewable energy generation.

2102551 Computational Methods for Power System Analysis and Design 3(3-0-9)
Condition: Prerequisite 2102461 or Consent of Faculty

Power network representation and reconfiguration algorithms; problem formulation and solution methods for the studies fundamental to planning, design and operation of electric power systems including power flow, security assessments, optimal power flow and fault calculations; dynamic simulation for power system studies.

2102552 Introduction to Distributed Generation 3(3-0-9)
Condition : Co-requisite 2102461 or Consent of Faculty

Introduction to Distributed Generation (DG); technologies of DG; power generation systems: synchronous, induction, converter; DG impact on load flow and voltage profiles; DG impact on fault and protection; and DG impact on power quality.

2102553 Fundamental of Electromagnetic Compatibility 3(3-0-9)
Condition: Consent of Faculty

EMI/EMC understanding and measurements; sources of EMI; definition and effect of EMI; EMMI 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 filter selection and usage.

2102554 Power System Harmonics 3(3-0-9)
Condition : Consent of Faculty

Harmonic and interharmonic definition and terminology; harmonic and interharmonics sources; effect of harmonics and interharmonics; harmonic flow in power system; harmonic standards; harmonic mitigation techniques; and tuned filter designs and applications

2102555 Fundamentals of Power Quality 3(3-0-9)
Condition : Consent of Faculty

Definitions and technical terms of power quality ; sources and effects of power quality disturbances; harmonics and interharmonics analysis voltage sag analysis; voltage fluctuations and flicker analysis; Power quality standards and mitigation techniqus.

2102556 Power System Economics 3(3-0-9)

Economic dispatch problems; economic dispatch considering transmission system losses; introduction to unit commitment planning; microeconomic theory; power pool structure; bilateral contract structure; power system analysis considering market structures.

2102557 High Voltage Engineering II 3(3-0-9)
Condition : Prerequisite 2102458 or Consent of Faculty

Properties of dielectric materials; insulations and their applications; constructions and performance of high voltage equipments: transformers, circuit breakers, insulators, cables, isolators, lightning arresters, capacitors, bushings; non-destructive test of insulating materials and high voltage equipments; partial discharge measurements, capacitance and dielectric loss measurement; design and layout of high voltage power systems.

2102558 Insulation Coordination 3(3-0-9)
Condition : Prerequisite 2102458 or Consent of Faculty

Switching overvoltage between phase and ground, between phase and phase and at substation; lightning overvoltage on transmission line and at substation; lightning protection for transmission line and substation; selection of lightning arrester; insulation coordination according to IEC60071.

2102559 Lighting System Design and Simulation 3(3-0-9)
Condition : Consent of Faculty

Lighting system design process and standards; lamps and luminaries applications; lighting design principles for interior; lighting model simulation; computer simulation and case studies for interior space; daylighting design and consideration for energy efficiency; lighting system installation and maintenance; lighting design principles for exterior; computer simulation and case studies for exterior space.

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.

2102573 Digital Communications 3(3-0-9)

Signals and Spectra, Random Signals and Power Spectral Density, Source Coding, Predictive Coding, Vector Quantizing, Transform Coding, Formatting and Baseband Transmission, Correlative Coding, Baseband Detection, Error Performance, Intersymbol Interference, Equalization, Digital Bandpass Modulations, Coherent and Noncoherent Detection, Bit and Symbol Error Rate, Spread-Spectrum Techniques, Direct-Sequence, Frequency Hopping, Fading Channels, Flat-Fading,

Frequency-Selective Fading, Doppler Shift, Diversity and Interleaver, Channel Codings, Block and Cyclic Codes, Hamming and BCH Codes, Convolutional Codes, Viterbi Decoding, Reed-Solomon Codes, Interleaving and Concatenated Codes, Turbo Codes.

2102574   Information Theory   3(3-0-9)
Information theory; probability and entropy; the source coding theorem; symbol codes; stream codes; communication over a noisy channel; the noisy-channel coding theorem; error-correcting codes; constrained noiseless channels; marginalization; low-density parity-check codes; convolutional codes and turbo codes; other modern codes.

2102577   Telecommunication Network   3(3-0-9)
Condition : Consent of Faculty
Telecommunication network fundamentals; multiplexing and switching; OSI principle; various network equipment technologies; network interconnection; signaling in network and applications; various network interconnection types; network management activities; telecommunication network management; network evaluation; network performance.

2102578   Satellite Communications   3(3-0-9)
Fundamentals of satellite communication; satellite orbits; satellites; satellite link design; modulation and multiplexing; multiple access; earth station; error control coding; polarization; interference; VSAT; various types of satellites and their operations such as geostationary, nongeostationary, low earth orbit, direct broadcast and global positioning systems.

2102580   Optoelectronics   3(3-0-9)
Condition : Prerequisite 2102385 or
Consent of Faculty
Physics of optical radiation; interaction between optical radiation and matter; principles and applications of optoelectronic devices: sources, detectors as well as other optical materials, devices, components and equipments.

2102581   Digital Circuit Design   3(3-0-9)
Condition : Prerequisite 2102282 or
Consent of Faculty
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.

2102582   Photonic Devices in Optical
            Communication Systems   3(3-0-9)
Condition :Prerequisite 2102222, 2102385
or Consent of Faculty
Fundamentals of semiconductor physics; electronic and optical properties of semiconductors; optical processes in semiconductors; junction theory; propagation of light; waveguide theory; couplers and coupled-mode theory; operating principles, structures and properties of LEDs, laser diodes, photodetectors optical modulators/switches, optical amplifiers and

semiconductor optical amplifiers (SOAs); the fabrication technology of photonic devices.

2102583   Introduction to Quantum Mechanics
            3(3-0-9)
Condition: Prerequisite 2102204,2102205,
2102222 or Consent of Faculty
Schroedinger's equation; bound states; wave packets and uncertainty relations; scattering by simple barriers; WKB approximation; expectation values and operators; variational principle; expansion principle and matrix formulation; perturbation theory.

2102584   Introduction to Nanoelectronics   3(3-0-9)
Condition : Prerequisite 2102380, 2102385
Introduction to nanotechnology, nanoscale fabrication (e.g. photolithography, electron-beam lithography, self-assemble growth); nanoscale characterisations (e.g. SEM, TEM, AFM); 1D quantum structure (quantum wires); 0D quantum structure (quantum dots); single electron devices, carbon nanotubes; molecular electronics, DNA chips, quantum dot cellula automata; MEMS/NEMS; spintronics.

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.

2102588   Biomedical Electronics   3(3-0-9)
Condition : Consent of Faculty
Electrical signals in human body; action potential in cells; electrodes; amplifiers; transducers; electronic monitoring systems: ECG, EEG, EMG; blood pressure and blood flow measurement; catheterisation; electrical hazards and prevention; medical instrumentation; computer in medicine.

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 science, precision measurement, telecommunications, material processing, spectroscopy, display hologram and nonlinear optics.

2102598 Special Problems in Electrical
          Engineering   3(3-0-9)
Condition : Consent of Faculty
Special problems assigned by the instructor with consent of the head of the Department.

2102601   Power and Energy Technologies in Smart
            Grids   3(3-0-9)
Condition : Consent of Faculty
Introduction to Smart Grids; fundamentals of power system operation and control; distributed generation, microgrid and active networks; introduction to wide area

monitoring and wide area protection systems; renewable energy generation; grid connection codes; renewable energy policy and regulation; energy storage; electric vehicle.

2102602 Information and Communication Technologies in Smart Grids 3(3-0-9)
Condition : Consent of Faculty
Substation operation and related communication within substation; equipment in distribution system; communication between control centers; architecture and components of Automatic Meter Infrastructure/Automatic Meter Reading including phasor measurement unit, digital fault recorder and interoperability; energy efficiency within home, building and factory; communication channels in smart: wired, wireless, optical fiber; network layer, sensing/control and control protocol; database management and cyber security.

2102605 Fourier Transforms and its Applications 3(3-0-9)
Condition : Consent of Faculty
Fourier's theorem; Fourier transforms of functions; discrete Fourier transform; other related transforms; applications to electric networks, sampling, antennas, noise waveforms, Fourier optics and statistics.

2102616 Advanced Industrial Measurement 3(3-0-9)
Condition : Consent of Faculty
Roles of industrial measurement; functional elements and characteristics of industrial measuring system; analysis, design, selection and applications. of sensors in industrial measuring system; factory automation, processautomation, and precision machinery; future trend of industrial sensors.

2102620 Electromagnetic Theory 3(3-0-9)
Condition : Prerequisite 2102322 or Consent of Faculty
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, 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.

2102625 Computational Electromagnetics for Microwave and Photonics 3(3-0-9)
Condition : Consent of Faculty
Basic concept of numerical modeling for electromagnetic problems; computational methods and programming techniques for solving linear electromagnetic wave problems in frequency domain for microwave and photonic applications such as finite-element method (FEM), boundary-element method (BEM), finite-volume method (FVM), and meshless method; computational methods and programming techniques for solving linear electromagnetic problems in time domain such as finite-difference time-domain (FDTD), finite- element time-domain (FETD), and finite-volume time-domain (FVTD).

2102627 Reliability and Survivability of Communication Networks and Systems 3(3-0-9)
Condition : Consent of Faculty
Fundamental probability; overview of network reliability; approaches to calculating network reliability; generic reliability and maintainability concept; overview of network survivability; fiber transport system components and signals; APS; dual homing; self healing rings; SONET analysis; DCS networks; survivable network design; IP and ATM network survivability.

2102628 Graph Theory and Combinatorial Optimization 3(3-0-9)
Condition : Consent of Faculty
Introduction to graph theory; concept of paths, cycles and trees; various types of graphs; transshipment problem; shortest path problem; maximum flows problem; minimum cost flows problem; network optimization; matching; Matriods and greedy algorithms; applications.

2102629 Traffic Engineering and Queuing Theory 3(3-0-9)
Condition : Consent of Faculty
Fundamentals of traffic engineering and queuing theory: quality of service and system performance analysis; computer simulation technique; single-service and multi-service loss network theory and its applications: congestion analysis, blocking probability, system utilization and revenue approximation, overflow traffic management, traffic prioritization; delay-system analysis and queuing theory: single queue models, queuing network models, mean value analysis; traffic characterization of broadband and multimedia services; applications in mobile communications and internet.

2102631 Optimal Control Systems 3(3-0-9)
Condition : Prerequisite 2102505 or Consent of Faculty
Discrete-time linear quadratic regulator; calculus of variations; continuous-time linear quadratic regulator; time-optimal control; constrained control input problem; the Pontryagin's maximum principle; singular control; dynamic programming; optimal controller design; computational methods in optimal controller synthesis.

2102632 Stochastic Control Systems 3(3-0-9)
Condition : Prerequisite 2102502 or Consent of Faculty
Review of probability; laws of large numbers; linear state-space models driven by white noise; sequential decision making via dynamic programming; unified approach to optimal control of stochastic dynamic systems; applications to LQG control; Kalman filter and its properties; implementation issues, including the solution of the Riccati equation; nonlinear filtering filtering and the extended Kalman filter.

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, controllability, observability; internal stability of interconnected systems; state feedback; linear quadratic regulation; observers and observer-based compensation; introduction to nonlinear systems.

2102637 Multivariable Control Systems 3(3-0-9)
Condition : Consent of Faculty
Performance issues in multivariable systems; uncertainties and robustness; multivariable control system designs: frequency domain methods, LOG and LTR methods, parameter optimization methods; H_2 and H_2 control; model reduction.

2102638 Nonlinear Control Systems II 3(3-0-9)
NONLIN CONT SYS II
Condition : Consent of Faculty
Input-output stability; small gain theorems; basic of differential geometry; feedback linearization; geometric nonlinear control theory; nonlinear control system design.

2102641 Computer-Aided Analysis Of Electronic Circuits 3(3-0-9)
Condition : Consent of Faculty
Methods for formulating circuit equations; modified nodal analysis; methods for solving matrix equation; AC analysis of linear circuits; methods for finding DC operating point of nonlinear circuits; time domain simulation of nonlinear dynamical circuits; computation of sensitivities of circuit variable with respect to parameters; symbolic analysis of linear circuits.

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.

2102645 Embedded System Design 3(3-0-9)
Condition : Consent of Faculty
Practical examples; performance evaluation; complex system designs: automotive, multimedia, biomedical instrumentation, measurement instrumentation, and robot.

2102650 Electrical Transient in Power Systems 3(3-0-9)
Condition : Consent of Faculty
Introduction to electrical transient; switching transient: simple and abnormal switch transients, transients in three phase circuits; transient in conversion equipment; electromagnetic phenomena undertransient conditions; lighting effects on power systems; traveling wave on transmission line; effects of transient voltage on transformerwindings; protection of systems and equipment against transient overvoltage and insulation co-ordination; computer aids to the calculation of electrical transients.

2102651 Power System Stability 3(3-0-9)
Condition : Prerequisite 2102461 or Consent of Faculty
Basics and descriptions of power system stability problems; mathematical reviews of state-space analysis and numerical integration; reference frame theory; synchronous machine representation in stability studies; power network representations and characteristics; excitation system components and functions; active power and frequency control; transient stability; small-signal stability; methods of improving transient and small-signal stability.

2102656 Power System Protection 3(3-0-9)
Condition : Consent of Faculty
Principles of power system protection; relays and their operating principles and characteristics; and protection of generators, motors, transformers, buses and lines.

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 solar cells; gallium arsenide solar cells; Cu2S/CdS. solar cells; photovoltaic system design; concentrated sunlight system; photovoltaic system 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 engineering for both fundamental research and process development in industrial production.

2102674 Optical Communication 3(3-0-9)
Condition : Consent of Faculty
An outline of optical communication systems; properties of laser light; characteristics of optical communication; fundamentals of optical fiber; light sources; modulation and demodulation; optical devices; optical communication and applications.

2102675 Pattern Recognition 3(3-0-9)
Condition : Prerequisite 2102284 or Consent of Faculty
Statistical pattern recognition: linear discriminant functions, Bayesian decision theory, maximum-likelihood and Bayesian parameter estimation.

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.

2102677 Broadband Network And Design 3(3-0-9)
Condition : Consent of Faculty
Demand for ATM broadband network; ATM fundamentals; ATM broadband network operation, administration and maintenance (OAM) fundamentals;

ATM network management; quality of service (QoS) and ATM performance; policing in ATM networks; 3G/4G wireless network architectures; next-generation wireless networks; wireless access technologies; demand for broadband network services; network design approaches; introductory graph theory and topological design; campus/LAN/WAN design; leased-line network consideration; requirements definition and service provider selection; network planning and management; network design project management.

2102680 Semiconductor Lasers 3(3-0-9)
Condition : Prerequisite 2102620 and
2102385 or Consent of Faculty
A review of semiconductor physics; optical process in semiconductor; junction theory; waveguide theory; coupler-mode theory; fundamental of semiconductor lasers ; semiconductor laser structure and its characteristics; quantum well lasers; dynamic single-mode lasers; vertical cavity surface emitting lasers; array lasers; quantum wire and quantum dot lasers; quantum cascade lasers; semiconductor laser modeling; the fabrication technology of semiconductor lasers.

2102682 Solid-State Physics for
Electronics Engineers 3(3-0-9)
Condition : Consent of Faculty
Crystal structures and lattices; dynamics of crystal lattices; lattice vibration and thermal properties of crystals; crystalline defects; elementary quantum mechanics; 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; magnetism and magnetic resonances; superconductivity; optical properties of materials.

2102684 Guided-Wave Optics and
Nanophotonics 3(3-0-9)
Condition : Consent of Faculty
Optical waveguides : planar, two-dimensional and three-dimensional waveguides; interaction between optical waveguides; optical waveguide devices; photonic crystals and photonic band gaps; photonic-crystal fibers and supercontinuum light generation; structures and optical properties of quantum nanostructures: quantum wells, quantum wires, quantum dots, and interaction between these structures; their applications in nanoelectronic and nanophotonic devices; coupled quantum nanostructures.

2102686 Switched-Mode Electrical Power
Processing II 3(3-0-9)
Condition : Prerequisite 2102548 or
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;

2102697 Special Problems in Electrical
Engineering II 3(3-0-9)
Condition : Consent of Faculty
Special problems in various fields of electrical engineering.

2102731 Infinite-Dimensional Control System
3(3-0-9)
Condition : Consent of Faculty
Semigroup theory and infinitesimal generator; Hille-Yosida theorem; contractive semigroups; dual semigroups; Riesz-spectral operators; invariant subspaces; problem formulation: abstract Cauchy problem, perturbed systems and composite systems; boundary control; basic system properties; stability, controllability, observability, exponential stabilizability and detectability; compensator design for infinite-dimensional systems.

2102732 Convex Optimization and
Engineering Applications 3(3-0-9)
Condition : Prerequisite 2102505 or
Consent of Faculty
Convex sets, functions, and optimization problems; basics of convex analysis; least-squares, linear and quadratic programs, semidefinite programming, minimax, extremal volume, and other problems; localization methods: cutting-plane, ellipsoid algorithms; optimality conditions, duality theory, theorems of alternative, and applications; interior-point methods; applications to control systems and other engineering topics.

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

2102755 Power System Electromagnetic
Transient Simulation 3(3-0-9)
Analysis of power system transient phenomena: lightning surges, switching surges, temporary overvoltage; modeling technique of lines and cables, transformers, rotating machines, arresters, protective systems.

2102757 Power System Reliability 3(3-0-9)
Condition : Consent of Faculty
Reliability evaluation and reliability indices; comparison between deterministic and probabilistic criterias; operating state modeling of power system equipment; generation system modeling; generation system reliability evaluation; generation system expansion planning; interconnection system reliability evaluation; operating reserve; composite system reliability evaluation; distribution system reliability evaluation.

2102770 Wireless Communications and
Networking 3(3-0-9)
Overview of future broadband wireless systems for voice video data and multimedia services; wireless channel characterization, narrowband and wideband; techniques for combating fading: adaptive equalizer, channel coding and diversity; spread spectrum, mutlicarrier modulation, CDMA, OFDM, multiuser systems,

multiple input/output systems (MIMO), adaptive modulation; wireless networks: IEEE802 wireless LANs, cellular mobile phone systems design, PDAs, smart homes and appliances, sensor networks, automated motorways, Ad-Hoc networks design and applications.

**2102774   Telecommunications Switching,
              Transmission and Signaling   3(3-0-9)**
Telecommunications traffic; congestion; mathematical model of telecommunications traffic; lost-call systems; queuing systems; switching networks; single-stage networks; gradings; link systems; grades of service of link systems; non-blocking networks; space and time switching; time-division switching networks; grades of service of time-division switching networks; non-blocking time-division switching networks; synchronization; telecommunications transmission systems; transmission of the 64-kbps signal; PCM primary rate transmission; higher order PCM transmission; optical fiber transmission system; SDH transmission system; subscriber networks; signaling; signalling networks; signalling system No. 7 levels.

2102785   Advanced Sensor Theory   3(3-0-9)
Condition : Consent of Faculty
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.

2102790   Electrical Engineering Seminar   2(2-0-6)
Condition : Consent of Faculty
Seminar in current research topics in electrical engineering including technical writing and presentation techniques of research works and thesis. Literature reviews of international journal papers relevant to the research topic. Submit a summary report in the forms of technical paper and thesis proposal which describes the motivation, problem formulation, main results and, examples.

2102791   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.

2102792   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.

2102793   Electrical Engineering Seminar III 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.

2102794   Electrical Engineering Seminar IV 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.

**2102796   Advanced Topics in Electrical
              Engineering I   3(3-0-9)**
Interesting topics or new developments in the field of electrical engineering.

**2102797   Advanced Topics in Electrical
              Engineering II   3(3-0-9)**
Interesting topics or new developments in the field of electrical engineering.

2101874   Speech Processing   3(3-0-9)
Condition : Consent of Faculty
Sampling; scalar quantization; vector quantization; speech modeling; speech perception; psychoacoustic; waveform coding; vocoders; hybrid coding; feature extraction; phonemes; statistical model training (HMM); speaker verification; text-to-speech (TTS); noise reduction techniques.

2101875   Digital Video Processing   3(3-0-9)
Condition : Consent of Faculty
Analog and digital video; video sampling and rate conversion; video modeling; two-dimensional motion estimation; foundation of video coding: binary coding, quantization, transform coding; image and video compression standards; error control in video communications.

2101876   Adaptive Signal Processing   3(3-0-9)
Condition : Consent of Faculty
Adaptive filtering and linear time-invariant filters together with their applications; linear optimum filtering including the principle of orthogonality and minimum mean-squared error performance criterion; least-mean-square (LMS) algorithm, and the method of least-squares and recursive least-squares.

2102813	Thesis	18 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)

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 development of the country.

Its integrated educational 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;
  o conceptualization of objectives and constraints,
  o identification of governing physical principles,
  o application 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 three degreed programs (Bachelor of Engineering, B.Eng.) in Mechanical Engineering, Automotive Engineering, and Naval Architecture and Marine Engineering, at the undergraduate level. At the graduate level, the department offers a Master of Engineering (M.Eng.) and a Doctor of Philosophy (Ph.D.), in Mechanical Engineering. Details for each program are given in the following sections.

HEAD:

Witaya   Wannasuphoprasit Ph.D. (Northwestern)

PROFESSORS :

Pramote	Dechaumphai	Ph.D. (Old Dominion)
Somsak	Chaiyapinunt	Ph.D. (Oregon State)
Viboon	Sangveraphunsiri	Ph.D. (Georgia Tech.)

ASSOCIATE PROFESSORS :

Asi	Bunyajitradulya	Ph.D. (UC, Irvine)
Angkee	Sripakagorn	Ph.D. (Washington)
Boonchai	Lertnuwat	D.Eng. (Tokyo)
Chairote	Kunpanitchakit	Ph.D. (Wisconsin-Madison)
Chittin	Tangthiang	Ph.D. (Penn State)
Kanit	Wattanavichien	Ph.D. (University of Melbourne)
Kuntinee	Maneeratana	Ph.D. (London)
Pairod	Singhatanadgid	Ph.D. (Washington)
Pongtorn	Charunyakorn	Ph.D. (Miami)
Phongsaen	Pitakwatchara	Ph.D. (Tokyo)
Ratchatin	Chanchareon	D.Eng. (Chula)
Thitima	Jintanawan	Ph.D. (Washington)
Thanyarat	Singhanart	Ph.D. (Tokyo)

ASSISTANT PROFESSORS :

Alongkorn	Pimpin	D.Eng. (Tokyo)
Chatchai	Hongsa-Utain	Dipl.Ing. (Braunschweig)
Chanat	Ratanasumawong	D.Eng. (Tokyo Tech.)
Chanyaphan	Virulsri	D.Eng. (Tokyo)
Jirapong	Kasivitamnuay	D.Eng. (Tokyo)
Nopdanai	Ajavakom	D. Eng (California)
Niphon	Wansophark	D.Eng. (Chula)
Nuksit	Noomwong	Ph.D. (TUAT)
Pairat	Tangpornprasert	D.Eng. (Tokyo)
Sompong	Putivisutisak	Ph.D. (London)
Sunhapos	Chatranuwathana	Ph.D. (Michigan)
Tul	Manwattana	Ph.D. (Stevens Inst.Of Tech.)
Thanyaatorn	Mekumpornpong	M.Eng.(Canterbury)
Witaya	Wannasuphoprasit	Ph.D. (Northwestern)
Werayut	Srituravanich	Ph.D. (UCLA)

LECTURERS :

Chirdpun	Vitooraporn	Ph.D. (M.I.T.)
Tawan	Paphapote	M.S. (Illinois)
สวัล ศาลากิจ		Ph.D. (U.S.A.)
กฤษฎา พนมเชิง		Post Doc. (U.S.A.)
สุรัฐ ขวัญเมือง		Ph.D. (U.S.A.)

MECHANICAL ENGINEERING UNDERGRADUATE PROGRAMS

The general aim of the Department of Mechanical Engineering is to give the student an understanding of theoretical principles and also, through experiment and design work, to provide him/her with confidence in solving practical problems. In accordance with the credit system of study, the Department provides an undergraduate curriculum for three programs: Mechanical Engineering, Naval Architecture and Marine 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 in order 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   147   credits

1.	General Education	30	credits
2.	Basic Science	27	credits
3.	Basic Engineering Science	26	credits
4.	Program Core Courses	46	credits
5.	Elective Courses	12	credits
6.	Free Electives	6	credits

Naval Architecture and Marine Engineering Program

Total credits for graduation   148   credits

1.	General Education	30	credits
2.	Basic Science	27	credits
3.	Basic Engineering Science	26	credits
4.	Program Core Courses	53	credits
5.	Elective Courses	6	credits
6.	Free Electives	6	credits

Automotive Engineering Program

Total credits for graduation   147   credits

1.	General Education	30	credits
2.	Basic Science	27	credits
3.	Basic Engineering Science	26	credits
4.	Program Core Courses	52	credits
5.	Elective Courses	6	credits
6.	Free Electives	6	credits

STUDY PROGRAM:
MECHANICAL ENGINEERING
FIRST YEAR CURRICULUM
COMMON TO ALL ENGINEERING STUDENTS

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER			**SIXTH SEMESTER**	
2103211	STATICS	3	2100311	ENG ESSENTIALS	3
2103241	THERMODYNAMICS I	3	2102391	ELEC ENG I	3
2301215	MULTIVARIABLE CALCULUS	3	2102392	ELEC ENG LAB I	1
2301216	LINEAR ALGEBRA AND		2103320	DES MECH ELEM	3
	DIFFERENTIAL EQUATIONS	3	2103361	EN THERM DESIGN I	3
2603284	STAT PHYS SCIENCE	3	2103433	INTRO MECH VIBRAT	3
xxxxxxx	GENERAL EDUCATION	3	2103460	ME EXP LAB III	2
		18			**18**
				SUMMER SEMESTER	
	FOURTH SEMESTER		2100301	ENG PRACTICE	2
2103212	DYNAMICS	3		**SEVENTH SEMESTER**	
2103231	MECH OF MAT I	3			
2103260	ME EXP LAB I	2	2103325	ME DES PROJ	2
2103305	MFR PROC ME	3	2103409	INTRO MECHANICS	3
2103351	FLUID MECHANICS I	3	2103489	MECH ENG PRE-PROJECT	1
5500208	COM PRES SKIL	3	5500308	TECH WRIT ENG	3
xxxxxxx	GENERAL EDUCATION	3	xxxxxxx	ELECTIVE ELECTIVIES	6
		20	xxxxxxx	GENERAL EDUCATION	3
					18
	FIFTH SEMESTER				
2103301	DES MTHD ME	3		**EIGHTH SEMESTER**	
2103304	AUTO CONTROL I	3			
2103306		3	2103499	MECH ENG PROJECT	3
2103322	MECH MACHINERY	3	OR 2100499	ENG PROJECT	3
2103360	ME EXP LAB II	2	XXXXXXX	APPROVED ELECTIVES	3
2103463	HEAT TRANSFER	3	XXXXXXX	GENERAL EDUCATION	6
		18	XXXXXXX	FREE ELECTIVES	3
					18

TOTAL CREDITS FOR GRADUATION = 147

STUDY PROGRAM :
AUTOMOTIVE ENGINEERING
FIRST YEAR CURRICULUM
COMMON TO ALL ENGINEERING STUDENTS

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER			**SIXTH SEMESTER**	
2103211	STATICS	3	2100311	ENG ESSENTIALS	3
2103241	THERMODYNAMICS I	3	2102391	ELEC ENG I	3
2301215	MULTIVARIABLE CALCULUS	3	2102392	ELEC ENG LAB I	1
2301216	LINEAR ALGEBRA AND		2103320	DES MECH ELEM	3
	DIFFERENTIAL EQUATIONS	3	2103482	MECH VEHICLES II	3
2603284	STAT PHYS SCIENCE	3	2103393	ME LAB NON ME	1
XXXXXXX	GENERAL EDUCATION	6	2103433	INTRO MECH VIBRAT	3
		18	2103471	INTER COMB ENGIN	3
					20
	FOURTH SEMESTER			**SUMMER SEMESTER**	
2103212	DYNAMICS	3	2100301	ENG PRACTICE	2
2103231	MECH OF MAT I	3			
2104257	MFR PROC	3			
2104258	MFR PROC LAB	1		**SEVENTH SEMESTER**	
2103351	FLUID MECHANICS I	3			
2103481	AUTOMOTIVE ENG	4	2103483	AUTOMOTIVE SYS DES	3
5500208	COM PRES SKIL	3	2103461	AE ENG LAB	2
		20	2103555	ENGINE EMIS & CONT	3
			2103489	MECH ENG PRE-PROJECT	1
	FIFTH SEMESTER		5500308	TECH WRIT ENG	3
			XXXXXXX	ELECTIVES COURSES	3
2103382	MECH VEHICLES I	3	XXXXXXX	GENERAL EDUCATION	3
2103408	AUTOMOTIVE CONTROL	3			**18**
2103335	VEH STRUC ANAL I	3			
2103322	MECH MACHINERY	3		**EIGHTH SEMESTER**	
2103463	HEAT TRANSFER	3			
XXXXXXX	GENERAL EDUCATION	3	2103499	MECH ENG PROJECT	3
		18	XXXXXXX	ELECTIVES COURSES	3
			XXXXXXX	GENERAL EDUCATION	3
			XXXXXXX	FREE ELECTIVES	6
					15

TOTAL CREDITS FOR GRADUATION = 147

STUDY PROGRAM:
NAVAL ARCHITECTURE AND MARINE ENGINEERING
FIRST YEAR CURRICULUM
COMMON TO ALL ENGINEERING STUDENTS

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER			**SIXTH SEMESTER**	
2103211	STATICS	3	2100311	ENG ESSENTIALS	3
2103241	THERMODYNAMICS I	3	2102391	ELEC ENG I	3
2301215	MULTIVARIABLE CALCULUS	3	2102392	ELEC ENG LAB I	1
2301216	LINEAR ALGEBRA AND		2103320	DES MECH ELEM	3
	DIFFERENTIAL EQUATIONS	3	2103332	SHIPBUILDING ENG	3
2603284	STAT PHYS SCIENCE	3	2103352	SHIP BUOY & STAB	3
XXXXXXX	GENERAL EDUCATION	3	2103361	EN THERM DESIGN	3
		18			**19**
				SUMMER SEMESTER	
	FOURTH SEMESTER				
			2100301	ENG PRACTICE	2
2103212	DYNAMICS	3			
2103231	MECH OF MAT I	3		**SEVENTH SEMESTER**	
2103260	ME EXP LAB I	2			
2103305		3	2103437	SHIP DESIGN I	3
2103351	FLUID MECHANICS I	3	2103473	SHIP RESIS & POWER	3
5500208	COM PRES SKIL	3	2103443	REFRIGERATION	3
XXXXXXX	GENERAL EDUCATION	3	2103489	MECH ENG PRE-	
		20		PROJECT	1
			XXXXXXX	ELECTIVES COURSES	3
			XXXXXXX	GENERAL EDUCATION	3
	FIFTH SEMESTER		XXXXXXX	FREE ELECTIVES	3
					19
2103304	AUTO CONTROL I	3			
2103322	MECH MACHINERY	3		**EIGHTH SEMESTER**	
2103462	FLUID MECHANICS II	3			
2103463	HEAT TRANSFER	3	2103471	INTER COMB ENG	3
5500308	TECH WRIT ENG	3	2103433	INTRO MECH VIBRAT	3
XXXXXXX	GENERAL EDUCATION	3	2103499	MECH ENG PROJECT	3
		18	2103393	ME LAB NON ME	1
			XXXXXXX	ELECTIVES COURSES	3
			XXXXXXX	FREE ELECTIVES	3
					16

TOTAL CREDITS FOR GRADUATION = 147

APPROVED ELECTIVES FOR UNDERGRADUATE PROGRAMS FOR 2016

Mechanical Engineering				Naval Architecture and Marine Engineering	Automotive Engineering
2102505	2103302	2103404	2103510	2103304	2103302
2102532	2103363	2103405	2103530	2103314	2103303
2102537	2103364	2103406	2103532	2103331	2103314
2103204	2103371	2103407	2103535	2103362	2103362
2104303	2103382	2103421	2103540	2103371	2103382
		2103432	2103541	2103421	2103411
		2103433	2103542	2103431	2103412
		2103443	2103543	2103432	2103413
		2103454	2103544	2103433	2103414
		2103455	2103545	2103438	2103415
		2103462	2103552	2103463	2103416
		2103464	2103555	2103454	2103421
		2103465	2103560	2103484	2103433
		2103466	2103566	2103494	2103434
		2103467	2103567	2103495	2103465
		2103471	2103570	2103496	2103467
		2103472	2103571	2103497	2103472
		2103475		2103498	2103474
		2103476		2104200	2103479
		2103477		2103472	2103480
		2103478		2103560	2103483
		2103479			2103488
		2103481			2103489
		2103485			2103494
		2103486			2103495
		2103487			2103496
		2103494			2103497
		2103495			2103498
		2103496			2109418
		2103497			2103510
		2103498			2103532
					2103540
					2103541
					2103555
					2103556
					2103557
					2103558
					2103559

Remark : Approved electives are subjected to change and will be announced by the department.

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.

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

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.

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 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, and 18 credits for thesis. One of the three programs below must be chosen:
1. Solid Mechanics area of study
2. Heat Transfer/Thermodynamics/Fluids area of study
3. Control/Dynamics/Manufacturing area of study

A small successful candidate must obtain an overall grade point average of at least 3.00.

For both programs, a period of study is not more than 8 regular semesters. The student must also demonstrate his or her power of the original thought and ability to organize his or her finding by presenting an acceptable thesis accompanied by an oral examination.

Students are also required to pass the thesis proposal within 4 regular semesters otherwise they will be dismissed from the Department according to the Graduate School Regulation.

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

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

2.1) 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(2-3-4)
2103541	Vibration Monitoring and Analysis	3(2-3-4)
2103542	Radiographic Testing	3(2-3-4)
2103543	Ultrasonic Testing	3(2-3-4)
2103544	Eddy Current Testing	3(2-3-4)
2103545	Surface Method Testing	3(2-3-4)
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(2-3-4)
2103613	Plasticity	3(3-0-9)
2103614	Continuum Mechanics	3(3-0-9)
2103615	Mechanical Vibrations	3(3-0-9)
2103616	Optimum Design of Complex Mechanical Elements	3(3-0-9)
2103618	Theory of Plates	3(3-0-9)
2103619	Theory of Shells	3(3-0-9)
2103620	Theory of Elastic Stability I	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)
2103657	Tribology	3(3-0-9)
2103701	Selected Topics in Mechanical Engineering	3(3-0-9)
2103720	Theory of Elastic Stability II	3(3-0-9)
2103721	Fracture Mechanics	3(3-0-9)

2.2) Heat Transfer/Thermodynamics/Fluid:
9 credits are to be chosen from the

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)
2103605	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)
2103660	Fundamentals of Turbulence	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)

2.3) Control/Dynamics/Manufacturing:
9 credits are to be chosen from the

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)
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	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)
2103535	Mechatronics	3(3-0-9)
2103540	Failure Analysis and Non-destructive Testing	3(2-3-4)
2103541	Vibration Monitoring and Analysis	3(2-3-4)
2103542	Radiographic Testing	3(2-3-4)
2103543	Ultrasonic Testing	3(2-3-4)
2103544	Eddy Current Testing	3(2-3-4)
2103545	Surface Method Testing	3(2-3-4)
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)
2103602	Measurement and Instrumentation	3(2-3-7)
2103604	Advanced Numerical Methods	3(3-0-9)
2103612	Elasticity	3(2-3-4)
2103613	Plasticity	3(3-0-9)
2103614	Continuum Mechanics	3(3-0-9)
2103615	Mechanical Vibrations	3(3-0-9)
2103616	Optimum Design of Complex Mechanical Elements	3(3-0-9)
2103617	Advanced Dynamics	3(3-0-9)
2103618	Theory of Plates	3(3-0-9)
2103619	Theory of Shells	3(3-0-9)
2103620	Theory of Elastic Stability I	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)
2103660	Fundamentals of Turbulence	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)
2103720	Theory of Elastic Stability II	3(3-0-9)
2103721	Fracture Mechanics	3(3-0-9)

5) Thesis

| 2103813 | Thesis | 18 | credits |
| 2103816 | Thesis | 36 | credits |

Ph.D. DEGREE PROGRAM

NAME OF THE DEGREE

: Doctor of Philosophy
: Ph.D.

ADMISSION

1. The applicant must have bachelor degree in mechanical engineering or master degree in mechanical engineering/related fields. The applicant with bachelor degree must have average grade point of not less than 3.25 based on a 4 point grading system or receiving second class honor degree. The applicant with master degree must earn the thesis qualification at the good or excellent level. Both the bachelor and master degree applicants must posses other qualifications which the Doctor of Philosophy Program Committee considers sufficient to enter the programme.
2. The applicant must present three letters of recommendation written by persons who are engaging in teaching the 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, 1981.

DEGREE REQUIREMENTS

The applicant with bachelor degree must take 24 credits of the listed elective courses. The applicant with master degree may take 0-12 credits of the listed elective courses depending on the consideration of the Program Committee. Both the bachelor and master degree applicants are required to submit a dissertation of 48 credits and satisfactory pass an oral examination. In addition, the applicant must fulfill the requirements of the graduate school by passing the English examination and publishing technical paper in an international journal.

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)
2103613	Plasticity	3(3-0-9)
2103614	Continuum Mechanics	3(3-0-9)
2103615	Mechanical Vibrations	3(3-0-9)
2103616	Optimum Design of Complex Mechanical Elements	3(3-0-9)
2103617	Advanced Dynamics	3(3-0-9)
2103618	Theory of Plates	3(3-0-9)
2103619	Theory of Shells	3(3-0-9)
2103620	Theory of Elastic Stability I	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)
2103660	Fundamentals of Turbulence	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 Computationl Fluid Dynamics	3(3-0-9)
2103701	Selected Topics in Mechanical Engineering	3(3-0-9)
2103720	Theory of Elastic Stability II	3(3-0-9)
2103721	Fracture Mechanics	3(3-0-9)

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)

2103106   Engineering Drawing   3(1-4-4)
Introduction, Lettering, Apply geometry, Orthographic projection principle, Orthographic writing, Pictorial sketching, Orthographic reading, Dimensioning, Threaded fastener, Assembly drawing, Introduction to computer-aid drafting.

2103211   Statics   3(3-0-6)
Force system; resultants; equilibrium; structures and machines; distributed forces; friction, friction in machines; principle of virtual work; stability.

2103212   Dynamics   3(3-0-6)
Condition: Corequisite 2103211 or 2103213
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; fundamental theory of vibration; free vibration and natural frequency.

2103231   Mechanics of Materials I   3(3-0-6)
Condition : Corequisite 2103211 or 2103213
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.

2103241   Thermodynamics I   3(3-0-6)
Some introductory comments, some concepts and definitions, properties of pure substances, work and heat, the first law of thermodynamics, the first law analysis for a control volume, the second law of thermodynamics, entropy, second law analysis for a control volume, power and refrigeration system.

**2103260   Mechanical Engineering Experimentation
        and Laboratory I   2(1-3-2)**
Understanding the configuration and underlying principles/theories of mechanical engineering devices or systems; basic knowledge in measurement and instrumentation; basic concept in experimentation; conducting simple experiments using simple devices or systems.

**2103301   Design Methodology for Mechanical
        Engineering   3 (2-2-5)**
Design process; defining design problems, conceptual design, evaluating conceptual design; configuration design; introduction to simple mechanisms and mechanical devices; standard parts in mechanical works; conceptual design project.

**2103303   Numerical Methods for Mechanical
        Engineering   3(3-0-6)**
Digital computer 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.

**2103305   Manufacturing Process for Mechanical
        Engineering   3(2-2-5)**
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.

**2103306   Computer-Aided Mechanical
        Engineering Design   3(3-0-6)**
Use of computer-aided engineering for design and analysis of mechanical engineering problems. Physical modeling and simulations of mechanical engineering problems and related applications. Numerical methods for analysis, modeling and design of mechanical engineering problems

2103320   Design of Mechanical Elements   3(3-0-6)
Condition : Prerequisite 2103231
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.

**2103325   Mechanical Engineering Design
        Project   2(0-4-2)**
Condition : Corequisite 2103320,2103322 and 2103361
Conducting a practical interesting design; project presentation and complete report writing.

2103331   Ship Strength I   3(3-0-6)
Quasi-static analysis of hull primary response; introduction to the probabilistic approach and strength of plated structures and ship's structural components; combined stresses and failure theories; framing systems; brittle fracture and fatigue failure modes; structural details; midship section synthesis, including classification society rules and techniques of stress superposition, material and fabrication consideration.

2103332   Shipbuilding Engineering   3(3-0-6)
Ship types; shipbuilding materials and material testing; classification societies and related regulation; welding and cutting processes in shipbuilding; classification society weld testing; fabrication of main

ship structural items; keel and bottom construction; shell plating, framing systems and decks; bulkheads and pillars; superstructures, etc.; fabrication of minor ship structural items; pumping and piping system; ventilation, refrigeration and insulation; shipbuilding process; shipyard layout and facilities; shipbuilding quality control; shipyard management and organization; industrial relations and psychology.

2103342   Thermodynamics II   3(3-0-6)
Condition: Prerequisite 2103241
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 2103241
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.

2103352   Ship's Buoyancy and Stability   3(2-3-4)
Condition: Corequisite 2103351
Ship geometry; ship's lines, nomenclature of form floatation; buoyancy; computations of areas, volumes and moments, the properties of floating bodies, hydrostatic curves; equilibrium and initial stability: equilibrium of floating objects,initial stability, metacentric radius, the inclining experiment, trim, stability curves; cross curves, stability characteristics; weight effects of stability; weight effects of stability; weight addition weight removal, grounding and docking; impaired stability and control of damage, free surface, flooding, permeability, estimate of the damaged ship's condition.

2103360   Mechanical Engineering Experimentation
and Laboratory II   2(1-3-2)
Condition : Prerequisite 2103260
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 and evaluating the results of the application of such principles and theories in thermodynamics, fluid or solid mechanics systems.

2103361   Energy and Thermal-Fluid System
Design I   3(3-0-6)
Condition : Prerequisite 2103241 and 2103351
Characteristics and performance of energy thermal-fluid systems; analysis; modeling; energy

transformation; design constraints; economic concept in engineering design; parametric study; introduction to optimization.

2103382   Mechanics of Vehicles I   3(3-0-6)
Condition: Prerequisite 2103211
Dynamics of wheels; vehicle's resistance forces and power requirement; performance & fuel consumption; dynamics of breaking.

2103393   Mechanical Engineering Laboratory
For NoN-ME   1(0-3-0)
Condition: Prerequisite 2103241 or 2103295 or 210326121
Experiments are designed to familiarize non mechanical students with experimental technique and instrumentations in the field of mechanical engineering. This course involves students working together in small groups on various experimental problems including gasoline and diesel engines, air compressor, hydraulic pump and turbine, friction loss in pipe and refrigeration cycle.

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.

2103437   Ship Design I   3(3-0-6)
Condition: Prerequisite 2103352
Ship types and rules of construction, international convention, ship owner's requirement, choice of vehicles; tendering and specifications; general design characteristics; estimation of principal parameters and dimensions; mass equations and estimation of masses, capacities, stability and trim; body plan design, choice of form and modification; producing of line plan general arrangement, inboard, inboard profile, out board profile, transverse sections through engine room and others; engine foundations, sturntube, struts, propellers rudders; engine room layout, piping systems; electric and electronic system, refrigerating systems and others.

2103460 Mechanical Engineering Experimentation
and Laboratory III (ME EXP LAB III) 2(1-3-2)
Condition: Prerequisite 2103360
Concepts in experimentation and design of an experiment, setting up specifications and objectives of an experiment; systematic design of an experiment according to the specifications and objectives using tools such as data reduction diagram (DRD) and uncertainty analysis, and knowledge and application of basic physical principles, and knowledge of instruments and measurement; outlining the process of extracting experimental results and conclusions from the designed experiment; outlining of data collection and data analysis schemes; outlining of experimental project phases, tasks, and schedule; design documentation and review by oral and written presentation; practices in the design of an experiment in the project-based setting; introduction to modern instrumentation and data acquisition through demonstration.

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 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 2103241 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; 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; heat exchanger design; boiling and condensation.

2103471   Internal Combustion Engines   3(3-0-6)
Condition: Prerequisite 2103241

Fundamental of how the design and operation of internal combustion engine effect their performance and fuel requirements. Study of fluid flow, thermodynamics, combustion, heat transfer and friction phenomena, and fuel properties, relevant to engine power, efficiency, and emissions. Examination of design features and operating characteristics of different types of engine: spark-ignition, compression-ignition.

2103473   Ship Resistance and Powering   3(3-0-6)
Condition: Prerequisite 2103351

Frictional resistance, residuary resistance, wave making resistance, Froude's law of comparison; model tests; powering of ships; estimation of effective horse power; propulsion and propellers horsepower, wake thrust deduction, hull efficiency, propellers, geometry of the screw propeller, propellers and law of similarity, design procedure.

2103481   Automotive Engineering   4(3-3-6)
Condition : Consent of Faculty

Basic principles; suspension system ; body and chassis, brake system; steering system; front wheel geometry; transmission system, automotive equipment; performance factors.

2103483   Automotive System Design   3(1-4-4)
Condition: Prerequisite 2103320

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.

2103489   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 : Senior Standing or 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.

**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.

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.

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.

2103542 Radiographic Testing 3(2-3-7)
Condition : Consent of Faculty
Nondestructive testing; manufacturing processes and their discontinuities; radiation sources: X-ray, γ-ray, and instruments; radiation principle; radiation safety and protection: biological effects of radiation, safety instruments; radiographic inspection procedures: geometrical unsharpness, contrast and definition, radiation scattering, image quality indicator; film and film processing; film interpretation; inspection standards.

2103543 Ultrasonic Testing 3(2-3-7)
Condition : Consent of Faculty
Nondestructive testing; manufacturing processes and their discontinuities; theory of wave: characteristics and behavior of waves; ultrasonic instruments: probes, operations; ultrasonic inspection procedures: instrument calibration, normal probe inspection, angle probe inspection, immersion testing; inspection standards.

2103544 Eddy Current Testing 3(2-3-7)
Condition : Consent of Faculty
Nondestructive testing; manufacturing processes and their discontinuities; theory of eddy current: impedance plane diagram, correlations between coil impedance and sample properties; eddy current instruments: probes, operations; eddy current inspection procedures: frequency selection, instrument calibration, flat surface inspection, tube inspection; signal analysis; inspection standards.

2103545 Surface Method Testing 3(2-3-7)
Condition : Consent of Faculty
Nondestructive testing; manufacturing processes and their discontinuities; visual testing; liquid penetrant testing; types and properties of penetrant; inspection procedures; quality control and calibration of PT inspection system; inspection standards; magnetic particle testing; theory of magnetism; magnetic induction techniques: circular field, longitudinal field; inspection procedures; quality control and calibration of MT inspection system; inspection standards.

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.

2103557 Catalytic Converters – Theory and Application 3(3-0-9)
Fundamental of pollution formation in IC engine; anatomy of a converter; converter design for optimizing flow; chemical reactions; catalyst performance and application; catalyst deactivation and contamination; performance control and calibration.

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.

**2103601　Advanced Engineering
　　　　　　Mathematics　　　　　3(3-0-9)**
Numerical and graphical methods of approximate solution; finite difference method; calculus of variations, solution of classical partial differential equations of mathematical physics including application of conferral mapping and the Laplace transformation.

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.

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.

2103613　Plasticity　　　　　　3(3-0-9)
*Condition: Prerequisite 2103612 or
　　　　Consent of Faculty*
Stress tensors and tensor notations, yield criteria, stress-strain relations, plastic-elastic problems, introduction to incremental plasticity theory, plane strain compression, slip-line fields, friction effects, extrusion, deep drawing, rolling, limit analysis, upper bound and lower bound solutions.

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 Vibrations　　　3(3-0-9)
One degree of freedom systems; applications of vibration principles to various types of practical problems; multi-degrees of freedom systems, formulation of equation, numerical solving methods, continuous system, non-linear vibration.

**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　Advanced Dynamics　　　　3(3-0-9)
Kinematics and kinetics of particles; variable mass problems; rigid body dynamics; Lagrange's equation; Hamilton's principle; Hamilton's canonical equations; Hamilton-Jacobi theory.

2103618　Theory of Plates　　　　　3(3-0-9)
*Condition: Prerequisite 2103432 or
　　　　Consent of Faculty*
Cylindrical and pure bending of plates, axisymmetrical bending of laterally loaded rectangular and circular plates with various boundary conditions; plates of various shapes, combined bending and stretching of plates.

2103619　Theory of Shells　　　　　3(3-0-9)
*Condition: Prerequisite 2103618 or
　　　　Consent of Faculty*
Stresses and deformations of shells; membrane theory of shells; bending theory of shells of revolution and other shapes.

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 furnances, the use of alternative fuels in transport, engine-fuels matching and optimisation, alternative engines, durability, vehicle fuel storage options, engine-vehicle matching.

2103660   Fundamentals of Turbulence   3(3-0-9)
Stochastic tools in turbulence; Reynolds equations; mean and turbulent kinetic energy equations; Reynolds-stress transport equation; dynamics of one-and two-point velocity correlations; dynamic equation for the energy spectrum; isotropic turbulence; homogeneous shear-flow turbulence; transport processes in turbulent flows.

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 there 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, incompresible 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.

2103720   Theory of Elastic Stability II   3(3-0-9)
Condition: Prerequisite 2103619, 2103620 or Consent of Faculty
Linear and nonlinear theories for shell buckling; stability of thin stiffened and unstiffened plates and cylindrical shells under various loads; edge effects; imperfection sensitivity studies.

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.

2103722   Elasticity II   3(3-0-9)
Condition: Prerequisite 2103612
Torsion, bending of bars, axisymmetric stress and deformation in a solid of revolution, thermal stress, the application of finite difference equations in elasticity, strain energy.

2103723   Plasticity II   3(3-0-9)
Condition: Prerequisite 2103612 and 2103624
Numerical approximation of some elastic-plastic problems, study of residual stresses induced by plastic deformation, shakedown analysis of elastic-plastic system, finite element formulation of small strain elastic-plastic deformation, introduction to large strain elastic-plastic deformation.

2103724   Contact Mechanics   3(3-0-9)
Condition: Prerequisite 2103612
Stress analysis of a wedge loaded along the faces, motion and forces at a point of contact, line loading of an elastic half space, point loading of an elastic half space, normal contact of elastic solids, Hertz theory, non-Hertzian normal contact of elastic bodies, normal contact of inelastic solids, tangential loading and sliding contact, rolling contact of elastic bodies, rolling contact of inelastic bodies.

2103790   Seminar in Mechanical Engineering   1(0-3-1)
Discussion of special topics in the advent of mechanical engineering; written report is required.

2103811   Thesis   12 credits

2103813   Thesis   18 credits

2103816   Thesis   36 credits

2103828   Dissertation   48 credits

2103829   Dissertation   60 credits

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 :

Paveena	Chaovalitwongse,	Ph.D. (Florida)

PROFESSORS :

Parames	Chutima,	Ph.D. (Nottingham)

ASSOCIATE PROFESSORS :

Jittra	Rukijkanpanich,	D.Eng. (A.I.T.)
Jlirapat	Ngaoprasertwong,	M.Sc. (Iowa)
Natcha	Thawesaengskulthai	Ph.D. (Nottingham)
Paveena	Chaovalitwongse,	Ph.D. (Florida)
Somkiat	Tangjitsitcharoen,	D.Eng' (Kobe)
Suthas	Ratanakuakangwan,	E.S.S. (Toulouse)
Wipawee	Tharmmaphornphilas,	Ph.D. (Pittsburgh)

ASSISTANT PROFESSORS :

Angsumalin Senjuntichai,		D.Eng.(A.I.T.)
		M.S.I.E. (Minnesota)
Daricha	Sutivong,	Ph.D. (Stanford)
Haruetai	Mekaroonreung,	MS. (VPI & SU)
Naragain	Phumchusri,	Ph.D. (Georgia Tech)
Napassavong	Osotssilp,	Ph.D. (Wisconsin-Madison)
Oran	Kittithreerapronchai,	Ph.D.(Georgia Tech)
Pramual	Suteecharuwat,	Ph.D. (TITECH)
Prasert	Akkharaprathomphong,	M.Eng. (Keio)

Seeronk	Prichanont,	Ph.D. Wisconsin-Madison)
Somchai	Puajindanetr,	Ph.D.(LONDON)
Surapong	Sirikulvadhana,	MS,EE,MS.IEOR

LECTURERS :

Arisara	Jiamsanguanwong	D.Eng.(Tokyo Tech)
Phairoat	Ladavichitkul,	Ph.D. (Texas Tech)
Pisit	Jarumaneeroj,	Ph.D. (Georgia Tech)
Poom	Luangjarmekorn,	M.Eng. (Nagoya) (Michingan Ann Arbor)
Worachok	Chaiwong,	M.Eng. (Chula)

INDUSTRIAL ENGINEERING
UNDERGRAD PROGRAMS

The department provides two undergraduate programs of study: a general program and a co-operative education program. Similar to all other engineering curriculums, the general program requires 2 credits of engineering practice during the summer semester. The co-operative education program offers a whole semester longer time for students to practice their skills in real workplaces.

INDUSTRIAL ENGINEERING CURRICULUM OF BACHELOR'S DEGREE
FIRST YEAR CURRICULUM
COMMON TO ALL ENGINEERING STUDENTS

GENERAL STUDY PROGRAM

COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER	
2103213	ENGINEERING MECHANICS I	3
2104251	INTRODUCTION TO MANUFACTURING SYSTEMS	2
2104253	ENGINEERING STATISTICS I	3
2301312	DIFFERENTIAL EQUATIONS	3
5500208	COMMUNICATION AND PRESENTATION SKILLS	3
2104255	APPLICATION DEVELOPING FOR INDUSTRIAL ENGINEERING	3
xxxxxxx	FREE ELECTIVE	3
		20

COURSE NO.	SUBJECT	CREDITS
	SIXTH SEMESTER	
2104352	FACILITY DESIGN	3
2104358	INTRODUCTION TO SAFETY ENGINEERING	3
2104354	INDUSTRIAL COST ANALYSIS AND BUDGETING	3
2104359	SIMULATION PROGRAMMING	3
2106362	INDUSTRIAL ENGINEERING LAB II	1
5500308	TECHNICAL WRITING FOR ENGINEERING	3
xxxxxxxx	GENERAL EDUCATION	3
		19

COURSE NO.	SUBJECT	CREDITS
	FOURTH SEMESTER	
2103261	FUNDAMENTALS OF THERMO-FLUID ENGINEERING	3
2103392	ME LAB FOR NON ME	1
2104252	OPERATIONS MANAGEMENT	2
2104254	ENGINEERING STATISTICS II	3
2104256	QUALITY MANAGEMENT	2
2104257	MANUFACTURING PROCESSES	3
2104258	MANUFACTURING PROCESSES LABORATORY	1
2104259	OPERATIONS RESEARCH	3
		18

COURSE NO.	SUBJECT	CREDITS
	SUMMER SEMESTER	
2100301	ENGINEERING PRACTICE	2 (S/U)
		2

COURSE NO.	SUBJECT	CREDITS
	SEVENTH SEMESTER	
2104491	INDUSTRIAL ENGINEERING PRE-PROJECT	1
xxxxxxxx	ELECTIVE	6
xxxxxxxx	GENERAL EDUCATION	6
xxxxxxxx	FREE ELECTIVE	3
		16

COURSE NO.	SUBJECT	CREDITS
	FIFTH SEMESTER	
2102391	ELECTRICAL ENGINEERING I	3
2102392	ELECTRICAL ENGINEERING LABORATORY I	1
2104351	WORK DESIGN	3
2104353	ENGINEERING ECONOMY	3
2104355	COMPUTER AND INFORMATION TECHNOLOGY FOR IE	2
2104356	QUALITY CONTROL	2
2104357	ENGINEERING EXPERIMENTAL DESIGN	3
2104361	INDUSTRIAL ENGINEERING LAB	1
		17

COURSE NO.	SUBJECT	CREDITS
	EIGHTH SEMESTER	
2104409	INDUSTRIAL BUSINESS MANAGEMENT	3
2104425	MAINTANANCE ENGINEERING	3
2104499	INDUSTRIAL ENGINEERING PROJECT	
OR		
2100499	SENIOR PROJECT	3
xxxxxxxx	ELECTIVE	3
xxxxxxxx	GENERAL EDUCATION	3
		15

TOTAL CREDITS FOR GRADUATION = 144

INDUSTRIAL ENGINEERING CURRICULUM OF BACHELOR'S DEGREE
FIRST YEAR CURRICULUM
COMMON TO ALL ENGINEERING STUDENTS

CO-OPERATIVE EDUCATION PROGRAM

COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER	
2103213	ENGINEERING MECHANICS I	3
2104251	INTRODUCTION TO MANUFACTURING SYSTEMS	2
2104253	ENGINEERING STATISTICS I	3
2301312	DIFFERENTIAL EQUATIONS	3
5500208	COMMUNICATION AND PRESENTATION SKILLS	3
2104255	APPLICATION DEVELOPING FOR INDUSTRIAL ENGINEERING	3
xxxxxxx	FREE ELECTIVE	3
		20

	FOURTH SEMESTER	
2103261	FUNDAMENTALS OF THERMO-FLUID ENGINEERING	3
2103392	ME LAB FOR NON ME	1
2104252	OPERATIONS MANAGEMENT	2
2104254	ENGINEERING STATISTICS II	3
2104256	QUALITY MANAGEMENT	2
2104257	MANUFACTURING PROCESSES	3
2104258	MANUFACTURING PROCESSES LABORATORY	1
2104259	OPERATIONS RESEARCH	3
		18

	FIFTH SEMESTER	
2102391	ELECTRICAL ENGINEERING I	3
2102392	ELECTRICAL ENGINEERING LABORATORY I	1
2104351	WORK DESIGN	3
2104353	ENGINEERING ECONOMY	3
2104355	COMPUTER AND INFORMATION TECHNOLOGY FOR IE	2
2104356	QUALITY CONTROL	2
2104357	ENGINEERING EXPERIMENTAL DESIGN	3
2104361	INDUSTRIAL ENGINEERING LAB	1
		18

COURSE NO.	SUBJECT	CREDITS
	SIXTH SEMESTER	
2104352	FACILITY DESIGN	3
2104358	INTRODUCTION TO SAFETY ENGINEERING	3
2104354	INDUSTRIAL COST ANALYSIS AND BUDGETING	3
2104359	SIMULATION PROGRAMMING	3
2106362	INDUSTRIAL ENGINEERING LAB II	1
5500308	TECHNICAL WRITING FOR ENGINEERING	3
xxxxxxxx	GENERAL EDUCATION	3
		19

	SUMMER SEMESTER	
2100301	ENGINEERING PRACTICE	2 (S/U)
		2

	SEVENTH SEMESTER	
2104401	CO-OPERATIVE EDUCATION	6
2104491	INDUSTRIAL ENGINEERING PRE-PROJECT	1
2104499	INDUSTRIAL ENGINEERING PROJECT	
OR		
2100499	SENIOR PROJECT	3
		10

	EIGHTH SEMESTER	
2104409	INDUSTRIAL BUSINESS MANAGEMENT	3
2104425	MAINTANANCE ENGINEERING	3
xxxxxx	ELECTIVE	3
xxxxxxx	GENERAL EDUCATION	9
xxxxxxx	FREE ELECTIVE	3
		21

TOTAL CREDITS FOR GRADUATION = 144

NAME OF THE DEGREE

: Master of Engineering
: M. Eng.

COURSE REQUIREMENTS

1) Required Courses — 6 credits

2104688	Research Methodology in Industrial Engineering and Operations Management	3(3-0-9) (S/U)
2104690	Quantitative Data Analysis for Industrial Engineering	3(3-0-9)

2) Approved Elective — 9 credits

The students must select 2 fields in the approved elective courses with a minimum of 2 subjects in each selected field,.
- Operations Research
- Quality Management and Control
- Production Engineering
- Safety Engineering and Ergonomics
- Industrial Management

Remark: Approved electives and subjects to change, with approval from the committee of the program or Industrial Engineering Department.

- Operations Research
2104523	Introduction to Stochastic Models	3(3-0-9)
2104612	Computer Simulation Technique	3(3-0-9)
2104613	Principle of Optimization	3(3-0-9)

- Quality Management and Control
2104516	Quality Improvement	3(3-0-9)
2104604	Advanced Quality Management	3(3-0-9)
2104615	Engineering Experimental Design	3(3-0-9)

- Production Engineering
2104512	Production and Operations Management Information Systems	3(3-0-9)
2104626	Materials and Processing	3(3-0-9)
2104627	Product and Production Design	3(3-0-9)
2104711	Advanced Manufacturing Engineering	3(3-0-9)

- Safety Engineering and Ergonomics
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)

- Industrial Management
2104601	Engineering Economic Analysis	3(3-0-9)
2104606	Advanced Industrial Organization and Management	3(3-0-9)
2104650	Project Management Concepts	3(3-0-9)

3) Free Elective — 12 credits

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)
2104555	System Safety	3(3-0-9)
2104559	Risk Management for Industry	3(3-0-9)
2104601	Engineering Economic Analysis	3(3-0-9)
2104602	Analysis of Business System	3(3-0-9)
2104603	Advanced Quality Control	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)
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)
2104637	Coordination and Communication	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)
2104650	Project Management Concepts	3(3-0-9)
2104671	Advanced Work Design	3(2-3-71)
2104677	Seminar in Safety Engineering	3(2-3-7)
2104691	Research Problems in Industrial Engineering I (OR techniques)	3(3-0-9)

2104692	Research Problems in Industrial Engineering II (Production techniques)	
		3(3-0-9)
2104693	Research Problems in Industrial Engineering III (Management Techniques)	
		3(3-0-9)
2104694	Research Problems in Industrial Engineering IV (Safety)	3(3-0-9)
2104711	Advanced Manufacturing Engineering	
		3(3-0-9)
2104723	Artificial Intelligence for Industrial Engineering	3(3-0-9)
2104741	Comparative Engineering Management	3(3-0-9)

Remark : The student can select other courses offered by the Industrial Engineering, which will be announced by Industrial Engineering Department.

2104811	Thesis	12 credits

INDUSTRIAL ENGINEERING CURRICULUM OF MASTER'S DEGREE

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
	FIRST SEMESTER			**THIRD SEMESTER**	
2104688	RES METHOD IEOM	3	2104811	THESIS	3
2104690	QUAN DATA ANAL IE	3	xxxxxxx	FREE ELECTIVES	6
xxxxxxx	APPROVED ELECTIVES	6			9
		12			
	SECOND SEMESTER			**FOURTH SEMESTER**	
xxxxxxx	APPROVED ELECTIVES	3	2104811	THESIS	6
2104811	THESIS	3	xxxxxxx	FREE ELECTIVES	3
xxxxxxx	FREE ELECTIVES	3			9
		9			

TOTAL CREDITS FOR GRADUATION = 39

INDUSTRIAL ENGINEERING CURRICULUM OF DOCTORAL DEGREE

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
	FIRST SEMESTER			**FOURTH SEMESTER**	
2104781	DOCTORAL SEMINAR IN INDUSTRIAL ENGINEERING I	(1)*	2104784	DOCTORAL SEMINAR IN INDUSTRIAL ENGINEERING IV	(1)*
2104828	DISSERTATION	6	2104828	DISSERTATION	9
		7			10
	SECOND SEMESTER			**FIFTH SEMESTER**	
2104782	DOCTORAL SEMINAR IN INDUSTRIAL ENGINEERING II	(1)*	2104785	DOCTORAL SEMINAR IN INDUSTRIAL ENGINEERING V	(1)*
2104828	DISSERTATION	6	2104828	DISSERTATION	9
		10			10
	THIRD SEMESTER			**SIXTH SEMESTER**	
2104783	DOCTORAL SEMINAR IN INDUSTRIAL ENGINEERING III	(1)*	2104786	DOCTORAL SEMINAR IN INDUSTRIAL ENGINEERING VI	(1)*
2104828	DISSERTATION	9	2104828	DISSERTATION	9
2104897	QUALIFYING EXAM	0			10
		10			

TOTAL CREDITS FOR GRADUATION = 48

Remarks : (1)* Credits for this course are not assessed towards the degree program

(3)* Credits for this course are not assessed towards the degree program

COURSE DESCRIPTIONS IN INDUSTRIAL ENGINEERING (B.ENG.)

2104204   General Manufacturing Process Lab
1(0-3-0)
Basic measuring equipment and general manufacturing process; drawing and reading designs for work operation: use of tools in designing and work operation and use of machine for manufacturing: turning machine, milling machine, drilling machine; designing and manufacturing parts and conclusion of work operation in the manufacturing process.

2104251   Introduction to Manufacturing
Systems   2(2-0-4)
Manufacturing systems overview; systematic problem solving ; modeling in IE and performance measurement; basic IE tools and techniques; management concepts in manufacturing systems; push and pull manufacturing concepts; logistics and supply chain management.

2104252   Operations Management   2(2-0-4)
Condition: Prerequisite 2104251 or
Consent of Faculty
Operations strategies, inventory and distribution management, capacity management, aggregate planning, master production scheduling, material requirements planning, operation scheduling, project management.

2104253   Engineering Statistics I   3(3-0-6)
Basis Engineering in Descriptive statistics; probability; discrete probability distributions; continuous probability distributions; joint probability distributions; point estimation; interval estimation; hypothesis and statistical inference for one population; engineering applications.

2104254   Engineering Statistics II   3(3-0-6)
Condition: Prerequisite 2104253 or
Consent of Faculty
Basis Engineering in Hypothesis and statistical inference for two populations; analysis of variance; randomized blocks; latin square design; goodness of fit test; non-parametric statistics; linear regression analysis; time- series analysis; engineering applications.

2104255   Application Developing for
Industrial Engineering   3(2-3-4)
Condition: Prerequisite 2110101 or
Consent of Faculty
Application Developing for Industrial Engineering; object-oriented programming; event-driven programming; application developing from data structure and algorithm; application design.

2104256   Quality Management   2(2-0-4)
Quality philosophy; quality management strategies: total quality management (TQM), Six Sigma; quality system management: ISO, Thailand Quality Award (TQA); problem solving tools; team building techniques; organizing for quality.

2104257   Manufacturing Processes   3(3-0-6)
Introduction to manufacturing industry; economic principles of manufacturing processes; mechanical

characterization of materials; casting; metal forming: rolling, metal drawing, extrusion, forging, cold forming; machining: turning, shaping and planning, milling, grinding; non-traditional machining; metal cutting: tool shape, forces and power requirement in metal cutting; tool's life equations; power metallurgy and cutting tool material; welding technology and welding inspection; CNC technology.

2104258   Manufacturing Processes
Laboratory   1(0-3-0)
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.

2104351   Work Design   3(2-3-4)
Fundamentals of method, work and process analysis; line balancing; collection of operation data, process improvement through the use of flow process chart; operation process chart (assembly process chart), Gantt chart, multi-activity chart, motion Study (micro motion study), introduction to anthropometry, work physiology and biomechanics, macro and temporal ergonomics, guidelines for design and organization of work stations, guidelines for manual material handling and hand tools, guidelines for controls and displays, principles of motion economy, proposed method implementation, learning curves, stopwatch time study, performance rating and allowances, standard data and formulas, predetermined time systems, work sampling, indirect and expense labor standards.

2104352   Facility Design   3(3-0-6)
Condition: Prerequisite 2104351 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 handing, machine, man, selection of facility location.

2104353   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.

2104354 Industrial Cost Analysis and Budgeting
3(3-0-6)
Condition: Prerequisite 2104353 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.

**2104355   Computer and Information Technology
for Industrial Engineering   2(1-3-2)**
*Condition: Prerequisite 2110101 or
Consent of Faculty*
Database system; network systems; information communication technology; network application development

2104356   Quality Control   2(2-0-4)
*Condition: Prerequisite 2104253 and
2104254 or Consent of Faculty*
Quality control philosophy; methods of statistical quality control: control charts, process capability analysis, measurement system analysis, acceptance sampling; product reliability.

2104357   Engineering Experimental Design 3(3-0-6)
*Condition: Prerequisite 2104254 or
Consent of Faculty*
Factorial design; 2^k factorial design; blocking and confound: fractional factorial design; factorial experiments with random factors; nested and split-plot design; non-linear regression analysis; response surface analysis.

2104358   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.

2104359   Simulation Programming   3(3-0-6)
*Condition: Prerequisite 2104253,
2104254 or Consent of Faculty*
Probabilistic operations research in industrial engineering problem solving with emphasis on the use of simulation; queuing theory; and inventory model.

2104361 Industrial Engineering Laboratory 1(0-3-0)
Laboratory work related to design, assign, control, and evaluation of work considering productivity and quality aspects.

2104362 Industrial Engineering Laboratory II 1(0-3-0)
Laboratory work related to design, assign, control, and evaluation of work considering productivity, safety and cost aspects.

2104391   Materials Technology I   3(2-3-4)
*Condition: Prerequisite 2104257 or
Consent of Faculty*
Various production techniques of material powders, manufacturing techniques of metal and ceramic components from powders, powder characterization techniques, mechanical properties of components in relation to micro-structure production and physical properties of inorganic glasses.

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.

**2104408   Energy management in
Industry   3(3-0-6)**
Types of energy in industrial processes; laws related to energy consumption; energy saving measures; instruments and energy auditing; economic analysis and work standard for efficient energy usage.

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.

2104426   Co-operative Education   3(0-18-0)
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.

**2104429   Applications of Operations Research
3(3-0-6)**
*Condition: Prerequisite 2104259 and
2104359 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.

2104431 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.

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 2104353 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 Industrial Engineering III 3(2-3-4)
Study or inrestigation of special problems assigned by the instructor with the consent of the head of the departmental.

2104494 Advanced Topics in Industrial Engineering III 3(3-0-6)
Study of current interesting topics and new development in industrial engineering.

2104495 Advanced Topics in Industrial Engineering I 3(3-0-6)
Study of current interesting, topics and new development in industrial engineering.

2104496 Advanced Topics in Industrial Engineering II 3(3-0-6)
Study of current interesting topics and new development in industrial engineering.

2104497 Special Problems in Industrial Engineering I 3(2-3-4)

Study or investigation of special problems assigned by the instructor with the consent of the head of the department.

2104498 Special Problems in Industrial Engineering II 3(2-3-4)
Study or investigation of special problems assigned by of the instructor with the consent of the head of the department.

2104499 Industrial Engineering Project 3(3-0-6)
Practical interesting project or problems in various fields of industrial engineering assigned by the instructor.

COURSE DECRIPTIONS IN INDUSTRIAL ENGINEERING (M.ENG., PH.D.)

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 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)
Condition : Prerequisite 2104252 or
2104524 or Consent of Faculty
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 Industrial Engineering Integration 3(3-0-9)
Condition : Prerequisite 2104252 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, transportors, 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: work place 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 Industrial Engineering 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 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, Work Station Design, Psychophysics, Job Analysis and Job Evaluation, Incentive and Work Payment, Shift Management and Cost; Unit Cost & ABC Analysis.

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.

2104601 Engineering Economic Analysis 3(3-0-9)
Condition: Prerequisite 2104353 or Consent of Faculty
Theoretical foundations and advanced topics in engineering economic analysis; investment project evaluation in industrial and engineering works under conditions of uncertainty; analysis of capital budgeting decisions.

2104602 Analysis of Business System 3(3-0-9)
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.

2104603 Advanced Quality Control 3(3-0-9)

Condition: Prerequisite 2104690 or
Consent of Faculty

Principles practice of quality control in industry; administrative and engineering aspects of quality control program.

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.

**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, log normal 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
Development of models of deterministic and stochastic inventory systems; derivation of optimal decision rules for the timing and size of replenishment orders; application of dynamic programming and markov chains in the modeling of dynamic systems.

**2104612   Computer Simulation Techniques
                                3(3-0-9)**
Condition: Prerequisites 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; non-linear 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 Design3(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

**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.

2104637   Coordination and Communication   3(3-0-9)
Relationships among communication, coordination and contradiction in organization; negotiation; public speaking; communication in business ethics of industrial entrepreneurs.

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, work places, 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, develop mint of a work place 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.

2104660   Stochastic Models for Financial
Engineering   2(2-0-6)
Probability; random variables; probability distributions; discrete-time Markov chain; Poisson process; normal distribution; continuous-time Markov chain; Martingale; random walk; Brownian motion.

2104661   Statistical Methods for Financial
Engineering   2(2-0-6)
Random sample; estimation and forecasting; confidence intervals; hypothesis testing; goodness of fit test; maximum likelihood estimators; general method of moments; volatility estimation; linear regression analysis.

2104662   Optimization for Financial Engineering
2(2-0-6)
Local and global optimality; linear programming; simplex algorithm; linear duality; sensitivity; nonlinear programming; Newton's method; Kuhn-Tucker conditions; saddle point conditions; convergence of algorithms; portfolio optimization.

2104663   Time-Series Analysis for Financial
Engineering   2(2-0-6)
ARMA, ARIMA, ARCH, GARCH processes for univariate and multivariate variables; unit root and cointegration; vector autoregression.

2104664   Statistics for Financial Engineering
3 (3-0-3)
Asymptotic properties of estimators; sampling statistics; hypothesis testing; linear regression; weighted linear regression; endogeneity problems and instrumental variable estimation; maximum likelihood estimators; nonlinear regression; Wald test; likelihood ratio test; general method of moments; information criteria.

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   TECH INNO MGT   3 (3-0-3)
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 Industrial Engineering
and Operations Management   3(3-0-9)
Research philosophy; epistemology; ontology; qualitative and quantitative research methodology in IE&OM; research proposal; literature review; research topic; research design; bibliography; research presentation.

2104690   Quantitative Data Analysis for
Industrial Engineering   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 Industrial Engineering I (OR Technics) 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 Industrial Engineering II (Production Technics) 3(3-0-9)
Condition : Consent of Faculty
Interesting problems in industry (Production techniques); current knowledge that helps solve the problems, searching for and sharing of knowledge that helps solve the problems.

2104693 Research problems in Industrial Engineering III (Management Technics) 3(3-0-9)
Condition : Consent of Faculty
Interesting problems in industry (Management techniques); current knowledge that helps solve the problems, searching for and sharing of knowledge that helps solve the problems.

2104694 Research problems in Industrial Engineering IV (Safety Technics) 3(3-0-9)
Condition : Consent of Faculty
Interesting problems in industry (Safety techniques); current knowledge that helps solve the problems, searching for and sharing of knowledge that helps solve the problems.

2104711 Advanced Manufacturing Engineering 3(2-3-7)
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.

2104723 Artificial Intelligence for Industrial Engineering 3(3-0-9)
Application of artificial intelligence techniques to industrial engineering problems, with emphasis on expert systems, neural networks, fuzzy logic, genetic algorithm, simulated annealing, and their hybrid forms.

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.

2104781 Doctoral Seminar in Industrial Engineering I 1(1-0-3)
Literature survey and discussion of academic development and recent applications in industrial engineering.

2104782 Doctoral Seminar in Industrial Engineering II 1(1-0-3)
Literature survey and discussion of academic development and recent applications in industrial engineering.

2104783 Doctoral Seminar in Industrial Engineering III 1(1-0-3)
Literature survey and discussion of academic development and recent applications in industrial engineering.

2104784 Doctoral Seminar in Industrial Engineering IV 1(1-0-3)
Literature survey and discussion of academic development and recent applications in industrial engineering.

2104785 Doctoral Seminar in Industrial Engineering V 1(1-0-3)
Literature survey and discussion of academic development and recent applications in industrial engineering.

2104786 Doctoral Seminar in Industrial Engineering VI 1(1-0-3)
Literature survey and discussion of academic development and recent applications in industrial engineering.

2104811 Thesis 12 credits
Research and report of research results in industrial engineering.

2104828 Dissertation 48 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 a Bachelor of Engineering degree, a Master of Engineering degree, and a Doctor of Engineering degree in Chemical Engineering. The department currently accepts a sophomore class of about 70 students for Bachelor's program, 100 students for Master program (50-60 for M.Eng.program, 30-40 for weekeng M.Eng.program) and 5-10 students for Doctoral program.

The Bachelor of Engineering's degree program offers a complete set of basic courses in Chemical Engineering. The curriculum also allows the students to choose several elective courses. This special feature broadens the student's knowledge to meet his or her interest and the demands of the industries. The senior project introduces the students to the integration of knowledge and gives them hand-on experiences in solving the engineering and technological problems. The curriculum additionally stresses the training of the student to think and present oneself logically and independently.

The department of Chemical Engineering offers two graduate programs leading to the degree of Master of Engineering and the degree of Doctor of Engineering

Students entering graduate study in the Department normally have a bachelor's degree in Chemical Engineering. The Department also admits exceptional students who majored in another branch of engineering, or science at the undergraduate level. Depending on their background, these students have to take undergraduate chemical engineering courses as necessary, while simultaneously taking graduate level subjects for which they have adequate preparation.

The applicant for a 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.

The research activities at the department are grouped into 10 areas of interest, namely, biochemical engineering, catalysts and catalytic reaction engineering, control and system engineering, environmental chemical engineering and safety, life cycle engineering, oleochemical, particle technology and material processing, polymer science and polymer engineering, process systems engineering, and separation technology. Each student can choose to do his or her research in any one of these research areas.

The collaboration between the department and top universities in several countries such as Japan, Canada, England, Australia and China will strengthen graduate program of the department.

The above curriculum and research activities together with strong interaction between faculties and students in all levels have produced the graduates who can 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 herself as an active partner in the advancement of Chemical Engineering discipline in Thailand.

HEAD :

Paisan	Kittisupakorn,	Ph.D. (London)

PROFESSORS :

Paisan	Kittisupakorn,	B.Eng. (Chula), M.Sc., D.I.C., Ph.D. (London)
Piyasan	Praserthdam,	B.Eng. (Chula), M.Sc. (P.I.N.Y.), Dr.Ing. (I.N.S.A.) (Toulouse)
Suttichai	Assabumrungrat,	B.Eng. (Chula), M.Sc., D.I.C., Ph.D. (London)

ASSOCIATE PROFESSORS :

Artiwan	Shotipruk,	Ph.D. (Michigan, Ann Arbor)
Anongnat	Somwangthanaroj,	Ph.D. (Michigan)
Bunjerd	Jongsomjit,	Ph.D. (Pittsburgh)
Deacha	Chatsiriwech,	B.Eng. (Chula), D.I.C., Ph.D. (London)
Joongjai	Panpranot,	Ph.D. (Clemson)
Kasidit	Nootong,	Ph.D. (Pennsylvania)
Prasert	Pavasant,	B.Eng, (Chula), M.Sc., D.I.C., Ph.D. (London)
Sarawut	Rimdusit,	B.Eng. (Chula), M.S.,Ph.D. (CWRU)
Seeroong	Prichanont,	B.Eng. (Chula), M.Sc., D.I.C., Ph.D. (London)
Siriporn	Damrongsukkul,	B.Eng. (Chula), M.Sc., D.I.C., Ph.D. (London)
Soorathep	kheawhom,	Ph.D. (Tokyo)
Tawatchai	Charinpanitkul,	B.Eng. (Chula) M.Eng., D.Eng. (Tokyo)
Tharathon	Mongkhonsi,	B.Eng. (Chula), M.Sc., D.I.C., Ph.D. (London)
Muenduen	Phisalaphong,	B.Sc. (Kasetsart), M.Eng. (Chula), M.Sc. (Lehigh), Ph.D. (Colorado State)
Varong	Pavarajarn,	Ph.D. (Oregon State)
Ura	Pancharoen,	B.S. (Newark), M.Sc., D.Eng.Sc. (NJIT)

ASSISTANT PROFESSORS :

Amornchai	Arpornwichanop,	D.Eng. (Chula)
Apinan	Soottitantawat,	B.Eng.(Chula), M.Sc.,D.eng. (Tottori)
Nattaporn	Tonanon,	D.Eng. (Kyoto)
Sorada	Kanokpanont,	Ph.D. (Drexel)
Suphot	Phatanasri,	B.Sc. (Chiengmai), M.Eng. (Chula), D.Eng. (Kyoto)

LECTURERS :

Akawat	Sirisuk,	Ph.D. (Wisconsin)
Chutimon	Satirapipathkul,	D.Eng (Tokyo Tech)
Jirdsak	Tscheikuna,	Ph.D. (OklahomaState)
Sirijutaratana	Covavisaruch,	Ph.D. (Michigan, Ann Arbor)
Sirikanya	Singcuna,	M.S. (Waterloo)
Varun	Taepaisitphongse,	Ph.D. (UCLA)
Pimporn	Ponpesh	Ph.D. (California)

CHEMICAL ENGINEERING CURRICULUM
FIRST YEAR CURRICULUM
COMMON TO ALL ENGINEERING STUDENTS

COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER	
2103213	ENG MECHANICS I	3
2105220	CHE CHEM	3
2105221	CHE CHEM LAB	1
2105222	CHE THERMO I	3
2105261	CHEM PROD IND	3
2105262	CHE PRIN	3
5500208	COM PRES SKIL	3
		19
	FOURTH SEMESTER	
2103231	MECH OF MAT I	3
2105223	CHE THERMO II	3
2105230	CHE MATH I	3
2105251	UNIT OP I	3
XXXXXXX	GENERAL EDUCATION	6
		18
	FIFTH SEMESTER	
2105331	CHE MATH II	3
2105332	CHE STAT	3
2105352	UNIT OP II	3
2105356	UNIT OP LAB I	1
2105373	CHEM ENG KIN REACT	3
5500308	TECH WRIT ENG	3
XXXXXXX	GENERAL EDUCATION	3
		19

COURSE NO.	SUBJECT	CREDITS
	SIXTH SEMESTER	
2105301	CHE SEM I	1
2102391	ELEC ENG	3
2102392	ELEC ENG LAB I	1
2105333	TRANS PHENO	3
2105353	UNIT OP III	3
2105357	UNIT OP LAB II	1
2105362	CHEM PROC ECON ASSESS	3
XXXXXXX	GENERAL EDUCATION	3
		17
	SUMMER SEMESTER	
2100301	ENG PRACTICE	2
	SEVENTH SEMESTER	
2105458	UNIT OP LAB III	1
2105463	CHE PROC	3
2105464	CHEM PROC DSGN	3
2105472	PROC DYN CONTROL	3
2105480	SAFETY IN CHEM OPER	3
2105491	CHE PROJ I	1
21054xx	ELECTIVE COURSE	3
		17
	EIGHTH SEMESTER	
2105402	CHE SEM II	1
2105465	CHEM PLANT DSGN	3
2105482	ENV CHEM ENG	3
2105498	CHE PROJ II	
OR 210099	ENGINEERING PROJECT	3
21054xx	ELECTIVE COURSE	3
XXXXXXX	FREE ELECTIVE	3
XXXXXXX	FREE ELECTIVE	3
		19

TOTAL CREDITS FOR GRADUATION = 146

NAME OF THE DEGREE

: Master of Engineering
: M.Eng.

PROFESSORS :

Paisan	Kittisupakorn,	B.Eng. (Chula), M.Sc., D.I.C., Ph.D. (London)
Piyasan	Praserthdam,	B.Eng. (Chula), M.Sc. (P.I.N.Y.), Dr.Ing. (I.N.S.A.) (Toulouse)
Suttichai	Assabumrungrat,	B.Eng. (Chula), M.Sc., D.I.C., Ph.D. (London)

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Joongjai	Panpranot,	Ph.D. (Clemson)
Kasidit	Nootong,	Ph.D. (Pennsylvania)
Prasert	Pavasant,	B.Eng. (Chula), M.Sc., D.I.C., Ph.D. (London)
Sarawut	Rimdusit,	B.Eng. (Chula), M.S.,Ph.D. (CWRU)
Seeroong	Prichanont,	B.Eng. (Chula), M.Sc., D.I.C., Ph.D. (London)
Siriporn	Damrongsukkul,	B.Eng. (Chula), M.Sc., D.I.C., Ph.D. (London)
Soorathep	kheawhom,	Ph.D. (Tokyo)
Tawatchai	Charinpanitkul,	B.Eng. (Chula) M.Eng., D.Eng. (Tokyo)
Tharathon	Mongkhonsi,	B.Eng. (Chula), M.Sc., D.I.C., Ph.D. (London)
Muenduen	Phisalaphong,	B.Sc. (Kasetsart), M.Eng. (Chula), M.Sc. (Lehigh), Ph.D. (Colorado State)
Varong	Pavarajarn,	Ph.D. (Oregon State)
Ura	Pancharoen,	B.S. (Newark), M.Sc., D.Eng.Sc. (NJIT)

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Sirijutaratana	Covavisaruch,	Ph.D. (Michigan, Ann Arbor)
Sirikanya	Singcuna,	M.S. (Waterloo)
Varun	Taepaisitphongse,	Ph.D. (UCLA)
Pimporn	Ponpesh	Ph.D. (California)

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 bachelor degree of chemical engineering graduated)

Students with bachelor degree of chemical engineering are required to complete 24 credits of courses and a thesis of 12 credits. The course consists of 9 credits of required courses in 1,not less than 6 credits of approved elective course from the same group in 2, and 9 credits of free elective courses in 3 or from another groups in 2. Chemical engineering seminar I and II are no credit required courses (S/U) and not counted to fulfill the program.

COURSE REQUIREMENTS

1. Required Courses   2 credits   from
2105605   Seminar I   1(1-0-3)
2105606   Seminar II   1(1-0-3)

2) Core Course   15 credits   from
- 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) |

2105676	Instrumentation in Chemical Process	
		3(3-0-9)
2105671	Process Dynamics	3(3-0-9)
2105623	Optimization of Chemical Processes	
		3(3-0-9)
2105689	Safe Process Operation and Design	
		3(3-0-9)
2105699	Multifunctional Reactor	3(3-0-9)

3) Elective Courses   9 credits   from

- Chemical Engineering Fundamental Division

2105526	Total Productive Management for	
	Chemical Process Industry	3(3-0-9)
2105608	Adsorption Process	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)
2105626	Advanced Heat Transfer	3(3-0-9)
2105663	Heat Transfer Operation	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)

- Process Control and System Engineering Division

2105522	Dyanamic Process Simulation	3(3-0-9)
2105599	Batch Chemical Processes	3(3-0-9)
2105619	Advanced Automatic Process Control	
		3(3-0-9)
2105693	Special Problems in Process	
	Control Engineering	3(3-0-9)

- Petrochemical Engineering Division

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)
2105634	Catalysis	3(3-0-9)
2105636	Heterogeneous Catalysis	3(3-0-9)
2105637	Design of Industrial Catalysis	3(3-0-9)
2105681	Catalyst Deactivation	3(3-0-9)
2105694	Special Problems in Petrochemical	
	Engineering	3(3-0-9)

- Polymer Engineering Division

2105527	Polymer Characterization and Fracture	
		3(3-0-9)
2105638	Advanced Polymer Engineering	3(3-0-9)
2105643	Polymer Processing	3(3-0-9)
2105649	Polymer Blends and Composites	3(3-0-9)
2105675	Polymer Chemistry for Engineers	3(3-0-9)
2105695	Special Problems in Polymer	
	Engineering	3(3-0-9)

- Biochemical Engineering Division

2105641	Biodegradable Material Engineering	
		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)
2105679	Bioactive Compounds	3(3-0-9)
2105683	Bioenergy Technology	3(3-0-9)
2105696	Special Problems in Biochemical	
	Engineering	3(3-0-9)

- Cleaner Production Engineering Division

2105666	Source Control of Particulate Emission	
		3(3-0-9)
2105667	Loss Prevention in Chemical Operations	
		3(3-0-9)
2105697	Special Problems in Cleaner Production	
	Engineering	3(3-0-9)

- Particle Technology Division

2105572	Encapsulation Process	3(3-0-9)
2105609	Advanced Particulate Technology	3(3-0-9)
2105616	Fluid and Particle Mechanics	3(3-0-9)
2105672	Simulation of Particulate and Material	
	Processing	3(3-0-9)
2105678	Introduction to Nanotechnology	3(3-0-9)
2105698	Special Problems in Particle	
	Technology	3(3-0-9)

4) THESIS

| 2105811 | THESIS | 12 | credits |
| 2105816 | THESIS | 36 | credits |

Master of Chemical Engineering Program

First Year

First Semester

2105602	ADV TRANS PHENOM	3
2105603	ADV CHE THERMO	3
2105604	ADV CHE KINETICS	3
21056xx/5xx	Free Elective	3
		12

Second Semester

2105605	Seminar I	1
21056xx	Approved Elective	3
21056xx	Approved Elective	3
21056xx/5xx	Free Elective	3
21056xx/5xx	Free Elective	3
2105811	Thesis	2
		15

Second Year

First Semester

2105606	Seminar II	1
2105811	Thesis	6
21056xx/5xx	Free Elective(Option)	3
		7,10

Second Semester

2105811	Thesis	4
21056xx/5xx	Free Elective(Option)	3
		4,7

DEGREE REQUIREMENTS
(for non-bachelor degree of chemical engineering graduated)

Students with non-bachelor degree of chemical engineering are required to complete 30 credits of engineering and chemical engineering fundamental courses, 24 credits of courses and a thesis of 12 credits. The fundamental courses of 30 credits are lists in 5. The course consists of 9 credits of required courses in 1, not less than 6 credits of approved elective course from the same group in 2, and 9 credits of free elective courses in 3 or from another groups in 2. The fundamental, chemical Engineering Seminar I and II are non credit required courses (S/U) and not counted for in order to fulfill the program.

Master of Chemical Engineering Program

First Year
First Semester

2105373	Chemical Engineering Kinetics and Reactor Design	3
2105331	Chemical Engineering Mathematics II	3
2103106	Engineering Drawing	3
2105603	ADV CHE THERMO	3
21056xx/5xx	Free Elective	3
		6

Second Semester

2105333	Transport Phenomena	3
2105251	Unit Operations I	3
21056xx	Approved Elective	3
21056xx/5xx	Free Elective	3
2105605	Seminar I	1
		6

Second Year
First Semester

2105352	Unit Operations II	3
2105356	Unit Operations Laboratory I	1
2105602	ADV TRANS PHEHOM	3
2105604	ADV CHE KINETICS	3
2105606	Seminar II	1
		6

Second Semester

2105353	Unit Operation III	3
2105357	Unit Operations Laboratory II	1
21056xx	Approved Elective	3
21056xx/5xx	Free Elective	3
2105811	Thesis	2
		8

Third Year
First Semester

2105464	Chemical Process Design	3
2105472	Process Dynamics and Control	3
2105458	Unit Operations Laboratory III	1
2105811	Thesis	4
21056xx/5xx	Free Elective (Option)	3
		4,7

Second Semester

2105811	Thesis	6
21056xx/5xx	Free Elective (Option)	3
		6,9

COURSE REQUIREMENTS

1) Fundamental Courses

2103106	Engineering Drawing	3(1-4-4)
2105251	Unit Operations I	3(3-0-6)
2105331	Chemical Engineering Mathematics II	3(3-0-6)
2105333	Transport Phenomena	3(3-0-6)
2105352	Unit Operations II	3(3-0-6)
2015353	Unit Operations III	3(3-0-6)
2105356	Unit Operations Laboratory I	1(0-3-0)
2105357	Unit Operations Laboratory II	1(0-3-0)
2105373	Chemical Engineering Kinetics and Reactor Design	3(3-0-6)
2105458	Unit Operations Laboratory III	1(0-3-0)
2105464	Chemical Process Design	3(2-3-4)
2105472	Process Dynamics and Control	3(3-0-6)

2) Required Courses   9   credits

2105602	Advanced Transport Phenomena	3(3-0-9)
2105603	Advanced Chemical Engineering Thermodynamics	3(3-0-9)
2105604	Advanced Chemical Engineering Kinetics and Chemical Reactor Design	3(3-0-9)
2105605	Chemical Engineering Seminar I	1(1-0-3)
2105606	Chemical Engineering Seminar II	1(1-0-3)

3) Approved Elective   6   credits

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)
2105622	Chemical Process Simulation and Optimization	3(3-0-9)
2105676	Instrumentation in Chemical Process	3(3-0-9)

4) Elective Courses   9   credits

Group 1 : Chemical Engineering Fundamental Division

2105526	Total Productive Management for Chemical Process Industry	3(3-0-9)
2105608	Adsorption Process	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 Operations	3(3-0-9)
2150626	Advanced Heat Transfer	3(3-0-9)
2150661	Special Problems in Chemical Engineering	3(3-0-9)
2105662	Selected Topics in Chemical Engineering	3(3-0-9)
2150663	Heat Transfer Operation	3(3-0-9)
2105665	Cryogenic Engineering	3(3-0-9)

2105673	Design and Analysis of Experiments in Chemical Engineering	3(3-0-9)
2105680	Multifunctional Reactor	3(3-0-9)
2105682	Surface Technology	3(3-0-9)
2105684	Chemical Analysis for Chemical Process Control I	3(3-0-9)

Group 2 : Process Control and Systems Engineering Division

2105522	Dynamic Process Simulation	3(3-0-9)
2105599	Batch Chemical Process	3(3-0-9)
2105619	Advanced Automatic Process Control	3(3-0-9)
2105621	Multivariable Process Control	3(3-0-9)
2105623	Optimization of Chemical Processes	3(3-0-9)
2105624	Computer Process Control	3(2-3-7)
2105625	Process Control and Management	3(3-0-9)
2105628	Process Control Instrumentation	3(3-0-9)
2105629	Process Identification and Data Analysis	3(3-0-9)
2105671	Process Dynamics	3(3-0-9)
2105674	Computer-Aided Process and Product Engineering	3(3-0-9)

Group 3 : Petrochemical Engineering Division

2105630	Heterogeneous Catalytic Reactor Modelling	3(3-0-9)
2105631	Advanced Catalysts for Polymers	3(3-0-9)
2105632	Petrochemical Technology	3(3-0-9)
2105634	Catalysis	3(3-0-9)
2105636	Heterogeneous Catalysis	3(3-0-9)
2105637	Design of Industrial Catalysts	3(3-0-9)
2105681	Catalyst Deactivation	3(3-0-9)

Group 4 : Polymer Engineering Division

2105527	Polymer Characterization and Fracture	3(3-0-9)
2105638	Advanced Polymer Engineering	3(3-0-9)
2105643	Polymer Processing	3(3-0-9)
2105649	Polymer Blends and Composites	3(3-0-9)
2105675	Polymer Chemistry for Engineers	3(3-0-9)

Group 5 : Biochemical Engineering Division

2105641	Biodegradable Material Engineering	3(3-0-9)
2105650	Biochemical Engineering	3(3-0-9)
2105652	Bioreactor Design Analysis and Control	3(3-0-9)
2105654	Biosensors	3(3-0-9)
2105655	Bioprocess Plant Design	3(3-0-9)
2105656	Bioremediation Engineering	3(3-0-9)
2105659	Biochemical Separation Technology	3(3-0-9)
2105679	Bioactive Compounds	3(3-0-9)
2105683	Bioenergy Technology	3(3-0-9)

Group 6 : Cleaner Production Engineering Division

2105666	Source Control of Particulate Emissions	3(3-0-9)
2105667	Loss Prevention in Chemical Operations	3(3-0-9)
2105668	Energy Conservation in Chemical Processes	3(3-0-9)
2105669	Cleaner Technology	3(3-0-9)

Group 7 : Particle Technology Division

2105571	Aerosol Engineering	3(3-0-9)
2105572	Encapsulation Process	3(3-0-9)
2105609	Advanced Particulate Technology	3(3-0-9)
2105616	Fluid and Particle Mechanics	3(3-0-9)
2105672	Simulation of Particulate and Material Processing	3(3-0-9)
2105678	Introduction to Nanotechnology	3(3-0-9)

4) Thesis

| 2105811 | Thesis | 12 Credits |

NAME OF THE DEGREE

: Doctor of Engineering
: D.Eng.

PROFESSORS :

Paisan	Kittisupakorn,	B.Eng. (Chula), M.Sc., D.I.C., Ph.D. (London)
Piyasan	Praserthdam,	B.Eng. (Chula), M.Sc. (P.I.N.Y.), Dr.Ing. (I.N.S.A.) (Toulouse)
Suttichai	Assabumrungrat,	B.Eng. (Chula), M.Sc., D.I.C., Ph.D. (London)

ASSOCIATE PROFESSORS :

Artiwan	Shotipruk,	Ph.D. (Michigan, Ann Arbor)
Anongnat	Somwangthanaroj,	Ph.D. (Michigan)
Bunjerd	Jongsomjit,	Ph.D. (Pittsburgh)
Deacha	Chatsiriwech,	B.Eng. (Chula), D.I.C., Ph.D. (London)
Joongjai	Panpranot,	Ph.D. (Clemson)
Kasidit	Nootong,	Ph.D. (Pennsylvania)
Prasert	Pavasant,	B.Eng, (Chula), M.Sc., D.I.C., Ph.D. (London)
Sarawut	Rimdusit,	B.Eng. (Chula), M.S.,Ph.D. (CWRU)
Seeroong	Prichanont,	B.Eng. (Chula), M.Sc., D.I.C., Ph.D. (London)
Siriporn	Damrongsukkul,	B.Eng. (Chula), M.Sc., D.I.C., Ph.D. (London)
Soorathep	kheawhom,	Ph.D. (Tokyo)
Tawatchai	Charinpanitkul,	B.Eng. (Chula) M.Eng., D.Eng. (Tokyo)
Tharathon	Mongkhonsi,	B.Eng. (Chula), M.Sc., D.I.C., Ph.D. (London)
Muenduen	Phisalaphong,	B.Sc. (Kasetsart), M.Eng. (Chula), M.Sc. (Lehigh), Ph.D. (Colorado State)
Varong	Pavarajarn,	Ph.D. (Oregon State)
Ura	Pancharoen,	B.S. (Newark), M.Sc., D.Eng.Sc. (NJIT)

ASSISTANT PROFESSORS :

| Amornchai | Arpornwichanop, | D.Eng. (Chula) |
| Apinan | Soottitantawat, | B.Eng.(Chula), M.Sc.,D.eng. (Tottori) |

Nattaporn	Tonanon,	D.Eng. (Kyoto)	2105601	Advanced Engineering Mathematics for Chemical Engineers 3(3-0-9)

Nattaporn Tonanon, D.Eng. (Kyoto)
Sorada Kanokpanont, Ph.D. (Drexel)
Suphot Phatanasri, B.Sc. (Chiengmai),
M.Eng. (Chula),
D.Eng. (Kyoto)

LECTURERS :

Akawat Sirisuk, Ph.D. (Wisconsin)
Chutimon Satirapipathkul, D.Eng (Tokyo Tech)
Jirdsak Tscheikuna, Ph.D. (OklahomaState)
Sirijutaratana Covavisaruch, Ph.D. (Michigan,
Ann Arbor)
Sirikanya Singcuna, M.S. (Waterloo)
Varun Taepaisitphongse, Ph.D. (UCLA)
Pimporn Ponpesh Ph.D. (California)
Ph.D.(UCD)

ADMISSION

The 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. The additional requirement for Pattern I is the minimum grade point average of 3.5 on Master's Degree in Chemical Engineering.

COURSE REQUIREMENTS

1) *Required Courses for Pattern II (1)*
12 credits

2105601 Advanced Engineering Mathematics for
Chemical Engineers 3(3-0-9)
2105602 Advanced Transport Phenomena 3(3-0-9)
2105603 Advanced Chemical Engineering
Thermodynamics 3(3-0-9)
2105604 Advanced Chemical Engineering
Kinetics and Chemical Reactor
Design 3(3-0-9)
2105717 Seminar in Chemical
Engineering III 1(1-0-3)
2105718 Seminar in Chemical
Engineering IV 1(1-0-3)

2) *Elective Courses for Pattern II (2)*
12 credits
2105645 Polymer Extrusion Process and
Design 3(3-0-9)
2105701 Advanced Process System
Engineering 3(3-0-9)
2105702 Advanced Separation Technology 3(3-0-9)
2105703 Optimal Process Control 3(3-0-9)
2105709 Special Projects in Chemical
Engineering 3(3-0-9)
2105710 Air Engineering and Control of
Gaseous Air Pollutants 3(3-0-9)

Students may select other courses offered by the Graduate School, Chulalongkorn University, with approval from their academic advisor or Chemical Engineering Department.

DEGREE REQUIREMENTS

There are two patterns of study as follows:

	Pattern I	Pattern II (1)	Pattern II (2)
	Master's Degree Holder	Bachelor's Degree Holder	Master's Degree Holder
Required Courses	0	12	0
Elective Courses	0	12	12
Seminar in Chem Eng.	2*	2*	2*
Dissertation	48	48	48
Total course requirements	48	72	60

DOCTOR OF CHEMICAL ENGINEERING PROGRAM

* Seminar in Chemical Engineering III and IV are non credit required courses (s/u) and not counted for in order to fulfill the program.

Pattern I for Master's degree holder

First Semester

2105717	Seminar in Chemical Engineering III	1
		(s/u)**
2105829	Dissertation	10
		10

Second Semester

2105718	Seminar in Chemical Engineering IV	1
		(s/u)**
2105829	Dissertation	10
		10

Third Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105829	Dissertation	10
		10

Fourth Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105829	Dissertation	10
		10

Fifth Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105829	Dissertation	10
		10

Sixth Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105829	Dissertation	10
		10

Pattern II (1) for Bachelor's degree holder

First Semester

2105717	Seminar in Chemical Engineering III	1
		(s/u)**
2105830	Dissertation	9
		9

Second Semester

2105718	Seminar in Chemical Engineering IV	1
		(s/u)**
2105830	Dissertation	9
		9

Third Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105830	Dissertation	9
		9

Fourth Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105830	Dissertation	9
		9

Fifth Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105830	Dissertation	9
		9

Sixth Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105830	Dissertation	9
		9

Seventh Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105830	Dissertation	9
		9

Eighth Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105830	Dissertation	9
		9

Pattern II (2) for Master's degree holder

First Semester

21056xx	Elective in CHE	3
21056xx	Elective in CHE	3
2105717	Seminar in Chemical Engineering III	1
		(s/u)**
2105828	Dissertation	4
		10

Second Semester

21056xx	Elective in CHE	3
21056xx	Elective in CHE	3
2105718	Seminar in Chemical Engineering IV	1
		(s/u)**
2105828	Dissertation	4
		10

Third Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105828	Dissertation	10
		10

Fourth Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105828	Dissertation	10
		10

Fifth Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105828	Dissertation	10
		10

Sixth Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105828	Dissertation	10
		10

Pattern II (2) for Bachelor's degree holder

First Semester

2105602	Advanced Transport Phenomena	3
2105603	Advanced CHE ENG Transport Phenomena	3
2105604	Advanced CHE ENG Kinetics and CHE Reactor Design	3
21056xx	Elective in CHE	3
2105717	Seminar in Chemical Engineering III	1
		(s/u)**
		12

Second Semester

21056xx	Approve Elective in CHE	3
21056xx	Approve Elective in CHE	3
21056xx	Elective in CHE	3
21056xx	Elective in CHE	3
2105718	Seminar in Chemical Engineering IV	1
		(s/u)**
		12

Third Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105828	Dissertation	8
		8

Fourth Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105828	Dissertation	8
		8

Fifth Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105828	Dissertation	8
		8

Sixth Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105828	Dissertation	8
		8

Seven Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105828	Dissertation	8
		8

Eight Semester

2105894	Doctoral Dissertation Seminar	0
		(s/u)**
2105828	Dissertation	8
		8

COURSES DESCRIPTIONS
IN CHEMICAL ENGINEERING (B.ENG.)

2105220 Chemical Engineering Chemistry 3(3-0-6)
Principles of chemical analysis for chemical engineers for quality control, process control, and researches, utilization of quantitative analysis and interpretation, techniques of chemical analysis, using traditional methods, and use of analysis instruments, principles of organic chemistry to be applied in chemical industries and bio-engineering, properties and reactions of basic functional groups: hydrocarbons, hydroxyl, ether, carbonyl, carboxylic, and organic complexes.

2105221 Chemistry for Chemical Engineering Laboratory 1(0-3-0)
Practice in chemical analysis using various techniques for quality control, process control, and research.

2105222 Chemical Engineering Thermodynamics I 3(3-0-6)
Prediction of thermodynamic properties of single components, ideal gas law, equation of states of gas and liquid, gaseous and liquid mixtures, thermodynamic laws, relationships of thermodynamic properties, phase equilibrium of single components, refrigeration cycle.

2105223 Chemical Engineering Thermodynamics II 3(3-0-6)
Prediction of thermodynamic properites of mixtures, phase equilibrium of mixtures, vapour-liquid equilibrium, liquid-liquid equilibrium, liquid-solid equilibrium, vapour-solid equilibrium, vapour-liquid-liquid equilibrium, chemical equilibrium, thermodynamics of chemical processes.

2105230 Chemical Engineering Mathematics I 3(3-0-6)
Fundamental of line integration and surface integration, polar co-ordinates, calculus of real value multivariable functions and application, analysis principles for solving chemical engineering problems.

2105251 Unit Operations I 3(3-0-6)
Units for transporting liquid and gas, fluidized systems, pneumatic system for transport particles, unit operations for separating particles from gaseous and liquid system with centrifugal forces, filtration, and diffusion.

2105261 Chemicals Production Industries 3(3-0-6)
Industrial standard, law related to chemical industries, components of chemical plants, responsibilities of engineers.

2105262 Chemical Engineering Principles 3(3-0-6)
Principles of chemical engineering, relationship of mass with chemical reactions, conservation of mass and energy, use of phase equilibrium and thermodynamic properties.

2105301 Chemical Engineering Seminar I 1(0-3-0)
Softskill improvement for quality chemical engineer. Discussion of various topics relevant for recent chemical engineering development.

2105331 Chemical Engineering Mathematics II 3(3-0-6)
Numerical techniques for solving chemical engineering problems, application of computer for solving chemical engineering problems.

2105332 Chemical Engineering Statistics 3(3-0-6)
Elementary principles of statistics and probability, random variables and probability distributions, experimental data analysis, chemical process parameter estimation, linear regression and correlation, multiple regression, design and analysis of chemical experiments with single factor and with several factors, chemical process modeling with stochastic approach.

2105333 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.

2105352 Unit Operations II 3(3-0-6)
Unit Operations for separating gaseous and liquid mixtures with distillation, absorption, extraction, adsorption and crystallization.

2105353 Unit Operations III 3(3-0-6)
Unit operations for exchanging heat, boilers, evaporators, condensers, dryers, and cooling water systems.

2105356 Unit Operations Laboratory I 1(0-3-0)
Condition: Prerequisite 2105251
Practice unit operations for momentum transports.

2105357 Unit Operations Laboratory II 1(0-3-0)
Condition: Prerequisite 2105352
Practice unit operations for mass transport and reaction kinetics.

2105362 Chemical Process Economic Assessment 3(3-0-6)
Cost components of chemical industries, chemical industrial cost indexes, capital cost components, capital investment estimates, purchase costs of process equipments, manufacturing cost components, manufacturing cost estimates, chemical process depreciation estimates, feasibility analysis, alternative investments and replacements

2105373 Chemical Engineering 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.

2105385 Recycling of Agricultural and Agro Inductrial Waste 3(2-3-4)
Wealth of Thailand, bio-diversity in Thailand, role of technology in full utilization of agri-waste or agro-industrial waste; cycles of agri-waste and agro-industrial waste; characterization of agri-waste and agro-industrial waste; utilization of agri-waste and agro-industrial waste; project/product evaluation.

2105402   Chemical Engineering Seminar II 1(0-3-0)
    Softskill improvement for quality chemical engineer. Discussion of various topics relevant for recent chemical engineering development.

**2105403   Special Topics in Chemical
        Engineering I   3(3-0-6)**
        Condition: Consent of Faculty
    Special topics in Chemical Enigeering including new technology.

**2105404   Special Topics in Chemical
        Engineering II   3(3-0-6)**
        Condition: Consent of Faculty
    Special topics in Chemical Enigeering including new technology.

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.

2105430   Particle Technology   3(3-0-6)
    Particle characterization, transport of powder, selection of transport equipment (screw conveyor, belt conveyor, bucket elevator, pneumatic conveyor, air slide, 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 rection engineering; applications of catalysts 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 fo 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.

2105458   Unit Operations Laboratory III   1(0-3-0)
        Condition: Prerequisite 2105353
    Practice unit operations for heat transport, and simultaneous heat and mass transports.

2105463   Chemical Engineering Processes 3(3-0-6)
    Development of industrial chemical processes, relationship of unit operations, with raw materials, products, and energy for production, process energy, by-products and wastes managements.

2105464   Chemical Process Design   3(2-3-4)
    Design principles of reaction sections, selection of reactors, design principles of separation sections, development principles of process simulation model with commercial process simulator.

2105465   Chemical Plant Design   3(2-3-4)
        Condition: Prerequisite 2105464
    Design principles of heat exchanger network, process energy recovery principles, estimate equipment dimensions, selection principles of process equipment materials, and plant layout design.

**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.

**2105472   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.

2105475 Total Productive Management for Chemical Process 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.

2105477 Computer Application in Chemical Engineering 3(3-0-6)
Computer software application for calculating and design related to chemical engineering.

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 plant; 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; transition phenomena, mechanical properties affected by the transition phenomena; elastomer, theory of rubber elasticity; Polymer rheology: types of mechanical deformations, simple rheological responses, viscoelastic properties of polymer, linear viscoelastic models; yielding and theories on yielding of glassy polymer.

2105480 Safety in Chemical Operations 3(3-0-6)
Condition: Senior Standing
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.

2105482 Environmental Chemical Engineering 3(3-0-6)
Effects of pollutants on environments standard environmental qualities, sources and industrial wastewater characteristics and treatment methods, sources of air pollutants, control of particles and gaseous, compositions of solid wastes and hazardous wastes, method of treatments.

2105486 Modern Techniques in Process Control 3(3-0-6)
Condition: Corerequisite 2105472
Principle and practice of modern control techiques in chemical processing; distributed control systems; computer integrated processing.

2105487 Digital Process Control Laboratory 3(1-4-2)
Condition: Prerequisite 2105472 or Consent of Faculty

Application of direct digital control principles of laboratory excercises supported by microcomputers; real time programming; data aquisition and control using simple and advanced control strategies; experiments in temperature, liquid level, pH controls; sequence control; term project.

2105491 Chemical Engineering Project I 1(0-2-1)
Data collection and assessment of suitable chemical industrial problems for chemical engineering projects.

2105492 Chemical Engineering Project II 2(0-4-2)
Condition: Prerequisite 2105491
A research on chemical engineering projects related to chemical industrial problems or innovations.

COURSES DESCRIPTIONS IN CHEMICAL ENGINEERING (M.ENG, D.ENG.)

2105522 Dyanamic 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 adn 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.

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 equiibrium, process analysis.

2105604　Advanced Chemical Engineering Kinetecs 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 II1(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 Menbrane And Application　3(3-0-9)
Variety of separation process via liquid membrane; selection of single/multiple extractant systems; design of a particular metal Ion 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.

2105616　Fluid and Particle Mechanics　3(3-0-9)
Nature of two-phase gas-liquid flows. Flow regime maps. Flow with phase change. Modeling of regime transition, Conservation equations. Correlations and empirical models for two-phase flow. Annular flow. Slug flow. Bubble flow. Mechanical and surface properties of particles. Fundamentals of particle particle interaction. Powder flow and conveying. Agglomeration. Separation Process.

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.

2105621 Multivariable Process Control 3(3-0-9)

Introduction to multivariable control, uncertainty and robustness for multivariable control system, controller design and control structure design.

2105622 Chemical Process Simulation and Optimization 3(3-0-9)

Process analysis and simulation: concept of model synthesis, model characterization based on behavioral principles and on mathematical properties, subsystems and systems analysis. To give a broad coverage of the field of computer applications to chemical engineering, with emphasis on steady-state flowsheeting and process simulation.

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.

2105624 Computer Process Control 3(3-0-9)

Computer hardware, interfacing, control algorithms and their implementation, distributed control system, predicitive control techniques, automatic tuning.

2105625 Process Control and Management 3(3-0-9)

Generalization concepts of process control; hierarchy in process concess control; planning and scheduling; manufacturing execution systems, plant information systems; process plan business function.

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-continum 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.

2105628 Process Control Instrumentation 3(3-0-9)

Sensors and actuators used in proess industries; signal conditioning and transmissionl analog and difital controllers; interfacing and communication; programmable logic controlers; distributed process control systems; safety in process automation.

2105629 Process Identification and Data Analysis 3(3-0-9)

Methods for modeling the dynamic behaviour of a process and its disturbances using data collected from the process; transfer function and time series modeling theory and techniques; statistical methods for structure determination parameter estimation, model validation, experiment design, and closed-loop data analysis, analysis and control, multivariate statistical methods including Principal Component Analysis (PCA), and Partial Least Squares (PLS) used for the efficient extraction of information from large databases typically collected by on-line process computer; analysis of process problems and on-line process improvement by using these model.

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.

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.

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.

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.
Microbial kinetics of growth. Barious fermentation reactors for pure cultures. Mass transfer in fermentors. Instrumentation and control of biochemical processes, downstream separation in biotechnology and their importance.

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   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.

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.

2105656   Bioremediation Engineering   3(3-0-9)
Concept of bioremediation engineering, use of microorganisms for pollution control; biodegradation kinetics, bioreaction design and insitu bioremediation.

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.

2105661   Special Problems in Chemical Engineering
3(3-0-9)
Study of investigation of special problems in chemical 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.

2105662   Selected Topics in Chemical Engineering
3(3-0-9)
Study of specialized topics of interest in chemical engineering assigned by the lecturer with the consent of the head of the department. Written report and oral examination are required.

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.

2105665   Cryogenic Engineering   3(3-0-9)
Basic principles involved in the production at low temperature and the separation of gases. Physical properties of cryogenic fluids and recent developments in their engineering applications.

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.

2105668   Energy Conservation in Chemical Processes   3(3-0-9)
Basic considerations and objective of energy conservation in chemical industry; Fundamentals of energy integration for chemical engineers; Synthesis, and optimization of heat exchanger networks in chemical processes; Other energy recovery technques; Alternative sources of energy.

2105669   Cleaner Technology   3(3-0-9)
Fundamental of clean technology; Pollution prevention in industrial processes: principles, approaches, application in process and equipment design; waste minimization: industrial waste reduction techniques; Life cycle analysis: concept, methods, application of pollution prevention.

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 Processinf   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.

2105673   Design and Analysis of Experiments in Chemical Engineering   3(3-0-9)
Simple comparative experiments; experiments with a single factor; analysis of variance; randomized blocks and Latin squares designs; Factorial design, Tow-level factorial design; Three-level and mixed-level factorial design; Robustness experiments with random factors.

2105674   Computer-aided Process and Product Engineering   3(3-0-9)
Computer-aided modeling and simulation; Computer-aided process and product design; Computer-aided process operation, Modeling in the process life cycle.

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.

2105680   Multifunctional Reactor   3(3-0-9)
Basic concepts and knowledge of different multifunctional reactors and their applications; mathematical modelling and simulation to understand effects of various operating parameters on the multifunctional reactors performance.

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 I   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   3(3-0-9)
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   3(3-0-9)
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   0(0-0-0)
Study and discussion of dissertation and present the progress of doctoral dissertation.

DEPARTMENT OF MINING AND PETROLEUM ENGINEERING

The Department of Mining and Petroleum Engineering currently offers two undergraduate programs namely Georesources Engineering and Petroleum Engineering. Mining Engineering program is replaced by Georesources Engineering Program where two majors mining, and resources engineering are conducted. These two existing programs are designed to prepare graduates for mining, resources, 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 are 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

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 advance 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 recycling will be provided for junior and senior level.

▯ 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. 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 interdiscipline 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:

Thitisak	Boonpramote,	Ph.D. (Colorado school at Mines)

ASSOCIATE PROFESSORS:

Dawan	Wiwattanadate,	Ph.D. (Osaka)
Somsak	Saisinchai,	M.Eng. (Chula)

ASSISTANT PROFESSORS:

Jirawat	Chewaroungroaj,	Ph.D. (Texas at Austin)
Sunthorn	Pumjan,	Ph.D. (Michigan Tech)
Suwat	Athichanagorn,	Ph.D. (Stanford)
Kreangkrai	Maheeintr	Ph.D. (Regina)

LECTURERS:

Pipat	Laowattanabandit	Ph.D.(Colorado School of Mines)
Falan	Srisuriyachai	Ph.D. (Bologna)
Apisit	Numprasanthai	Ph.D. (Griffith)
Raphael	Bissen	Dr.rer.nat (Freiburg)

GEORESOURCES ENGINEERING UNDERGRADUATE CURRICULUM (Georesources Engineering)
FIRST YEAR CURRICULUM
COMMON TO ALL ENGINEERING STUDENTS

COURSENO.	SUBJECT	CREDITS	COURSE NO	SUBJECT	CREDITS
	THIRD SEMESTER			**SIXTH SEMESTER**	
2103213	ENG MECHANICS I	3	2103393	ME LAB NON ME	1
2301207	CALCULUS III	3	2108302	FIELD PRACTICE I	1
2106251	GENERAL GEOLOGY	3	2106441	GEOTECH	3
2106208	CHEM MAT	3	2106442	GEOTECH LAB	1
2106209	CHEM MAT LAB	1	2106412	RES ECON MGT	3
2106222	FUND GE	1	2106432	SEPARATION TECHNOLOGY	3
5500208	COM PRES SKIL	3	2106333	RES PROC LAB II	1
xxxxxxxx	GENERAL EDUCATION	3	5500308	TECH WRIT ENG	3
		20	xxxxxxxx	GENERAL EDUCATION	3
					19
	FOURTH SEMESTER			**SUMMER SEMESTER**	
2101202	MECH MAT I	3	2100301	ENG PRACTICE	2
2108298	SURVEYING I	3			
2106458	MINING GEOLOGY	3			
2106316	SUR MIN	3		**SEVENTH SEMESTER**	
2106315	MIN ENG LAB	1			
2104253	ENG STAT I	3	2102391	ELEC ENG I	3
xxxxxxx	GENERAL EDUCATION	3	2102392	ELEC ENG LAB I	1
		19	2106489 OR	GEO-RES ENG PROJ	3
			2100499	ENG PROJ	
			xxxxxxx	GENERAL EDUCATION	3
			xxxxxxx	FREE ELECTIVES	3
			xxxxxxx	FREE ELECTIVES	3
					16
	FIFTH SEMESTER			**EIGHTH SEMESTER**	
2100311	ENG ESSENTIALS	3	2106446	MIN PLAN DSGN	3
2112346	HYDRAULICS I	3	2106413	RES ENV POLL PRVNT	3
2103295	BASIC THERM	3	xxxxxxx	ELECTIVE COURSE	3
2106310	MINERAL PROCESS ENG	3	xxxxxxx	ELECTIVE COURSE	3
2106332	RES PROC LAB I	1	xxxxxxx	ELECTIVE COURSE	3
2106445	UNDERGROUND MIN	3			15
2106444	ENG EXP ROCK BLAST	3			
		19			

TOTAL CREDITS FOR GRADUATION = 146

PETROLEUM ENGINEERING UNDERGRADUATE CURRICULUM
FIRST YEAR CURRICULUM
COMMON TO ALL ENGINEERING STUDENTS

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
THIRD SEMESTER			**SIXTH SEMESTER**		
2103213	ENG MECHANICS I	3	2103393	ME LAB NON ME	1
2301207	CALCULUS III	3	2106361	WELL LOGGING	3
2103295	BASIC THERMO	3	2106368	RESERVOIR ENG II	3
2106261	PETROLEUM GEOLOGY	3	2106369	PROD TECH	3
2106263	FUND PE	3	5500308	TECH WRIT ENG	3
xxxxxxx	GENERAL EDUCATION	3	xxxxxxx	ELECTIVE COURSE	6
		18			**19**
FOURTH SEMESTER			**SUMMER SEMESTER**		
2103231	MECH OF MAT I	3	2100301	ENG PRACTICE	**2**
2103351	FLUID MECHANICS I	3			
2104253	ENG STAT I	3	**SEVENTH SEMESTER**		
2106266	PETROPHYSICS	3			
2106267	PET FLUID PROP	3	2102391	ELEC ENG I	3
5500208	COM PRES SKIL	3	2102392	ELEC ENG LAB I	1
		18	2106462	PET PROC ENG	3
			2106465	PETROL ECONOMICS	3
			xxxxxxx	ELECTIVE COURSE	3
			xxxxxxx	GENERAL EDUCATION	3
					16
FIFTH SEMESTER			**EIGHTH SEMESTER**		
2100311	ENG ESSENTIALS	3			
2106268	PET DRILL FLUID LAB		2106474	PETRO RES DEV	3
2106362	DRILLING ENG	3	2106479	PETROLEUM PROJECT	3
2106367	RESERVOIR ENG I	3	OR		
2106464	PRODUCTION ENG	3	2100499	ENG PROJ	
2301312	DIFF QUATIONS	1	xxxxxxx	FREE ELECTIVES	6
xxxxxxx	GENERAL EDUCATION	3	xxxxxxx	GENERAL EDUCATION	3
		16			**15**

TOTAL CREDITS FOR GRADUATION = 143

STUDY PROGRAM FOR MASTER DEGREE IN GEORESOURCES AND PETROLEUM ENGINEERING
(MINING ENGINEERING)

First Semester

2186532	Geomechanics	3	Credits
2186608	Resources Environment and Life Cycle Pollution Prevention	3	Credits
2186670	Sustainable Mineral and Petroleum Resources Development	3	Credits
		9	

Second Semester

2186533	Mine Planning and Design	3	Credits
2186642	Resources Economics	3	Credits
	Elective Courses	3	Credits
		9	

Third Semester

2186756	Research Seminar	S/U	Credits
	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

2186509	Resources Process Technology and Utilization	3	Credits
2186608	Resources Environment and Life Cycle Pollution Prevention	3	Credits
2186670	Sustainable Mineral and Petroleum Resources Development	3	Credits
		9	

Second Semester

2186623	Process Separation for Resources Recovery	3	Credits
2186642	Resources Economics	3	Credits
	Elective Courses	3	Credits
		9	

Third Semester

2186756	Research Seminar	S/U	Credits
	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

2186651	Advanced Reservoir Engineering	3	Credits
2186667	Production System Analysis	3	Credits
2186670	Sustainable Mineral and Petroleum Resources Development	3	Credits
		9	

Second Semester

2186671	Advanced Natural Gas Engineering	3	Credits
	Elective Courses	6	Credits
		9	

Third Semester

2186756	Research Seminar	S/U	Credits
2186664	Petroleum Well Construction	3	Credits
	Elective Courses	3	Credits
	Thesis	3	Credits
		9	

Fourth Semester

	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	

COURSE DESCRIPTION INS GEORESOURCES ENGINEERING (B.ENG.)

2106208   Chemical for Materials   3(3-0-6)
Condition: Concurrent 2106209
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; ore sampling and dissolution foranalysis; separation and analysis of metal ions in solution.

2106209   Chemical for Materials Lab   1(0-3-0)
Condition: Concurrent 2106208
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.

2106222   Fundamental of Georesources Engineering   1(1-0-2)
Introduction to mining industry and georesousces development. exploration , evaluation and mineral deposit development; Environment , health and safety considerations in mine operations.

2106251   General Geology   3(2-3-4)
Scope of geology; the universe and the earth; surface features 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.

2106252   Minerals and Rocks   3(2-3-4)
Basic knowledge of mineralogy; crystallography ; crystal system; physical properties; identification of rock-forming and economic minerals; origin of igneous; sedimentary and metamorphic rocks; geological and engineering classification rocks.

2106296   Engineering Geology   3(2-3-4)
Condition : Prerequisite 2103105 and 2108205 or 2108291
A general survey of geology with particular reference to civil engineering; common rockforming 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 habour improvement; geological, factors affecting quarrying, tunnelling, landslide, land subsidence, foundations, and building materials.

2106310   Mineral Processing Engineering   3(3-0-6)
Condition: Concurrent 2106332
Theory of Physical methods of mineral processing. Fundamental of mineral processing including sampling, cominution and liberation, screening, classification, size determination, gravity concentration, magnetic separation, electrostatic separation, introduction to flotation. Construction of simple flow sheets for mineral processing plants.

2106315   Mining Engineering Laboratory   1(0-3-0)
Condition: Consent of Faculty
Laboratory experiments in mining development and mining operation.

2106316   Surface Mining   3(3-0-6)
Exploration, evaluation and development of mineral deposits, classification and selection of various mining methods; mine planning and design concept; earth and rock excavation; drilling and bench blasting ; mine loading and haulage; environmental protection; mine welfare and safety.

2106331   Mineral and Process Engineering   3(3-0-6)
Condition: Concurrent 2106332
Theory of Physical methods of mineral processing. Fundamental of mineral processing including sampling, cominution and liberation, screening, classification, size determination, gravity concentration, magnetic separation, electrostatic separation, introduction to flotation. Construction of simple flow sheets for mineral processing plants.

2106332   Resources Process Laboratory I   1(0-3-0)
Condition: Concurrent 2106331
Laboratory experiments in resources separation and recovery.

2106333   Resources Process Laboratory II 1(0-3-0)
Condition: Concurrent 2106331
Laboratory experiments in resources separation and recovery.

2106412   Resources Economics and Management   3(3-0-6)
Mineral demand and supply; mineral trade and markets; mineral market forecasting techniques; government regulations and taxation; resources evaluation; economics of resources development; project management.

2106413   Resources Environment and Pollution Prevention   3(3-0-6)
Major environmental problems from production and utilization of resources; environmental technology to manage and control the problems; waste minimization and waste disposal, environmental planning for the development and utilization of resources.

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 principles 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.

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; and use of computer codes.

2106432   Separation Technology   3(3-0-6)
Condition: Concurrent 2106333

General description of separation and classification efficiency; hydrocyclones, screens, electrostatic precipitators; mixing, granulation, crystallisation; comminution matrix description of size reduction, milling circuit simulation, size enlargement and agglomeration; motion of particles in fluids; flow of fluids through granular beds; incompressible and compressible cake filtration; gravity sedimentation and clarification; pneumatic and hydraulic transport of solids; surface chemistry and thermodynamics of particles-bubbles attachment; mechanisms of mineral flotation; kinetics of mineral flotation and mechanics; flotation processes of minerals and materials.

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 and 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.

2106439   Particle Technologies for Georesources Engineering   3(3-0-6)

Particle characterization, grinding; powder separation; mixing; agglomeration; transport of powder; storage of powder; safety in operation; dust explosion; dust collection.

2106441   Geotechniques   3(3-0-6)

Engineering properties of soil and rock measurements and classification: stress-strain analysis : failure criteria : stability analysis : geotechnical application to soil and rock excavation.

2106442   Geotechniques Laboratory   1(0-3-0)

Laboratory experiments in rook properties.

2106443   Rock Engineering   3(3-0-6)

Basic rock mechanics; discontinuities; rock and rock mass; strength and failure criteria; in-situ stress; site investigation; rock mass classification; rock testing, in-situ testing; rock mechanics and engineering works; rock slope stability; rock excavation; geotechnical instrumentation and monitoring

2106444   Engineering Explosives 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, fly rock, drilling and blasting cost evaluation,

2106445   Underground Mining   3(3-0-6)

Basic soil and rock mechanics; discontinuities; geological factors for underground excavation Site investigation for underground excavation; underground excavation in mining and civil engineering; underground mining methods, underground monitoring, explosive and blasting in underground excavation, rock support and rock reinforcement; underground mine planning and design, equipment and machine used in underground mining; basic mine ventilation, underground mine safety.

2106446   Mine Planning and Design   3(3-0-6)

Concepts of mine planning and design; application of relevant knowledge in mining on mine design; computer application and simulation in mine planning design; selection of heavy equipment;case studies on mine planning and design.

2106458   Mining Geology   3(3-0-6)
Condition : Prerequisite 2106252

Origin and Occurrence of mineral deposits; mineral associations, alterations and classification, geologic factors controlling characteristics of ore-body; surface and underground geological mapping principles and application of geological, geochemical and geophysical prospecting; planning for exploration drilling, sampling techniques; ore reserve estimation; grade control; and 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.

2106482   Advanced Topics in Geo-Resources Engineering II   3(3-0-6)
Condition: Consent of Faculty

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)
Condition: Consent of Faculty

Special problems in Geo-Resources Engineering and their solutions.

2106484   Special Problems in Geo-Resources Engineering II   3(2-3-4)
Condition: Consent of Faculty

Special problems in Geo-Resources Engineering and their solutions.

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)**
Condition : Consent of Faculty
Practical interesting projects of problems in various fields of Geo-Resource Engineering.

COURSES DESCRIPTIONS IN PETROLEUM ENGINEERING (B.ENG.)

2106261   Petroleum Geology   3(3-0-6)
Fundamental principles of petroleum regarding its origin, migration, and accumulation; chemical composition of petroleum; nature of source rocks, reservoirs, and traps; sedimentary environment and facies; geological field methods; characteristics of natural gas and oil fields of Thailand.

**2106263   Fundamental of Petroleum
                 Engineering   3(3-0-6)**
Introduction to petroleum industry; economics and structure of petroleum industry; petroleum prospecting; drilling operation; petroleum production system; reservoir performance; oil and gas separation; oil and gas transportation; utilization of oil and natural gas.

2106266   Petrophysics   3(3-0-6)
Porosity, Permeability, Fluid Saturation, Resistivity, Wettability, Capillary Pressure, Relative Permeability, Application of Darcy's equation, Measurement of Particle Size Distribution, Measurement of Porosity and Permeability, Measurement of Formation Resistivity, Measurement of Fluid Saturation, Measurement of Wettability and Measurement of Relative Permeability.

2106267   Petroleum Fluid Properties   3(3-0-6)
Phase behavior; equations of state; and PVT properties and determination.

**2106268   Petroleum and Drilling Fluid Laboratory
                                           3(3-0-6)**
Viscosity; specific gravity; composition analysis; pressure, volume, and temperature (PVT) analysis of petroleum fluids; physical and chemical properties of drilling fluids.

2106361   Well Logging   3(3-0-6)
Condition: Prerequisite 2106265
Principles, applications, and interpretation of openhole 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, and 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; well performance; water and gas coning; and water influx.

2106368   Reservoir Engineering II   3(3-0-6)
Condition: Prerequisite 2106367
Oil and gas well tests; and 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)
Prerequisite: 2106267
Handling, separating of oil, natural gas and water from petroleum production; acid gas treating; gas dehydration; LNG; transmission and natural gas.

2106464   Production Engineering   3(3-0-6)
Condition : Prerequisite 2106265
Multiphase flow in pipe; inflow performance; restricted flow into a wellbore; artifical lift; and oil and gas production system and facilities.

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; and thermal recovery; microbial flooding; screening criteria for improved oil recovery.

**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 2106361,
                 2106367, 2106464*
Integrated approaches 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.

**2106488   Practical Education for Resources
              Engineering   3(2-3-4)**
Practical interesting projects/topics for resources and petroleum engineering.

COURSE DESCRIPTIONS IN
GEORESOURCES AND PEROLEUM ENGINEERING
(M.ENG.)

**2186509   Resources Process Technology
              and Utilization   3(3-0-9)**
Extraction, separation 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 bankers; design of bins and bankers; conveyors and feeders; homogenization; hydraulic transport in pipe, pneumatic transport and waste sorting and disposal.

2186512   Chemical Process Separation   3(3-0-9)
Chemical separation of materials; solid state and solution chemistry; thermodynamics and kinetics; stability of compounds; oxidation and reduction; roasting; calcination and sintering; dissolution and mechanisms; effects of thermal treatment; leaching reactions, including halogenation and cyanidation; leaching process variables; recovery from solution and purification; ion exchange and solvent extraction applications; chemical process flowsheets and case studies.

2186522   Materials Characterization   3(3-0-9)
Theories and techniques in material analysis, including mineralogy, microscopy, differential thermal analysis, x-ray diffraction, x-ray fluorescence, spectrometry, electron 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; development of mineral resources; environment, health and safety considerations in mine operation.

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 stresse; 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 of 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)
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 srike, 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 in mineralogy; crystallography; crystal system; physical properties; identification of rock-forming and economic minerals; origin of igneous, sedimentary and metamorphic rocks; geological and engineering classification of rocks.

**2186550   Numerical Methods for Georesources
              Engineer   3(3-0-9)**
Cases of mathematical calculation and modeling in georesources engineering; error analysis; various approaches to numerical methods; application of finite element method (FEM), finite difference method (FDM), and boundary element method (BEM) to solve 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 maps and sections; 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; porosity crossplots.

2186567   Basic Reservoir Engineering   3(2-3-7)
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 design; well control.

2186569   Basic Production Engineering   3(3-0-9)
Well completion; subsurface and wellhead equipment; perforating; sand control; formation damages and production stimulation; surface production processes; production problems and remedies; well intervention and workover.

2186608   Environment and Pollution Prevention in the Life Cycle of Resources   3(3-0-9)
Major environmental problems from production and utilization of resources; technology in managing and controlling environmental effects; waste minimization, waste storage and disposal; environmental management planning for sustainable resource development and utilization; relevant environmental issues in the global arena.

2186623   Process Separation for Resources Recovery   3(3-0-9)
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)
Technology in industrial minerals: extraction, separation and utilization of some major industrial minerals and dimension stones and improvement of their quality to meet industrial requirements; discussion of advanced technology in industrial minerals and case studies.

2186636   Fuel Minerals Technology   3(3-0-9)
Technology in fuel minerals; mineral resource evaluation or assessment, mining processing and utilization of fuel minerals and their quality improvement to meet industrial requirements; discussion of advanced technology in industrial minerals and case studies.

2186637   Quarry Technology   3(3-0-9)
Quarry technology: rock resource evaluation, quarrying, size reduction to various industrial applications; economic aspects of the technology; quality improvement of products according to industrial requirements; discussion of advanced technology in quarry and case studies.

2186638   Advanced Geotechnique   3(3-0-9)
Review of soil and rock mechanics; investigation and data collection; application of soil mechanics theory to both mining and civil engineering works; grouting in engineering works; rock support and reinforcement; various analysis methods in geotechnique; case studies in 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; resources utilization and recycling; waste utilization; waste-to-raw materials and waste-to-energy; life cycle and sustainable resource management; concepts and case studies of sustainable production and consumption.

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 mineral taxation; specification of boundaries and distribution of earth resources; resources evaluation; utilization; cost-benefit analysis; optimal control of the development of earth resources.

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 carbon capture; carbon storage; storage capacity assessment.

2186657   Unconventional Resources Production   3(3-0-9)
Properties of heavy oil; recovery 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 Enhanced Oil Recovery (EOR); miscible flooding, thermal flooding, chemical flooding, current technology in EOR, and stages of EOR screening.

2186664   Petroleum Well Construction   3(3-0-9)
Well planning process; well design and drilling program; well completion; perforating; sand control; well stimulation and workover.

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 rock formation; shaly sand interpretation, carbonate interpretation; abnormally overpressure; fractures.

2186667   Production System Analysis   3(3-0-9)
Single- and multiple-phase horizontal and vertical flows; 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; future availability of resources; implications of sustainable development of mining and petroleum industry; community relationship in the resource development project.

2186671 Advanced Natural Gas Engineering   3(3-0-9)
Phase behavior of the natural gas system; natural gas properties; gas flow in pipe; gas compression calculations; field separation; dehydration; gas processing and transportation; gas production and production problems.

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 assessment; probabilistic models of petroleum exploration projects; expected value; decision tree analysis; and value of information.

**2186721 Advanced Resources Recovery and
Recycling 3(3-0-9)**

Principle of resource recovery and recycling; types of secondary resources; criteria for resource recovery and recycling; benefits and limitations of recycling; rate of recycling and resource depletion; energy conservation from recycling; review of separation processes including physical, chemical and bacterial processes; recycling of ferrous and non ferrous metals, non metals, industrial waste, electrical and electronic equipment waste, end of life vehicles, packaging waste, construction and demolition waste, liquid and waste water from processes recovery in the form of energy, sub-marginal mineral deposit and low grade tailings; energy recovery from waste; unconventional resources; economic aspects in resource recovery and recycling; environmental considerations; current legislation and management for resource recovery and recycling in Thailand and international communities; trade and market for recycling; planning and design of separation for resource recovery project; feasibility case studies.

2186756 Research Seminar 1(1-0-3) (S/U)

Condition: - Consent of faculty
Presentation and discussion of the topics to the researched into or current interesting research topics.

2106811 Thesis 12 Credits

DEPARTMENT OF ENVIRONMENTAL ENGINEERING

The aim of the Department of Environmental Engineering 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 :

Khemarath Osathaphan,   Ph.D. (Oregon State)

ASSOCIATE PROFESSORS:

Chavalit	Ratanatamskul,	Ph.D. (Tokyo)
Chanathip	Pharino,	Ph.D. (MIT)
Orathai	Chavalparit,	Ph.D. (Chula)
Petchporn	Chawakitchareon,	Ph.D. (ENTPE-LYONI)
Pisut	Painmanakul,	Ph.D. (INSA-Toulouse)
Sutha	Khaodhiar,	Ph.D. (Oregon State)
Sirima	Panyametheekul,	Ph.D. (Imperial College)
Thares	Srisatit,	Ph.D. (Savoie)
Khemarath	Osathaphan,	Ph.D. (Oregon State)
Patiparn	Punyapalakul,	Ph.D. (Tokyo)
Tawan	Limpiyakorn,	Ph.D. (Tokyo)
Wiboonluk	Pungrasmi,	Ph.D. (Tokyo)

ASSISTANT PROFESSORS :

Achariya	Suriyawong,	Ph.D. (Washington)
Benjaporn	Suwannasilp	Ph.D. (Stanford)
Chaiyaporn	Puprasert,	Ph.D. (INSA-Toulouse)
Manaskorn	Rachakornkij,	Ph.D. (New Jersey)
Pichaya	Rachdawong,	Ph.D. (Wisconsin-Milwaukee)
Sarun	Tejasen,	Ph.D. (Oregon State)
On - anong	Lavrpparisudthi	Ph.D. (Coventry)
Viboon	Sricharoenchaikul,	Ph.D. (Georgia Tech)

LECTURERS :

Dao Suwansang Jancharoen   Ph.D. (Illinois at Urbana-Champaign)

ENVIRONMENTAL ENGINEERING CURRICULUM
FIRST YEAR CURRICULUM
COMMON TO ALL ENGINEERING STUDENTS

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER			**SIXTH SEMESTER**	
2103213	ENG MECH I	3	2107452	PHYSICO-CHEMICAL TREATMENT	3
2107311	BIO ENV ENG	3	2107462	HAZ WASTE TREAT	3
2107214	AQUA CHEM ENV ENG	3	2107481	INT ENV IMP ASSESSMENT	3
2107346	HYDRAULICS I	3	2108302	FIELD PRACTICE I	1
xxxxxxx	APPROVED ELECTIVE	2	2100311	ENGINEERING ESSENTIALS	3
xxxxxxx	GENERAL EDUCATION	3	xxxxxxx	APPROVED ELECTIVE	2
xxxxxxx	FREE ELECTIVE	3	xxxxxxx	GENERAL EDUCATION	3
		20			*18*
	FOURTH SEMESTER			**SUMMER SEMESTER**	
2107215	WASTE CHEM ENV ENG	2	2100301	ENGINEERING PRACTICE	2
2107312	UNIT OP ENV ENG	3			
2107253	ENG STAT I	3			
2112344	HYDRAULICS LAB I	1		**SEVENTH SEMESTER**	
2112342	PRIN HYDROLOGY	3			
2301312	DIFF EQUATIONS	3	2107411	WAT SUPP ENG DES	4
xxxxxxx	APPROVED ELECTIVE	3	2107444	BUILDING SAN	3
xxxxxxx	GENERAL EDUCATION	3	2107482	ENV ENG PROJ I	1
		20	2107484	SOLID WASTE ENG	3
			5500208	COMMUNICATION AND PRESENTATION SKILL	3
			xxxxxxx	GENERAL EDUCATION	3
					17
	FIFTH SEMESTER			**EIGHTH SEMESTER**	
2107313	UNIT PROC ENV ENG	3	2107412	WASTE ENG DES	4
2107445	AIR POL CONT & DESIGN	4	2107450	ENV SYS MANAGE	3
2112440	ENGINEER GEOLOGY	3	2107483	ENV ENG PROJ II	2
2104203	ENG MANAGEMENT	3	5500308	TECHNICAL WRITING FOR ENGINEERING	3
2108298	SURVEYING	3	xxxxxxx	FREE ELECTIVE	3
xxxxxxx	APPROVED ELECTIVE	3			*15*
		19			

TOTAL CREDITS FOR GRADUATION = 147

NAME OF THE DEGREE

: Master of Engineering
: M.Eng.

DEPARTMENT STAFFS

Khemarath Osathaphan,   Ph.D. (Oregon State)

ASSOCIATE PROFESSORS:

Chavalit	Ratanatamskul,	Ph.D. (Tokyo)
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Benjaporn	Suwannasilp	Ph.D. (Stanford)
Chaiyaporn	Puprasert,	Ph.D. (INSA-Toulouse)
Manaskorn	Rachakornkij,	Ph.D. (New Jersey)
Pichaya	Rachdawong,	Ph.D. (Wisconsin-Milwaukee)
Sarun	Tejasen,	Ph.D. (Oregon State)
On - anong	Lavrpparisudthi	Ph.D. (Coventry)
Viboon	Sricharoenchaikul,	Ph.D. (Georgia Tech)

LECTURERS :

Dao Suwansang Jancharoen   Ph.D. (Illinois at Urbana-Champaign)

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 17 are required and 7 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:

2107701	Seminar in Environmental Engineering I	1(1-0-3)

2) Required Courses   20   credits

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)
2107670	Air Quality Management and Engineering	4(3-3-10)
2107671	Solid and Hazardous Waste Management	4(3-3-10)
2107673	Principles for Environmental Engineering Management	3(3-0-9)
2107702	Seminar in Environmental Engineering II	1(1-0-3)

3) Elective Courses   74   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)
2107608	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 :

Chaiyaporn Puprasert,   Ph.D. (INSA-Toulouse)

ASSOCIATE PROFESSORS :

Chavalit	Ratanatamskul,	Ph.D. (Tokyo)
Orathai	Chavalparit,	Ph.D. (Chula)
Petchporn	Chawakitchareon,	Ph.D. (ENTPE-LYONI)
Pisut	Painmanakul,	Ph.D. (INSA-Toulouse)
Thares	Srisatit,	Ph.D. (Savoie)
Sutha	Khaodhiar,	Ph.D. (Oregon State)
Sirima	Panyametheekul,	Ph.D. (Imperial College)

ASSISTANT PROFESSORS :

Benjaporn	Suwannasilp	Ph.D. (Stanford)
Chaiyaporn	Puprasert,	Ph.D. (INSA-Toulouse)
Chanathip	Pharino	Ph.D. (MIT)
Khemarath	Osathaphan,	Ph.D. (Oregon State)
Pichaya	Rachdawong,	Ph.D. (Wisconsin-Milwaukee)
Sarun	Tejasen,	Ph.D. (Oregon State)
Tawan	Limepiyakorn	Ph.D. (Tokyo)
Wiboonluk	Pungrasmi,	Ph.D. (Tokyo)
Patiparn	Punyapalakul,	Ph.D. (Tokyo)
Manaskorn	Rachakornkij,	Ph.D. (New Jersey)
Viboon	Sricharoenchaikul,	Ph.D. (Georgia Tech)

LECTURERS :

Achariya	Suriyawong,	Ph.D. (Washonton)
On - anong	Lavrpparisudthi	Ph.D. (Coventry)

ADMISSION

1) The applicant must have a Bachelor's Degree in Engineering with a minimum of second class honors
or
2) The applicant must have a Master's Degree in Environmental Engineering or Sanitary Engineering.

DEGREE REQUIREMENTS

Pattern 1 for a Master's Degree student who has a grade point average minimum of 3.5
- require 48 credits of doctoral dissertation
Pattern 2(1) for a Bachelor's Degree student
- require 72 credits of which 24 credits are course work and 48 credits are doctoral dissertation
Pattern 2(2) for a Master's Degree student who has a grade point average less than 3.5
- require 60 credits of which 12 credits are course work and 48 credits are doctoral 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)
2107608	Technology of Solid and Hazardous Waste Technology	3(3-0-9)
2107615	Advanced Environmental Biology	2(1-3-4)
2107616	Air Quality Management	3(3-0-9)
2107618	Water and Wastewater Treatment Plant Operation	3(2-3-7)
2107622	Environmental Control Planning	2(2-0-6)
2107626	Stream Sanitation	2(2-0-6)
2107627	Advanced Sanitary Engineering Laboratory	3(1-6-5)
2107630	Treatment and Disposal of Industrial Waste	3(2-3-7)
2107631	Environmental System Engineering	3(3-0-9)
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)
2107636	Industrial Hygiene Practices	3(3-0-9)
2107637	Advanced Wastewater Technology	3(3-0-9)
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)
2107643	Public Health Engineering	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)
2107647	Process Chemistry of Water Treatment	3(3-0-9)
2107648	Industrial Water Conditioning	3(3-0-9)
2107649	Treatment Plant Hydraulics for Environmental Engineers	1(1-0-3)
2107650	Process Design for Nitrogen Control in Wastewater Treatment Plants	2(2-0-6)
2107652	Upgrading Wastewater Treatment Plants	2(2-0-6)
2107653	Modeling of Biochemical Reactors	3(3-0-9)
2107654	Sampling and Analysis of Air Pollutants	3(2-3-7)
2107655	Statistics for Environmental Engineers	3(3-0-9)
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(3-3-9)
2107659	Theory and Design of Advanced Wastewater Treatment Processes	4(3-3-9)
2107660	Industrial and Hazardous Waste Management	3(3-0-9)
2107669	Environmental Impact Assessment	3(3-0-9)
2107663	Industrial Waste Management	3(3-0-9)

3) Dissertation

2107828	Dissertation	48 credits
2107894	Doctorial Dissertation Seminar	0(0-0-0)
2107897	Qualifying Examination	0(0-0-0)

COURSE DESCRIPTIONS IN ENVIRONMENTAL ENGINEERING (B.ENG.)

2107211 Introduction to Environmental Sanitation and Engineering 3(3-0-6)
An introduction course to the field of Sanitary and Environmental Engineering for rural and urban development; topics include the communicable diseases and methods of communication, control of disease vectors, excreta disposal, refuse collection and disposal, building sanitation, industrial hygiene, air and noise pollution, sources of water supply and treatment, wastewater collection, treatment and disposal.

2107212 Chemistry for Environmental Engineering I 2(1-3-2)
Condition : Prerequisite 2302127, 2302163
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, adsorption, chlorination.

2107213 Chemistry for Environmental Engineering II 2(1-3-2)
Condition : Prerequisite 2302127,2302163
Chemical and physical characteristics of wastewater, general considerations, methods for determination and application of data to Environmental Engineering practice; sample collection and preservation; determinations of solids, DO, BOD, COD, Nitrogen (in all forms related to Environmental Engineering practice), phosphorus and phosphates, grease and oil, volatile acids and sulfides; instrumentation for wastewater analysis.

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.

2107215 Wastewater Chemistry for Environmental Engineering 2(1-3-2)
Chemical and physical characteristics of wastewater, general considerations, methods for determination and application of data to environmental engineering practice; sample collection and preservation; determinations of solids, DO, BOD, COD, nitrogen (in all forms related to environmental engineering practice), phosphorus and phosphates, grease and oil, volatile acids, sulfides and gas analysis; instrumentation for wastewater analysis.

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.
(***** Elective course for non Environmental Engineering Students)

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.

2107312　Unit Operations for Environmental
**　　　　　Engineering　　　　　3(3-0-6)**
An overview of unit processes and application of unit operations in water and waste treatment as well as air pollution control: aeration and gas transfer, mixing, sedimentation, aerosol separation, filtration, coagulation, precipitation, ion exchange, adsorption.

2107313　Unit Process for Environmental Engineering
**　　　　　　　　　　　　　　　3(2-3-4)**
Reactor design, flow model, reaction kinetics, screening, sedimentation, filtration, coagulation-flocculation, absorption, stripping, sorption, stoichiometry of biological process, microbial growth kinetics, activated sludge system.

2107411　Water Supply Engineering and
**　　　　　Design　　　　　　　4(3-3-6)**
Condition : Prerequisite 2107212,2107312
Sources of public water supply, quality and quantity requirements: water standards, population prediction, water consumption and flow variation; design of water distribution systems; design of water treatment plant; planning.

2107412　Wastewater Engineering and
**　　　　　Design　　　　　　　4(3-3-6)**
Condition : Prerequisite 2107311, 2107312,
*　　　　　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; land treatment and disposal.

2107441　Air Pollution Control　　3(3-0-6)
Basic knowledge in air pollution: major pollutions, sources, effects on health and welfare, meteorological transport. Sampling and analysis, techniques for control of emissions of particulates and gas, air pollution control regulations and standards, air quality management, enforcement systems.

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.

2107445　Air Pollution Control and Design 4(3-3-6)
Basic knowledge in air pollution: major pollutions, sources, effects on health and welfare, meteorological transport, sampling and analysis, techniques for control of emissions of particulates and gas, air pollution control regulations and standards, air quality management, enforcement systems.

2107446　Treatment of Industrial
**　　　　　Wastewater　　　　　3(3-0-6)**
Condition : Prerequisite 2107412
Industrial wastewater effluent standards; laws and regulations; industrial wastewater monitoring systems; sources, quantity and qualification characteristics of industrial wastewater; industrial wastewater treatment technology; water pollution control and management in major industries; case studies on wastewater reuse and product recovery.

2107448　Noise and Vibration Control　　2(2-0-4)
Behavior of sound waves; instrumentation; practical measurements; environmental impact of noise and vibration; regulations and criteria for noise and vibration control in environmental systems; use of acoustic materials, noise and vibration barriers.

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.

2107452   Physico-chemical Treatment   3(3-0-6)
Theoretical approach to physico-chemical treatment processes : Chemical reaction treatment, Oxidation-reduction treatment, Floculation, Sedimentation, Precipitation, Separation units, Floatation, Adsorption, Membrane Processes.

2107453   Public Health Engineering   3(3-0-6)
Public health and safety in different environmental quality settings; principles, of managing the environment and safety of working places; managing and promoting the safety during work; law and regulations related to public health; Implementation of engineering principles to manage and minimize environmental problems in working places, communities and metropolitan.

**2107460   Introduction to Hazardous Waste
              Treatment   3(3-0-6)**
An introduction course to hazardous waste treatment technology : topics include definition, classification, regulations, sources, impacts on environment, chemical, biological, thermal, stabilization/solidification treatment, and final disposal method.

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.

2107480   Sanitary System in Architecture   2(2-0-4)
Fundamentals of building sanitary engineering ; conceptual design and installation of building water supply and hot water supply, wastewater collection, rain water drainage, wastewater treatment, fire protection, swimming pool water treatment , solid wastes collection and disposal.

**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.

**2107482   Environmental Engineering
              Project I   1(0-3-1)**
Practical interesting project on problems in various fields of Environmental Engineering.

**2107483   Environmental Engineering
              Project II   2(0-3-2)**
Practical interesting project on problems in various fields of Environmental Engineering.

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.

2107491*   General Water Supply Engineering 3(3-0-6)
Sources of Water supply; drinking water standards; quantity required, ground water collection; water transmission and distribution; water treatment technique: screening, coagulation and flocculation, sedimentation, filtration, disinfection, softening, iron removal, taste and odor removal.

**2107494*   Industrial Water Supply and
              Wastewater Treatment   3(3-0-6)**
Sources of water supply; industrial water standards; water treatment techniques: screening, coagulation and flocculation, sedimentation, filtration, softening, demineralization and disinfection; industrial wastewater characterization; effluent standards; industrial wastewater treatment processes.

**2107495   Advanced Topics in Environmental
              Engineering I   3(3-0-6)**
Condition : Senior Standing
Study topics of current inerest and new developments in various fields of environmental engineering.

**2107496   Advanced Topics in Environmental
              Engineering II   3(3-0-6)**
Condition : Senior Standing
Study topics of current interest and new developments in various fields of environmental engineering.

**2107497   Special Problems in Environmental
              Engineering I   3(2-3-4)**
Condition : Senior Standing
Study or investigation of special problems in Environmental Engineering.

**2107498   Special Problems in Environmental
              Engineering II   3(2-3-4)**
Condition : Senior Standing
Study or investigation of special problems in Environmental Engineering.

**2107499   Environmental Engineering
              Project   3(0-6-3)**
Condition : Senior Standing
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.)

2107530 Advanced Techniques in Physical
and Chemical Treatment   3(3-0-9)

Applications of theoretical approaches to the following physical and chemical treatment processes: absorption, adsorption, stripping, distillation, sedimentation, flotation, coagulation, flocculation, neutralization, gas / liquid transfer, heavy metal removal, membrane filtration.

2107551 Environmental management System
ISO 14000   3(3-0-6)

Environmental management system and ISO 14000 series; ISO 14001 criteria and requirements; environmental situation review; search for environmental aspect, policy and action plans; environmental management system auditing and management review.

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.

2107608 Technology of Solid and Hazardous Waste
Treatment   3(3-0-9)

Basic principles of solid and hazardous materials; atom structure and chemical reaction; combustion mechanisms of reactive materials; laws governing gas temperature, pressure and volume; behavior of compressed and cryogenic gases; explosive mechanism; shock waves; toxicity, corrosive and radiation; hazardous waste treatment technologies, physical chemical and biological treatments; precipitation, sedimentation, chemical oxidation, neutralization, extraction, incineration, landfill, land treatment, ocean disposal; sources, types and composition of waste to be treated and utilized; advantages and disadvantages in recycling waste; processes of basic technologies; processes of utilizing; organic and inorganic waste.

2107611 Advanced Water Treatment
Processes   3(3-0-9)
Condition : Prerequisite 2107212 or
Consent of Faculty

Water sources. Water chemistry and quality. Aeration, Coagulation, Sedimentation, Filtration, Ion exchange, membrane processes, disinfection, adsorption, neutralization and stabilization.

2107612 Advanced Wastewater Treatment
Processes   3(3-0-9)
Condition : Prerequisite 2107213, 2107311
or Consent of Faculty

Development in wastewater technology: wastewater collection and transportation, design of sewers and appurtenances, advanced wastewater treatment, treatment by microbial and biological control techniques, laws relating to effluent disposal, wastewater treatment plant organization and management.

2107613 Design of Water Treatment Plant and
Distribution System   3(1-6-5)
Condition : Prerequisite 2107611
or Consent of Faculty

Development of design criteria for water sources, pipe lines distribution and storage facilities, water treatment and softening, engineering design of water distribution system, functional and hydraulic design of complete water treatment plant.

2107614 Design of Wastewater Treatment Plant and
Collection System   3(1-6-5)
Condition : Prerequisite 2107612
or Consent of Faculty

Combined and separate system: pumping stations, functional and hydraulic design of complete wastewater treatment plant.

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.

2107617 Solid Wastes and Hazardous Wastes
Management   3(3-0-9)

Quantity and composition of solid wastes and hazardous wastes; impacts to environment; legislation; collection and transportation system; disposal technique; choice of disposal site; planning and management; case study.

2107622 Environmental Control Planning 2(2-0-6)

Fundamental of comprehensive environmental planning; planning for environmental health : program planning process; rural and urban development; ecosystem concepts; energy; toxicology; environmental health standards; economic principles of pollution control; social cost and pollution damage functions and their economic, social and health implication; problems associated with environmental management.

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 Assessment2(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   Advances in 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-base equilibria, 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.

**2107647   Process Chemistry of
Water Treatment   3(3-0-9)**
Criteria and standards of water quality, organic compounds in raw and finished water, tastes and odors in drinking water, removal of particulate matter by coagulation, removal of particulate matter by filtration, removal of hardness and other scale. Foaming substances, removal of inorganic contaminants, removal of corrosive substances, removal of pathogenic bacteria and viruses.

**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.

**2107655   Statistics for Environmental
Engineers   3(3-0-9)**
Review of basic statistics; sampling methods for quantitative and qualitative data collection, sample size determination; statistics for data quality control in laboratory; design of experiments, and basic model building techniques.

**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 chemicals 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 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)**
Condition : Prerequisite: 2107661 or C.F.
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)
Condition : Prerequisite: 2107311, 2107661 or C.F.

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.

2107661 Fundamental Chemistry for Environmental Engineering 3(2-3-7)

Chemical and physical characteristics of water and wastewater, general considerations, methods for determination and application of data to environmental engineering practice; instrumentation; sample collection and preservation; laboratory analysis of water; interpretation of water analysis results as related to their treatment; neutralization, precipitation, coagulation, water softening, ion exchange, corrosion, absorption, chlorination; determinations of solids, DO, BOD, COD, nitrogen (in all forms related to environmental engineering practice), phosphorus and phosphates, grease and oil, volatile acids, sulfides and gas analysis.

2107662 Unit Processes for Environmental Engineering 3(3-0-9)

An overview of unit processes and application of unit operations in water and waste treatment by physical, chemical and biological processes as well as air pollution control processes.

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, prevention, design for environment, life cycle analysis (LCA) and waste exchange; linkage of Industrial activity with environmental and social sciences; 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.

2107666 Fundamental 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 and 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, sulphur, phosphorus cycles; freshwater ecology and its inhabitants, lake stratification, river pollution, roles of inhabitants and biota dynamics in wastewater treatment environments.

2107667 Fundamental Engineering for Environmental Engineering 3(3-0-9)

Basic principles of mathematics, statistics, calculus, ordinary differential equation, mechanic, hydraulics and hydrology required for environmental engineering.

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 process: microbial destruction of pollutants process: bioremediation approach: factors influencing bioremediation: bioremediation technology: design of bioremediation systems: detection of microorganisms by molecular tools: phytoremediation: case studies.

2107669 Environmental Impact Assessment 3(3-0-9)

Selection of feasible projects by engineering, socio-economic and environment; environmental changes and its on communities, assessment methodology; environmental planning and decision making; risk assessment caused by chemical of hazardous waste; case studies.

2107670 Air Quality Management and Engineering 4(3-3-10)
Effects of air pollutants, standards, law and regulations, the organization and management of mitigation programs, emission source inventory, pollutant dispersion and mathematical modeling, principles and design of air pollution control system, measurement and monitoring system.

2107671 Solid and Hazardous Waste Management 4(3-3-10)
Overview of management schemes, sources and generation of solid and hazardous wastes, important physical, chemical, and biological characteristics of wastes, regulations, international laws and standards, collection and transfer, transport of hazardous wastes and code of practices, resource recovery of solid wastes, treatment procedures and stabilization of hazardous wastes, thermal processes, various disposal means of solid and hazardous wastes including landfill.

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.

2107673 Principles for Environmental Engineering Management 3(3-0-9)
Principles of planning and setting policies for environmental management; example of policy application in working; principles of using economic instruments in setting policies for natural resource conservation and environmental protection; methods of cost survey and estimation; effectiveness and advantages of policies for environmental management; comparison of advantages and disadvantages of each type of policies in order to achieve the objective as planned; analysis and comparison of current guidelines and policies for environmental management by using case studies in Thailand and abroad; related projects.

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.

2107701 Seminar in Environment Engineering I 1(1-0-3)
A once a week seminar series on work done in sanitary engineering points of view. Invited speakers from government industry and various professionals will present these seminar. Every student is expected to present paper on his own research.

2107702 Seminar in Environment Engineering II 1(1-0-3)
A once a week seminar series on work done in sanitary engineering points of view. Invited speakers from government industry and various professionals will present these seminar. Every student is expected to present paper on his own research.

2107791 Advanced Seminar in Environmental Engineering I 1(1-0-3)
Seminar on recent and interesting topics in the field of environmental engineering, and report presentation.

2107792 Advanced Seminar in Environmental Engineering II 1(1-0-3)
Seminar on recent and interesting topics in the field of environmental engineering, and report presentation.

2107793 Advanced Seminar in Environmental Engineering III 1(1-0-3)
Seminar on recent and interesting topics in the field of environmental engineering, and report presentation.

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.

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.

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

Code	Title	Credits
2107811	Thesis	12 Credits
2107816	Thesis	36 Credits
2107826	Dissertation	36 Credits
2107828	Dissertation	48 Credits
2107830	Dissertation	72 Credits
2107894	Doctorial Dissertation Seminar	0(0-0-0)
2107897	Qualifying Examination	0(0-0-0)

DEPARTMENT OF SURVEY ENGINEERING

The objective of the department is aimed at providing theoretical principles and practical techniques on surveying and mapping 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 which is four years is designed such that the student will have basic knowledge in engineering in general and a more intensive knowledge of survey engineering in particular. The curriculum is blended with theories and practices. Students will have experiences on various surveying instruments and computer programming. confidence and completence 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 seminars on topics of the student's interest. It is expected that the program would enable the students to
1. understand the structures and requirements of surveying and mapping;
2. apply the theories and techniques to general surveying tasks effectively, efficiently, and economically;
3. analyse the instrumental mechanics for evaluating the accuracy and precision attained;
4. follow new technology and development in the field of surveying and mapping and spatial information 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 sector;
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 :

Banjerd	Phalakarn,	Doctorat (Denis Diderot)
Itthi	Trisirisatayawong,	Ph.D. (Melbourne)
Chanin	Tinnachote,	D.Eng. (AIT)
Phisan	Santitamnont,	Dr.-Ing. (Leibniz Hannover)
Vichai	Yiengveerachon,	M.Eng. (Chula)

ASSISTANT PROFESSORS :

Sanphet Chunithipaisarn,	Ph.D. (Newcastle upon Tyne)
Colonel Kanok Weerawong	Ph.D. (Purdue)
Somchai Kriengkraiwasin	M.Eng. (Chula)

LECTURERS :

Octavian Andrei,	Ph.D (TUI, Romania)
Chaichoke Vaiphasa.	Ph.D. (ITC)
Thongthit Chayakula,	Ph.D. (London)
Teetat Charoenkalunyuta,	Ph.D. (Chula)
Garavig Tanaksaranond,	Ph.D. (London)

SURVEY ENGINEERING CURRICULUM
FIRST YEAR CURRICULUM
COMMON TO ALL ENGINEERING STUDENTS

COURSE	SUBJECT	CREDITS	COURSE	SUBJECT	CREDITS
	THIRD SEMESTER			**SUMMER SEMESTE R**	
2301207	CALCULUS III	3	2100301	ENGINEERING PRACTICE	2
2103205	DESCRIPTIVE DRAWING	3			
2103213	ENGINEERING MECHANICS I	3			
2104253	ENGINEERING STATISTICS I	3			
2108234	NUMERICAL ANALYSIS IN GEOMATICS	3		**SEVENTH SEMESTER**	
xxxxxxxx	GENERAL EDUCATION I	<u>3</u>	2108415	GEODETIC SUREYING	3
		18	xxxxxxxx	APPROVE ELECTIVES I	3
			xxxxxxxx	APPROVE ELECTIVES II	3
			xxxxxxxx	GENERAL EDUCATION III	3
			xxxxxxxx	FREE ELECTIVES I	<u>3</u>
					15
	FOURTH SEMESTER				
2101344	FUNDAMENTAL OF CIVIL ENGINEERING	3		**EIGHTH SEMESTER**	
2106251	GENERAL GEOLOGY	3			
2108202	SURVEYING ENGINEERING	3	2108413	FIELED PRACTICE ON PRECISE SURVEYING	1
2108311	GLOBAL GEODESY	3	2108414	FIELD PRACTICE ON DIGITAL MAPPING	1
5500208	COMMUNICATION AND PRESENTATION SKILLS	3	2108499 OR	SURVEY ENGINEERING	3
xxxxxxxx	GENERAL EDUCATION II	<u>3</u>	2100499	SENIOR PROJECT	
		18	xxxxxxxx	APPROVE ELECTIVES III	3
			xxxxxxxx	APPROVE ELECTIVES IV	3
			xxxxxxxx	GENERAL EDUCATION IV	3
	FIFTH SEMESTER		xxxxxxxx	FREE ELECTIVES II	<u>3</u>
					17
2108301	SURVEYING WITH CONSTRUCTION APPLICATIONS	3			
2108371	PHOTOGRAMMETRY AND REMOTE SENSING SYSTEM	3			
2108342	MATHEMATICAL CARTOGARPHY	3			
2108325	GEOGRAPHIC INFORMATION SYSTEM AND APPLICATIONS	3			
2108332	ADJUSTMENT COMPUTATION	3			
2100311	ENGINEERING ESSENTIALS	<u>3</u>	**TOTAL CREDITS FOR GRADUTATION**	**=**	***144***
		18			
	SIXTH SEMESTER				
2112343	HYDROLOGY FOR SURVEYING ENGINEERS	3			
2108372	ADVANCED REMOTE SENSING	3			
2108373	ADVANCED PHOTOGRAMMETRY	3			
2108306	FIELD PRACTICE ON TOPOGRAPHIC SURVEYING	1			
2108307	FIELD PRACTICE ON ROUTE SURVEYING	1			
2108412	SATELLITE SURVEYING	3			
2108326	GEOSPATIAL INFORMATION ANALYSIS AND VISUALIZATION	3			
5500308	TECHNICAL WRITING FOR ENGINEERING	<u>3</u>			
		20			

NAME OF THE DEGREE
: Master of Engineering
: M.Eng.

PROFESSORS :

Chalermchon Satirapod,   Ph.D. (New South Wales)

ASSOCIATE PROFESSORS :

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Chanin Tinnachote,	D.Eng. (AIT)
Phisan Santitamnont,	Dr.-Ing. (Leibniz Hannover)
Vichai Yiengveerachon,	M.Eng. (Chula)

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Teetat Charoenkalunyuta,	Ph.D. (Chula)
Garavig Tanaksaranond,	Ph.D. (London)

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 :

Banjerd Phalakarn,	Doctorat (Denis Diderot)
Itthi Trisirisatayawong,	Ph.D. (Melbourne)
Chanin Tinnachote,	D.Eng. (AIT)
Phisan Santitamnont,	Dr.-Ing. (Leibniz Hannover)
Vichai Yiengveerachon,	M.Eng. (Chula)

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Teetat Charoenkalunyuta,	Ph.D. (Chula)
Garavig Tanaksaranond,	Ph.D. (London)

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, tunnel surveying, hydrographic surveying, survey project planning and management.

**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
Figure of the earth, geodetic datums, gravity field of the earth, reference coordinate systems, astro-geodetic method, computation on the ellipsoid, gravimetric method, satellite method.

**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
Geospatial data analysis functions; spatial interpolation and surface modeling; exploratory spatial data analysis; process modeling and simulation; cartographic fundamentals; principles of graphic design; scientific visualization; animation and virtual worlds; cognitive basis of visualization; cartographic communication; cartographic symbolization and map design; map annotation and name placement; geospatial data generalization; web cartography.

2108332   Adjustment Computation   3(2-3-6)
Condition : Prerequisite 2108233, 2108234
Statistical concepts; principle of propagation ; least squares adjustment methods; post adjustment analysis.

2108342   Mathematical Cartography   3(2-3-6)
Condition : Prerequisite 2108311
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.

2108373   Advanced Photogrammetry   3(2-3-6)
Condition : Prerequisite 2108302
Imaging air-borne and high-resolution sensor systems, geometry on single image frame, information from stereo images, aerial triangulation, sensor modeling and its orientation, mapping and other data products from photogrammetry, applications of photogrammetric products.

2108374   Close-range Photogrammetry   3(3-0-6)
Introduction to close-range photogrammetry. calibration of cameras, geometric and non geometric factors of projects, accuracy and reliability, 3D models, visualization. applications of close-range photogrammetry in civil engineering, industry, architecture, archeology.

2108408   Computer Aided Surveying and Design   3(2-3-4)
Condition : Prerequisite 2108202
Survey automation system:- field code system, triangulated irregular network, earth work; road design and civil works.

2108411   High Precision Surveying   2(1-3-2)
Condition : Prerequisite 2108311 ,2108332
High precision Instruments:- calibration and testing, target, benchmark; Horizontal measurement methods, vertical measurement methods, 3D measurement methods, computation technique, modern surveying technology.

2108412   Satellite Surveying   3(2-3-6)
Condition : Prerequisite 2108311
Concept of satellite positioning, global positioning systems, NAVSTAR GPS concept, errors in GPS measurements, observables in GPS, survey planning, field methods, data processing, practical applications.

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 2108201, 2108301 and 2108311
Introduction to physical geodesy, Height systems, Height from GNSS (GPS), High precision instruments:- calibration and testing, target, benchmark and geodetic control point; Datum transformation, Horizontal measurement methods, Vertical measurement methods, 3D measurement methods, computation technique on UTM.

2108421   Modern Integrated Surveying Technology   3(2-3-4)
Condition : Senior Standing
Concepts of integrating modern surveying technologies to speed up survey: robotic theodolite, laser ranging, laser scanner, GNSS receiver, inertial surveying system, digital camera and video.

2108436   Spatial Database   3(2-3-6)
Condition : Prerequisite 2108326
Introduction to Spatial Database; spatial concept and data model; spatial query language; simple feature for SQL; spatial storage and indexing; query processing and optimization; introduction to spatial data mining; trends in DBMS.

2108450   Advanced GIS Techniques   3(2-3-6)
Condition : Prerequisite 2108326
Overview of GIS and spatial data base management system; review of spatial data models; GIS data management functions; data analysis modeling and functions; output presentation functions; data applications in natural resources and environmental management; applications in disaster management; applications in socio-economic and business problems; GIS development processes; GIS development in Thailand; standard and data quality; trends of future GIS technology.

2108455   GIS Application Development   3(2-3-6)
Condition : Prerequisite 2108326
Types of GIS application; GIS application environment; software development technologies; VBA; Python; .NET; Web application development; opensource tools and software; Software customization.

2108457   Seminar in Survey Engineering   1(1-0-2)
Condition : Senior Standing
Presentation and discussion on topics of interest in survey engineering.

2108495   Advanced Topics in Survey Engineering I   3(3-0-6)
Condition : Senior Standing or Consent of Faculty

Topics of current interest and new developments in various fields of survey engineering.

2108496 Advanced Topics in Survey Engineering II 3(3-0-6)
Condition : Senior Standing or Consent of Faculty
Topics of current interest and new developments in various fields of survey engineering.

2108497 Special Problems in Survey Engineering I 3(2-3-7)
Condition : Senior Standing or Consent of Faculty
Study or investigation of special problems in survey engineering.

2108498 Special Problems in Survey Engineering II 3(2-3-7)
Condition : Senior Standing or Consent of Faculty
Study or investigation of special problems in survey engineering.

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., 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 ; 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.

**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)**
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)**

2108828   Dissertation   48   Credits

2108894   Doctoral Dissertation Seminar

2108897   Qualifying Exam   S/U

2108811   Thesis   12   Credits

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 :

Gobboon   Lothongkum,   Dr.-Ing. (F.A.F. Hamburg)

ASSOCIATE PROFESSORS :

Gobboon	Lothongkum,	Dr.-Ing. (F.A.F. Hamburg)
Ekasit	Nisaratanaporn,	Ph.D. (I.C. London)
Tachai	Luangvaranunt,	Ph.D. (Tokyo)
Seksak	Asavavisithchai,	Ph.D. (Nottingham)
Patama	Visuttipitukul,	Ph.D. (Tokyo)

ASSISTANT PROFESSORS :

Ittipon	Diewwanit,	Sc.D. (MIT)
Panyawat	Wangyao,	Ph.D. (T.U. Kosice)
Suvanchai	Pongsugitwat,	M.Eng. (Tokyo)
Mawin	Supradist Na Ayudhaya,	
		Ph.D. (CarnegieMellon)
Boonrat	Lohwongwatana,	Ph.D. (Caltech)

LECTURERS:

Chedtha	Puncreobutr,	Ph.D. (I.C.London)
Jirapon	Khamwannah,	Ph.D. (U.C.San Diego)

METALLURGICAL AND MATERIALS ENGINEERING CURRICULUM

COURSE NO.	SUBJECT	CREDITS

THIRD SEMESTER

2103213	ENG MECH I	3
2109210	THERMO MAT	3
2109211	PRIN ENG MAT I	3
2109276	ENG MAT LAB	1
2301207	CACULUS III	3
xxxxxxx	GENERAL EDUCATION	6
		19

FOURTH SEMESTER

2103231	MECH OF MAT I	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

FIFTH SEMESTER

2102391	ELEC ENG I	3
2102392	ELEC ENG LAB I	1
2109310	CHEM ENG MAT	3
2109321	QC QM MAT	3
2109333	MET MAT	3
2109377	MICROSTRUC LAB	1
xxxxxxx	GENERAL EDUCATION	3
xxxxxxx	FREE ELECTIVES	3
		20

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.

FIRST YEAR CURRICULUM COMMON TO ALL ENGINEERING STUDENTS

COURSE NO.	SUBJECT	CREDITS

SIXTH SEMESTER

2109334	POLY MAT	3
2109335	CERAMIC MAT	3
2109341	MAT CHAR	3
2109399	IND VISIT	1
2100311	ENGINEERING ESSENTIALS	3 OR
2109336	MAT DAILY LIFE	3
5500208	COM PRES SKIL	3 OR
2109400	COM PRES MET	3
xxxxxxx	ELECTIVES	3
		19

SUMMER SEMESTER

2100301	ENGINEERING PRACTICE	2

SEVENTH SEMESTER

2109411	MECH BEHAV MAT	3
2109478	MECH TEST LAB	1
2109428	MAT PROC	3
2109430	CORROSION OF METAL	3
xxxxxxx	ELECTIVES	6
		16

EIGHTH SEMESTER

5500308	TECH WRIT ENG	3 OR
2109300	CON VOC MAT	3
2109445	FAIL ANAL	3
2109450	MAT SELECT DESIGN	3
2109488	MET MAT ENG PROJ	3
xxxxxxx	ELECTIVES	3
		15

TOTAL CREDITS FOR GRADUATION = 146

METALLURGICAL ENGINEERING

NAME OF DEGREE

: Master of Engineering
: M. Eng.

HEAD :

Gobboon   Lothongkum,   Dr.-Ing.(F.A.F. Hamburg)

ASSOCIATE PROFESSORS :

Gobboon	Lothongkum,	Dr.- Ing.(F.A.F.Hamburg)
Patama	Visuttipitukul,	Ph.D. (Tokyo)
Seksak	Asavavisithchai,	Ph.D. (Nottingham)
Tachai	Luangvaranunt,	Ph.D. (Tokyo)
Ekasit	Nisaratanaporn,	Ph.D.(I.C. London)

ASSISTANT PROFESSORS :

Ittipon	Diewwanit,	Sc.D. (MIT)
Suvanchai	Pongsugitwat,	M.Eng. (Tokyo)
Mawin	Supradist Na Ayudhaya,	
		Ph.D. (Carnegie Mellon)
Boonrat	Lohwongwatana,	Ph.D. (Caltech)
Panyawat	Wangyao,	Ph.D.(T.U. Kosice)

LECTURERS:

Chedtha	Puncreobutr	Ph.D. (I.C.London)
Jirapon	Khamwannah	Ph.D. (U.C.SanDiego)

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 course work and thesis.

Candidates must earn a minimum of 24 credits of graduate course work 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)
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)
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 :

Gobboon   Lothongkum,   Dr.-Ing.(F.A.F. Hamburg)

ASSOCIATE PROFESSORS :

Gobboon	Lothongkum,	Dr.- Ing.(F.A.F. Hamburg)
Ekasit	Nisaratanaporn,	Ph.D.(I.C.London)
Patama	Visuttipitukul,	Ph.D.(Tokyo)
Seksak	Asavavisithchai,	Ph.D.(Nottingham)
Tachai	Luangvaranunt,	Ph.D. (Tokyo)

ASSISTANT PROFESSORS :

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Suvanchai	Pongsugitwat,	M.Eng. (Tokyo)
Panyawat	Wangyao,	Ph.D. (T.U.Kosice)
Boonrat	Lohwongwatana,	Ph.D. (Caltech)
Mawin	Supradist Na Ayudhaya,	
		Ph.D.(Carnegie Mellon)

LECTURERS:

Chedtha	Puncreobutr	Ph.D. (I.C.London)
Jirapon	Khamwannah	Ph.D. (U.C.SanDiego)

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 VI	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 MATERILLS 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.

2109321 Quality Control and Quality Management for Materials Engineering 3(3-0-6)
Quality philosophy; quality management strategies in Materials Engineerings, organizing for quality. quality concepts; quality control techniques in Materials Engineering.

2109333 Metallic Materials 3(3-0-6)
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.

2109336 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 architecture, fashion, arts and craft materials, biomedical materials and biomaterials, automotive materials and household materials.

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.

2109377 Microstructure Laboratory 1(0-3-0)
Analysis of microstructure of metallic materials.

2109399 Industrial Visit 1(0-3-0)
Condition : 3rd year student
Visiting the factories related to metal and materials processings; analyzing the processes and presenting a report of the visit.

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 systemic 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, 2103231
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.

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.

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.

2109478 Mechanical Testing Laboratory 1(0-3-0)
Mechanical properties testing: tension test, bending and torsion test, impact test and hardness test.

2109488 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.

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.

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.

2109480   Seminar   1(1-0-2)
Condition : Consent of Faculty
Presentation and discussion on topics of interest in metallurgical and materials engineering.

**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; 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)
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.

**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.

**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)

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)

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)

Engineering aspects of corrosion and its control; forms by which corrosion manifests itself; simplified mechanisms of corrosion and methods of combationg 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)

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)

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)

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-imension, one-dimensional, two-dimensional and three-imensional nanomaterials; nanomaterials characterizations; environmental and health impacts of nanomaterials.

COURSES DESCRIPTIONS IN METALLURGICAL ENGINNERING (M.ENG., D.ENG.)

2109501　Physical Metallurgy　　3(3-0-9)
Structures of metals; physical properties of single crystals, and polycrystals; defects in crytals; 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 comblined 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.

2109511　Extractive Metallurgy　　3(3-0-9)
Principles of extractive metallurgy; thermodynamics and kinetics of pyrometallurgy including roasting, smelting and refining; physical chemistry of iron and steel-making; principles of hydrometallurgy including thermodynamics of aqueous solutions, kinetics of leaching and precipitation.

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 combationg corrosion; electrode processes; activation, ohmic, and oncentration 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 quantilative 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; 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.

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.

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 physica, crystal structure, lattice vibration, energy band; electric, electronic, optical and thermal properties of metal; electron spins; introduction to basis 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 thier 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.

2109605 Steel Manufacture 3(3-0-9)
Structure and properties of slage; 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.

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 machanics 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.

2109701   Seminar in Metallurgical
**   Engineering I   1(1-0-3)**
Condition : Consent of Faculty
Seminar in selected research topics of interest in Metallurgical Engineering.

2109702   Seminar in Metallurgical
**   Engineering II   1(1-0-3)**
Condition : Consent of Faculty
Seminar in selected research topics of interest in Metallurgical Engineering.

2109703   Seminar in Metallurgical
**   Engineering III   1(1-0-3)**
Condition : Consent of Faculty
Seminar in selected research topics of interest in Metallurgical Engineering.

2109704   Seminar in Metallurgical
**   Engineering IV   1(1-0-3)**
Condition : Consent of Faculty
Selected research topics of interest in Metallurgical Engineering.
2109705   Seminar in Metallurgical
**   Engineering V   1(1-0-3)**
Condition : Consent of Faculty
Selected research topics of interest in Metallurgical Engineering.

2109706   Seminar in Metallurgical
**   Engineering VI   1(1-0-3)**
Condition : Consent of Faculty
Selected research topics of interest in Metallurgical Engineering.

2109707   Seminar in Metallurgical
**   Engineering VII   1(1-0-3)**
Condition : Consent of Faculty
Selected research topics of interest in Metallurgical Engineering.

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.
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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 VI   1(1-0-3)**
Selected research topics of interest in metallurgical and materials engineering.

2109811   Thesis   12 Credits

2109828   Dissertation   48 Credits

2109894   Doctorial Dissertation Seminar   0(0-0-0)

2109897   Qualifying Examination   0(0-0-0)

DEPARTMENT OF COMPUTER ENGINEERING

Objectives

1. Graduates have knowledge of basic sciences and engineering sciences necessary to engage in further learning.
2. Graduates have knowledge and skills needed for the engineering profession.
3. Graduates are able to use engineering tools appropriately.

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 : Courses cover the design and analysis of information processing systems, information technology, software engineering, artificial intelligence, data base management system, computer graphics, 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 :

Natawut	Nupairoj,	Ph.D. (Michigan St.)

PROFESSORS :

Boonserm	Kijsirikul,	Ph.D. (Tokyo Institute of Technology)
Prabhas	Chongstitvatana,	Ph.D. (Edinburgh U.)

ASSOCIATE PROFESSORS :

Atiwong	Suchato,	Ph.D. (M.I.T.)
Kultida	Rojviboonchai	Ph.D (Tokyo)
Nongluk	Covavisaruch,	M.S. in E.E. (Missouri Columbia) M.A. (Languages & International Trade) (Eastern Michigan)
Pornsiri	Muenchaisri,	Ph.D. (Oregon State)
Sartid	Vongpradhip,	Ph.D. (U.of Tech. Sydney)
Setha	Pan-Ngum,	Ph.D. (U. of Warwick)
Somchai	Prasitjutrakul,	Ph.D. (U. of Illinois)
Wiwat	Vatanawood,	Ph.D. (Chula)
Taratip	Suwannasart,	Ph.D. (Illinois Institute of Technology)
Twittie	Senivongse,	Ph.D. (U. of Kent)
Yachai	Limpiyakorn,	Ph.D. (Illinois Institute of Technology)

ASSISTANT PROFESSORS :

Arthit	Thongtak,	D.Eng. (Tokyo Institute of Technology)
Athasit	Surarerks,	Ph.D. (U.of Pierre et Marie Curie)
Attawith	Sudsang,	Ph.D. (U. of Illinois)
Boonchai	Sowanwanichakul,	B.Eng. (Chula)
Chotirat	Ratanamahatana,	Ph.D. (U. of California)
Krerk	Piromsopa,	Ph.D. (Michigan St.)
Natawut	Nupairoj,	Ph.D. (Michigan St.)
Nakornthip	Prompoon,	M.S. (George Wash.U.)
Nattee	Niparnan	Ph.D. (Chula)
Suebskul	Phiphobmongkol,	Ph.D. (Auburn)
Sukree	Sinthupinyo	Ph.D. (Chula)
Proadpran	Punyabukkana Pitsatorn,	Ph.D. (Claremont)
Pizzanu	Kanongchaiyos,	Ph.D. (U.of Tokyo)
Thanawan	Chantaratanapibul,	M.Sc. (Chula)
Thanarat	Chalidabhongse	Ph.D. (Maryland)
Veera	Muangsin,	Ph.D. (U. of Manchester)
Vishnu	Kotrajaras,	Ph.D. (Imperial College)

LECTURERS :

Chairat	Phongphanphanee,	Ph.D. (U. of Southampton)
Chate	Patanothai,	M.Sc. in EE. (U. of Miami)
Duangdao	Wichadakul	Ph.D. (U. of Illinois)
Nuttapong	Chentanez	Ph.D. (Berkeley)
Peerapon	Vateekul	Ph.D. (U. of Miami)
Pitchaya	Sitthi-Amorn	Ph.D. (U. of Virginia)
Thit	Siriboon,	Ph.D. (Oregon State)
Thongchai	Rojkangsadan,	M.Sc. (Chula)

COMPUTER ENGINEERING CURRICULUM
FIRST YEAR CURRICULUM
COMMON TO ALL ENGINEERING STUDENTS

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
THIRD SEMESTER			**SIXTH EMESTER**		
2110200	DISCRETE STRUC	3	2110318	DIS SYS ESSEN	1
2110215	PROG METH I	3	2110332	SYS ANA DESIGN	3
2110221	COMP ENG ESSENTIALS	3	2110422	DB MGT SYS DESIGN	3
2110251	DIG COMP LOGIC	3	2110471	COMP NETWORK I	3
2110253	COMP ELEC INTF	3	2110xxx	APPROVED ELECTIVES	3
2110263	DIG LOGIC LAB I	1	5500308	TECH WRIT ENG	3
xxxxxxx	GENERAL EDUCATION	3	xxxxxxx	GENERAL EDUCATION	3
		19			*19*
FORTH SEMESTER			**SUMMER SEMESTER**		
2110201	COMP ENG MATH	3	2100301	ENGINEERING PRACTICE	2
2110211	INTRO DATA STRUCT	3			
2110254	DIG DESIGN VER	3	**SEVENTH SEMESTER**		
2110265	DIG DESIGN LAB I	1			
2603284	STAT PHYS SCIENCE	3	2110423	SOFTWARE ENG	3
5500208	COM PRES SKIL	3	2110355	FORM LANG/AUTO	3
xxxxxx	GENERAL EDUCATION	3	2110490	COMP ENG PRE-PROJ	1
		19	2110xxx	APPROVED ELECTIVES	6
			xxxxxxx	FREE ELECTIVE	3
					16
FIFTH SEMESTER			**EIGHTH SEMESTER**		
2110313	OS AND SYS PROG	3	2110499	COMP ENG PROJECT	3
2110316	PROG LANG PRIN	3	2110xxx	APPROVED ELECTIVES	9
2110327	ALGORITHM DESIGN	3	xxxxxxx	FREE ELECTIVE	3
2110352	COMP SYS ARCH	3			
2110363	HW SYN LAB I	1			*15*
xxxxxx	GENERAL EDUCATION	3			
		16			

TOTAL CREDITS FOR GRADUATION = 142

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: 9 credits (including a non-credit Seminar course)
2. Track Elective Courses: 9 credits chosen from one of the following tracks:
   a. Intelligent Systems track
   b. Enterprise Information Systems track
3. General Elective Courses: 6 credits
4. Thesis: 12 credits

COURSE REQUIREMENTS

1) Required Courses

2110607	Research Methods in Computer Science	3(3-0-9)
2110636	Performance Analysis and Evaluation	3(3-0-9)
2110681	Computer Algorithm	3(3-0-9)
2110701	Seminar in Computer Engineering I	1(0-1-3)

Remark: 2110701 Seminar in Computer Engineering I is a non-credit course, with S/U evaluation.

2) Track Elective Courses

Each student must choose one of the tracks.

Intelligent Systems Track
Each student chooses 3 courses from the following list. (Remaining courses in the track can be chosen as General Elective Courses.)

2110654	Artificial Intelligence	3(3-0-9)
2110682	Embedded and Real-Time Systems	3(3-0-9)
2110714	Digital Systems	3(3-0-9)
2110743	Machine Learning	3(3-0-9)
2110773	Data Mining	3(3-0-9)

Enterprise Information Systems Track
Each student chooses 3 courses from the following list. (Remaining courses in the track can be chosen as General Elective Courses.)

2110523	Enterprise Application Architecture	3(3-0-9)
2110637	Large-Scale Information Systems	3(3-0-9)
2110640	Information Security	3(3-0-9)
2110663	Worldwide Network Infrastructure	3(3-0-9)
2110673	Information Storage and Retrieval	3(3-0-9)

3) General Elective Courses

Each student chooses 2 courses from the following list.

2110522	UNIX/LINUX for Enterprise Environment	3(3-0-9)
2110638	Object-Oriented Technology	3(3-0-9)
2110651	Digital Image Processing	3(3-0-9)
2110678	Mobile Computing	3(3-0-9)
2110694	Directed Studies in Computer Science	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)
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)
2110781	Special Topics in Distributed Systems	3(3-0-9)
2110792	Advanced Topics in Artificial Intelligence	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. Remaining elective courses of the chosen track which are not part of the 9-credit Track Elective Courses
2. Electives courses of the other track that is not chosen
3. Graduate courses of other programs of the Department (i.e. 21105xx, 21106xx, or 21107xx courses not listed as the General Elective Courses above)
4. Graduate courses of Chulalongkorn University (approval by the Computer Science Program Committee is required).

4) Thesis

2110811	Thesis	12	credits

STUDY PROGRAM

First Semester

2110606	Research Methods in Computer Science	3
2110636	Performance Analysis and Evaluation	3
2110681	Computer Algorithm	3
		9

Second Semester

2110xxx	Track Elective Courses	6

| 2110xxx | General Elective Courses | <u>3</u> |
| | | *9* |

Third Semester

2110711	Seminar in Computer Engineering I	-
2110xxx	Track Elective Courses	3
2110xxx	General Elective Courses	3
2110811	Thesis	<u>3</u>
		9

Fourth Semester

| 2110811 | Thesis | <u>9</u> |
| | | *9* |

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	-
2110816	Thesis	9
		9

Second Semester

2110701	Seminar Computer Eng. I	-
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	-
2110 xxx	Electives	9
		9

Second Semester

2110701	Seminar Computer Eng. I	-
2110 xxx	Electives	3
2110814	Thesis	6
		9

Third Semester

2110702	Seminar Computer Eng. II	-
2110814	Thesis	9
		9

Fourth Semester

| 2110814 | Thesis | 9 |
| | | *9* |

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 other qualifications as announced each year by 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
   - 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 but have **at least 1 year** experience working in Information Technology or Computer.

2. Have other qualifications as announced each year by 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 Courses (2 courses)

2. Required Courses 12 credits
3. Electives 12 credits
4. Thesis 12 credits

Plan B
1. Non-credit Courses (2 courses)
2. Required Courses 18 credits
3. Electives 12 credits
4. Master Project 6 credits
5. Comprehensive Exam

COURSE REQUIREMENTS

Plan A(2)

1) Non-credit Courses

2110606	Research Methods in Computer Engineering	3(3-0-9)
2110701	Seminar in Computer Engineering I	1(0-3-1)

Remark: Non-credit courses 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)
2110721	Software Metrics	3(3-0-9)
2110724	Software Testing and Quality Assurance	3(3-0-9)

3) Electives

Choose 4 courses. Electives will be divided in 2 groups: Software Engineering Electives and General Electives. Student must study at least 2 courses (6 credits) of Software Engineering Electives.

---Software Engineering Electives

2110502	Formal Verification	3(3-0-9)
2110521	Software Architectures	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)
2110722	Software Project Management	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

Student can enroll in any courses open for graduate students. Course must be instructed either by the Department of Computer Engineering or any department in Chulalongkorn University (approval by the Software Engineering Program Committee is required).

4) Thesis

2110811 Thesis	12 credits

Plan B

1) Non-credit Courses

2110606	Research Methods in Computer Engineering	3(3-0-9)
2110701	Seminar in Computer Engineering I	1(0-3-1)

Remark: Non-credit courses 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)
2110721	Software Metrics	3(3-0-9)
2110722	Software Project Management	3(3-0-9)
2110724	Software Testing and Quality Assurance	3(3-0-9)
2110725	Software Engineering Process and Improvement	3(3-0-9)

3) Electives

Choose 4 courses. Electives will be divided in 2 groups: Software Engineering Electives and General Electives. Student must study at least 2 courses (6 credits) of Software Engineering Electives.

---Software Engineering Electives

2110502	Formal Verification	3(3-0-9)
2110521	Software Architectures	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)
2110723	Advanced Software Engineering Development	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

Student can enroll in any courses open for graduate students. Course must be instructed either by the Department of Computer Engineering or any department in Chulalongkorn University (approval by

the Software Engineering Program Committee is required).

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 can enroll in this course since the semester that all courses in the program are registered.

STUDY PROGRAMS

Plan A(2)

First Semester

2110623	Software Requirement Eng.	3
2110701	Seminar in Computer Engineering I	-
2110724	Software Testing and Quality Assurance	3
2110xxx	Elective	3
		9

Second Semester

2110634	Software Design and Development	3
2110721	Software Metrics	3
2110xxx	Elective	3
		9

Third Semester

2110606	Research Methods in Computer Engineering	-
2110xxx	Electives	6
2110811	Thesis	3
		9

Fourth Semester

2110811	Thesis	9
		9

Plan B

First Semester

2110623	Software Requirement Eng.	3
2110701	Seminar in Computer Engineering I	-
2110 722	Software Project Management	3
2110724	Software Testing and Quality Assurance	3
		9

Second Semester

2110634	Software Design and Development	3
2110721	Software Metrics	3
2110 725	Software Engineering Process And Improvement	3
		9

Third Semester

2110606	Research Methods in Computer Engineering	-
2110xxx	Electives	6
2110797	Pre-Master Project in Software Engineeing	3
		9

Fourth Semester

2110xxx	Electives	6
2110798	Master Project in Software Engineeing	3
2110896	Comprehensive Exam	-
		9

PH.D. DEGREE PROGRAM

NAME OF THE DEGREE

: Doctor of Philosophy
: Ph.D.

ADMISSION

The applicant must hold one of the following qualification :
A) Bachelor's Degree (Hons-2nd level or equivalent) or grade point not less than 3.25.
B) Master's Degree of Engineering or Science in Computer, Physics or Mathematics.
In addition he/she has to meet the Graduate School requirement.

DEGREE REQUIREMENTS

The program for Bachelor's Degree Holder, plan 2(1), consists of 12 credits of required courses including 4 non - credit seminars , 12 credits of elective courses ,and 48 credits of thesis , for a total of 72 credits.

The program for Master's Degree Holder, plan 2(2), consists of 4 non - credits seminars, 12 credits of elective courses, and 48 credits of Dissertation , for a total of 60 credits.

The student who has fulfilled the requirement of the program and of the Graduate School will be awarded the Degree of Doctor of Philosophy in Computer Engineering.

COURSE REQUIREMENTS

	1) Required Courses	12 credits
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)
2110716	Seminar I	1(1-0-3)
2110717	Seminar II	1(1-0-3)
2110718	Seminar III	1(1-0-3)

2110719	Seminar IV	1(1-0-3)

	2) Elective Courses	*12*	*credits*
2110694	Directed Studies in Computer Science	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)
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)
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)
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)

	1) Dissertation	
2110828	Dissertation	48 credits
2110894	Doctoral Dissertation Seminar	0(0-0-0)
2110897	Qualifying Examination	0(0-0-0)

STUDY PROGRAMS

Plan 2 (1)

First Semester

2110716	Seminar I	-
2110 xxx	Required coures	12
		12

Second Semester

2110717	Seminar II	-
2110 xxx	Electives	9
2110828	Thesis	3
		12

Third Semester

2110718	Seminar III	-
2110 xxx	Electives	3
2110828	Thesis	9
		12

Fourth Semester

2110719	Seminar IV	-
2110828	Thesis	12
		12

Fifth Semester

2110828	Thesis	12
		12

Sixth Semester

2110828	Thesis	12
		12

Plan 2 (2)
First Semester

2110716	Seminar I	-
2110 xxx	Electives	9
		9

Second Semester

2110717	Seminar II	-
2110 xxx	Electives	3
2110828	Thesis	6
		9

Third Semester

2110718	Seminar III	-
2110828	Thesis	9
		9

Fourth Semester

2110719	Seminar IV	-
2110828	Thesis	9
		9

Fifth Semester

2110828	Thesis	12
		12

Sixth Semester

2110828	Thesis	12
		12

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.

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.

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.

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.

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.

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 LaboratoryI 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 algorthms; 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.

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), association rules, 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, rendering: 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,sequential 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.

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)
Condition : Consent of Faculty
Theory of game design; graphics programming; computer graphics model; data structure for game programming; online game.

2110512 Computer Animation 3(3-0-9)
Condition : Consent of Faculty
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)
Background, issues, and research in assistive technology, application of IT in desigeing and developing software application; tools, or programs to the need of disabled or the eldeily to increase their independence and improve their quality of life.

2110521 Software Architectures 3(3-0-9)
Condition : Consent of Faculty
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 Architecture3(3-0-9)
Foundation concepts of enterprise architecture; analysis and design of enterprise application; UML profile speciflcation, design quality metrics; patterns of enterprise application architecture: structure, constraints and limitation of the patterns; enterprise applications integration techniques and implementaion: presentation, data, application level integration approach and their implementations; best practices and enterprise architecture modelling standards and tools.

2110541 Computer Systems Audit 3(3-0-9)
Design of information system; internal control and auditing of data; validity; reliability; security and protection.

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, jphysical simulation scientific computing and games.

2110605 Computer Programs Structure 3(3-0-9)
High-level structured programming languages; data types and operations; control structures; subprograms; records, sets, pointers and dynamic memory allocations; recursive programming; non-numerical problem solving techniques; problem analysis and program design; introduction to software engineering.

**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.

**2110611 Information Processing and
Computer System 3(3-0-9)**
Introduction to information processing concepts, processing methods, computer development and applications; classification and architecture; data communications and computer networks; computer center management.

2110612 System Programming 3(3-0-9)
Components of a programming system; evolution of operating systems; design of assembler, macro language, macro processor, loader schemes; types of loaders; design of loaders.

**2110614 Programming Languages and
Compilation 3(3-0-9)**
Language structures data, operation, control structures; software-simulated computer; language translation lexical analysis, and parsing, and code generation; other language methodologies list processing, logic programming, object-oriented programming.

2110621 System Analysis and Design 3(3-0-9)
Basic analysis steps, determining system alternatives, determining system economics, defining logical system requirements, basic design tools and objectives; hardware and software: selection and evaluation; design and engineering of software; database development, program development, system implementation, post implementation analysis.

2110622 Data Management 3(3-0-9)
List structures: lists, stacks, queues; table and hash in tree structures: binary search trees, AVL trees, B- trees, heaps; searching and sorting; fundamental of file structures

**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.

2110629 File Management 3(3-0-9)
Introduction to data management, files, and applications; an overview of input/output system architecture; logical file organizations; mapping logical organization onto physical storage; operating systems; file system interface; higher level languages; data management facilities.

2110631 Operating System 3(3-0-9)
Evolution, types, goals, functions and organization: concepts of process; process synchronization; process management; memory management; device management; file management;

**2110632 Advanced Topics in Operating
Systems 3(3-0-9)**
Condition: Consent of Faculty
Advanced and current topics in Operating Systems.

**2110634 Software Design and
Development 3(3-0-9)**
Techniques of software design and development: project management, structured programming, verification and validation, security and privacy, and project documentation; students are required to apply these techniques to large software projects.

**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

2110661 Computer Network 3(3-0-9)
Introduction to network and network components; transmission links and protocols; design and analysis of networks; WAN; IMP; topology; network protocols; flow control and routing techniques.

2110662 Communication and Computer Network 3(3-0-9)
Network components; transmission links and protocols; design and analysis of networks; WAN; IMP; topology; network protocols; flow control and routing techniques.

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.

2110664 Network Management 3(3-0-9)
Condition: Consent of Faculty
Information systems environment, business, and networks; network management data integrity, data security, network availability, network service, network adaptability.

2110665 Computer Communication System and Standards 3(3-0-9)
Introduction to computer and communication systems: on-line system, computer networks, distributed processing; communication model: OSI Standard; networks and standards: ISDN, X.25.

2110671 Database Management Systems 3(3-0-9)
Definition, objectives, and basic concepts information storage and retrieval system; data management system; data management functions and components of database management system: database interrogation, update; data model; security policy; major trade-offs in database management; introduction to object oriented database.

2110672 Data Modeling Techniques 3(3-0-9)
Data modelling concepts; conceptual objects used on simple and complex abstraction level: entity and

entity set, entity attributes, relationship and relationship sets, relationship attributes, domain; normalization of relation: INF, 2NF,3NF,4NF and 5NF; conceptual data modeling: entity-relationship,data folw,logical and physical model, transformation of theological modle into a physical model,and functional design; object-oriented design concept.

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.

2110674 Information Technology Center Management 3(3-0-9)

Organization of the Information-Technology Center, computer personnel; nature of the users; software development tools; computer site operation; personnel management; systems software tuning; hardware evaluation; problems facing the director of the center.

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.

2110683 Concurrent Processing 3(3-0-9)

Principles of distributed, parallel and concurrent systems, parallel architecture and concurrent computing models; concepts of networks protocols for concurrent processing, operating systems and hardware support for distribution of codes, concurrent processing, parallel processing and networking.

2110684 Information System Architecture 3(3-0-9)

Hardware systems: personal computers, network equipment, servers, clusters and super servers, embedded system; application systems: multi-tier systems, markup language, query language; transaction systems: process abstraction, inter-process communication, synchronization, deadlock, transactions, concurrency control; Web-based applications; global systems.

2110685 Computer Application in Enterprises 3(3-0-9)

Business transaction; processes and organisation; information and business decision; human resources and knowledge management; data warehousing.

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 software product and process quality; roles of Total Quality Management (TQM); use of metrics, feasibility studies; cost and effort estimates; discussion of project planning and scheduling; the Capability Maturity Model; basis tenets and application of process validation.

**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 management views of software testing and SQA; quality concepts; black and white box testing techniques; test coverage; 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 such as IEEE and ISO 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)**
Condition : Consent of Faculty
Basic knowledge on software evolution; software comprehension and software maintenance; definition of software evolution and maintenance; laws of software evolution; maintenance categories; maintenance process and process models; maintenance metrics and testing; impact analysis; software rejuvenation; software maintainability.

**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 entablishment; process management premise; process improvement models; improvement paradigms; quality management in process im provement context; conflguration 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 Represintation 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, methodoiogy 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   Per-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 in the project proposal.

2110798   Per-Master Project in Software Engineering   3(0-0-12)
Condition : Prerequisite 2110797
Integration of software engineering principles for software engineering project.

2110799   Master Project   6(0-0-24)

2110811   Thesis   12 Credits

2110814   Thesis   24 Credits

2110816   Thesis   36 Credits

2110828   Dissertation   48 Credits

2110894   Doctoral Dissertation Seminar   0(0-0-0)

2110896   Comprehensive Examination   0(0-0-0)

2110897   Qualifying Examination   0(0-0-0)

COURSES OFFERED TO STUDENTS OUTSIDE FACULTY OF ENGINEERING ONLY :

2110102   Computer Programming - Fortran
Computer systems, problem-solving procedures, algorithms, control structures, data types,vector, array and record, string manipulation. Coding, compiling and linking Fortran programs, constants and variables, operators and expressions, assignment statements, control statements, functions and subprograms, numeric and character applications.

2110103   Computer Programming-Pascal
Computer systems, problem-solving procedures, algorithms, control structures, data types, vector, array and record, string manipulation. Pascal data types, variables, operators, expression, assignment statement, identifiers, program structure, input, output and control statements, procedures and functions composited data types, files.

2110104   Computer Programming - C
Computer system, problem-solving procedures, algorithms, control structures, data types, vector, array and record, string manipulation. C programming concepts, constants, variables, operators and expressions, statements, functions, array and pointer, structure, preprocessor.

2110172   Information Technology   3(2-2-5)
Application software packages: word processing, spreadsheet, presentation and database software; utility software; basic computer system management: backup and restore, software installation and uninstallation.

2110182   Introduction to computer and data Processing   2(2-0-4)

An overview of computer components, hardware and software interaction: basic data processing concepts, data transformation, method of data processing, data communication and programming concepts.

2110183   Introduction to Computer and Programming   3(3-0-6)
An overview of computer components, hardware and software interaction, EDP concepts: programming concepts and introduction to FORTRAN programming.

2110206   Assembly Language Programming   3(2-2-4)
This course will emphasized hand-on experience with Assembly language programming, loader, assembler and I/O devices.

2110281   Basic Programming   2(1-2-3)
Overview of elements of Basic Language, including BASIC statements: arithmetic, input and output, flow of control, subprogram; file processing; sequential access, and random access; application programs in various fields.

DEPARTMENT OF NUCLEAR ENGINEERING

The Department of Nuclear Technology (former name) or the Department of Nuclear Engineering was established in 1972 with the main purpose to train students planning a career in nuclear energy. The department offers programs leading to degrees in Doctor of Engineering (D.Eng.) 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 curriculum is a multidisciplinary one and structured to cover diversified principles of nuclear technology ranging from fundamental science and mathematics to specialized engineering applications. Areas of specialization include nuclear power engineering, environmental and industrial applications of radiation, nuclear instrumentation, radioisotope production, radiation processing, radiation protection and nuclear materials. Most of the graduates entered the government institutions such as Office of Atoms for Peace (OAP), Thailand Institute of Nuclear Technology (TINT) public and private universities, Electricity Generating Authority of Thailand (EGAT), Department of Medical Sciences and various industrial and medical sectors.

At present, the use of nuclear energy in industry is increasing. Thus, there is a need for personnel in this specialized field for safety control and research & development leading to proper, efficient and safe use of radioisotopes including develop techniques and instruments for in-house use. Furthermore, preparations of personnel with solid background in nuclear engineering is crucial to the future decision to use nuclear energy in generating electricity, if necessary.

HEAD :

Sunchai	Nilsuwankosit,	Ph.D. (Wisconsin)

ASSOCIATE PROFESSORS :

Somyot	Srisatit,	M.Eng. (Chula)
Supitcha	Chanyotha,	Ph.D. (Arizona)
Sunchai	Nilsuwankosit,	Ph.D. (Wisconsin)
Doonyapong	Wongsawaeng,	Ph.D. (Berkeley)

ASSISTANT PROFESSORS :
-

LECTURERS :

Decho	Thong-Aram,	M.Eng. (Chula)
Chadet	Yenchai,	M.Sc. (Chula)
Phongphaeth	Pengvanich	Ph.D. (Michigan)
Somboon	Rassame	Ph.D. (Purdue)
Phannee	Saengkaew	Ph.D. (Magdeburg)

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's 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's continuing Ph.D with Nuclear Background

The applicant must have a Bachelor's 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's 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's continuing Ph.D. with Non-Nuclear Background

The applicant must have a Master's 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 1 research paper related to the dissertation work in an international research journal;
- present the dissertation work in a national or international symposium; and meet publication requirements of the Graduate School.

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) Prerequisite Courses

Student with insufficient background knowledge of mathematics and/or nuclear engineering must take

2111600 Nuclear Engineering I *
3(3-0-9)
2111631 Applied Mathematics in Nuclear Technology *
3(3-0-9)
*Non-credit course. Student is given S (atisfied) /U (nsatisfied) instead of letter grades.

Student with Admission Type 1.1 or 1.2 with insufficient practical knowledge of experimental nuclear 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. Student is given S(atisfied)/U(nsatisfied) instead of letter grades.

Student may be exempted from doing so upon receiving approval from the Programme Board. Proof of prior 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)

*Non-credit course. Student is given
S(atisfied) /U (nsatisfied) instead of letter grades.

2) 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 13 credits.

2111604 Radiation Detectors and Nuclear Instruments Laboratory   1(0-3-7)
2111613 Radiation Safety and Shielding   3(3-0-9)
2111642 Nuclear Reactor Engineering   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)

and select from ONE of the following courses

2111642 Nuclear Reactor Engineering   3(3-0-9)
2111643 Nuclear Power Engineering   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 course

2111829 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 course

2111830 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 received a Bachelor's Degree in engineering or a Bachelor Degree of 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 not less than 3.00 within a period of study of not less than 4 regular semesters and not 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 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 publication requirements of the Graduate School; and
- obtain "satisfied (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 a minimum of 27 credits of the required and the elective courses (see COURSE REQUIREMENTS);
- pass total of 12 credits of the thesis course;
- present an acceptable thesis and pass an oral examination;
- meet 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

2111600   Nuclear Engineering I *   3(3-0-9)
*Non-credit course. Student is given S (atisfied) /U (nsatisfied) instead of letter grades.

Student may be exempted from the course upon receiving approval from the Programme Board. Proof of prior 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(atisfied)/U(nsatisfied) 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. Student is given S (atisfied) /U (nsatisfied) instead of letter grades.

Student may be exempted from the course upon receiving approval from the Programme Board. Proof of prior 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)
2111642 Nuclear Reactor Engineering   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)

and select from ONE of the following courses

2111642 Nuclear Reactor Engineering   3(3-0-9)
2111643 Nuclear Power Engineering   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 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 to those students who plan a career of research related to nuclear technology. The courses cover basic nuclear science & technology, radiation protection, radiation measurement, application of radiation and radioisotope, nuclear materials and radiation chemistry & processing. From November 2013, the program also includes courses related to nuclear security and safeguards.

To be eligible for admission to the program an applicant must hold a Bachelor's degree in science, applied science, technology or engineering. Applicants are required to take the entrance examination administered by the department.

DEGREE REQUIREMENTS

The program consists of 27 credits of courses, 12 credits of required courses and 15 credits of electives. 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 of 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 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 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) Prerequisite Courses

Student with insufficient background knowledge of nuclear engineering must take

2111601*	Introduction to Nuclear science and Technology	3(3-0-9)
2111631*	Applied Mathematics in Nuclear Technology	3(3-0-9)

*Non-credit course. Student is given S (atisfied) /U (nsatisfied) instead of letter grades.

Student may be exempted from the course upon receiving approval from the Programme Board. Proof of prior 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 Technology Field of Study: All of the following courses are required for the total of 10 credits

2111603	Radiation Detection and Measurement Laboratory	1(0-3-7)
2111608	Practical Radiation Detection and Measurement	3(3-0-9)
2111612	Radiation Protection	3(3-0-9)
2111684	Current Topics in Nuclear Technology	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)

3) Specific Elective Courses minimum 9 credits

3.1) Nuclear Technology Field of Study: Choose from the following courses; minimum of 9 credits are required.

2111604	Radiation Detectors and Nuclear Instruments Laboratory	1(0-3-7)
2111607	Environmental Radiation Measurements	3(3-0-9)
2111609	Radiation Dosimetry	3(3-0-9)
2111613	Radiation Safety and Shielding	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)
2111662	Nuclear Electronics	3(3-0-9)

2111663	Radiation Detectors and Nuclear Instruments	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)
2111686	Special Topics in Nuclear Technology	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 6 credits of the courses available in the Master of Science in Nuclear technology Program.

5) Thesis

2111811	Thesis	12 credits

NUCLEAR AND RADIOLOGICAL ENGINEERING CURRICULUM
FIRST YEAR CURRICULUM
COMMON TO ALL ENGINEERING STUDENTS

COURSE NO.	SUBJECT	CREDITS		COURSE NO.	SUBJECT	CREDITS
	THIRD SEMESTER				**SIXTH EMESTER**	
2103213	ENG MECHANICS I	3		2111311	RAD MAC I	3
2103241	THERMODYNAMICS I	3		2111303	ENV ASP NUC	3
2111200	ESS NUC ENG	3		2111304	PRI NUC INS	3
2111202	BAS NUC DET	3		2111305	NUC INS LAB	1
2111203	NUC RAD LAB	1		2111310	NUC REA SAF	3
2111204	HEA PHY RAD	3		2111309	NUC REA LAB	1
2111205	INT NUC MAT	3		2111401	SEM NUC ENG	1
				xxxxxxx	APPROVED ELECTIVES	3
		19				**18**
	FORTH SEMESTER				**SUMMER SEMESTER**	
2104223	ENG STAT I	3		2100301	ENGINEERING PRACTICE	2
2111206	NUC PLA TEC	3				
2102391	ELEC ENG I	3			**SEVENTH SEMESTER**	
2102392	ELEC ENG LAB I	1				
2103351	FLUID MECHANICS I	3		2104203	ENG MANAGEMENT	3
2111208	NUC REAC ANALYSIS	3		2111402	PRO NUC ENG I	1
5500208	COM PRES SKIL	3		2111444	SOC SCI NUE	3
		19		xxxxxxx	APPROVED ELECTIVES	3
				xxxxxxx	GENERAL EDUCATION	6
				xxxxxxx	FREE ELECTIVE	3
						19
	FIFTH SEMESTER				**EIGHTH SEMESTER**	
2100311	ENG ESSENTIALS	3		2111403	PRO NUC ENG II	1
2111301	ENV ASP NUC	3		xxxxxxx	APPROVED ELECTIVES	3
2111308	ELE CIR NUC	3		xxxxxxx	GENERAL EDUCATION	6
2111306	IND RAD MAT	3		xxxxxxx	FREE ELECTIVE	3
2111307	IND RAD LAB	1				**13**
2111312	NUC3S	3				
5500308	TECH WRIT ENG	3				
		19				

TOTAL CREDITS FOR GRADUATION = 145

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, otheradvanced reactor types, Thermodynamics of nuclear power plants, rankine cycle, thermal design of nuclear reactors, reactor heat generation, single phase heat transfer, two phase heat transferin nuclear reactor.

2111208   Nuclear Reactor Analyis   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.

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 3(3-0-6)
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　3(3-0-6)
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　3(3-0-6)
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　3(3-0-6)
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　3(3-0-6)
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 modeling, 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 wastemanagement; 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.

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.

2111627 Material Analysis with Nuclear Techniques 3(3-0-9)
Condition: Prere 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: Prere 2111642

Phylosophy of nuclear reactor and plant control; elementary physics of reactor control; nuclear reactor kinetics; nuclear reactor control radiation instruments; nuclear reactor control mechnisms; nuclear reactor control problems; computer simulation of nuclear reactor power.

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 kinetics and nuclear reactor control.

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 prokiferation 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; sefeguards issues; international framework of nuclear material safeguard; nuclear proliferation threat; radiological threat; detectinlg 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: Prere 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 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: PRER2111663 และ 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 diginlal 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; hight 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.

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 relted to research works.

2111811	Thesis THESIS	12(0-0-0)
2111817*	Thesis THESIS	37(0-0-0)
2111829*	Dissertation DISSER	49(0-0-0)
2111826*	Dissertation DISSER	36(0-0-0)
2111830*	Dissertation DISSER	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 :

Sucharit   Koontanakulvong,
                    D.Agr. (Kyoto)
Saree   Chanyotha   Ph.D. (Arizona)
Tuantan   Kitpaisalsakul, D.Eng. (AIT)

ASSISTANT PROFESSORS :

Aksara   Putthividhya, Ph.D. (U. of Michigan)
Anurak   Sriariyawat,   Ph.D. (Nottingham)

LECTURERS :

Busawan   Bidorn,   Ph.D. (FSU)
Piyatida   Ruangrassamee Ph.D. (MIT)
Pongsak   Suttinon   D.Eng (Kochi UT)
Supattra   Visessri   Ph.D. (ICL)

NAME OF THE DEGREE

: Master of 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)
2112631	Hydrological Processes	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)
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)
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)
2112674	Water Management	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 |

NAME OF THE DEGREE

: Doctor of 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 with a period of study no more than 10 regular semesters 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)
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)
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)
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)
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 |

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)
Condition: Prerequisite 2112346
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)
Condition: Prerequisite 2112346
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 probabilititistic 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 2112341 or
　　　2112342 and Senior Standing
　　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 Analysis
　　　　　for 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.

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.

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)
Condition : Prerequisite 2112671 or
Consent of Faculty
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)
Condition : Prerequisite 2112671 or
Consent of Faculty
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)
Condition : Prerequisite 2112671 or
Consent of Faculty
Water requirements for agriculture, industries, communities and environmental; economic, social and political criteria in water resources allocations; water resources allocation techniques and optional allocations.

2112681 Engineering for Water Disaster Mittiagtion 3(3-0-9)
Condition : Consent of Faculty (S/U)
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)

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.

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)

2112828 Dissertation 48(0-0-0)

2101894 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 (2016)

Chairman
Dean
Supot   Techavorasinskun

Member
Associate Dean

Sompong	Putivisutisak,Asst.Prof.Dr.
Naebboon	Hoonchareon,Asst.Prof.Dr.
Suebskul	Phiphobmongkol,Asst.Prof.Dr.
Suttichai	Assabumrungrat, Prof.Dr.
Cherdkul	Sopavanit,Asst.Prof.Dr.
Natawut	Nupairoj, Asst.Prof.Dr
Manoj	Lohatepanont,Asst.Prof.Sc.D.
Natcha	Thawesaengskulthai,Asst.Prof.Dr.

Assistant Dean

Chatpan	Chintanapakdee,Asst.Prof.Dr.
Kuntinee	Maneeratana,Assoc.Prof.Dr.
Athasit	Surarerks,Asst.Prof.Dr.
Anongnat	Somwangthanaroj,Assoc.Prof.Dr.
Boonrat	Lohwongwatana,Dr.
Paveena	Chaovalitwongse,Asst.Prof.Dr.
Noppadon	Jokkaw,Asst.Prof.Dr.
Sanphet	Chunithipaisan,Asst.Prof.Dr.
Atiwong	Suchato,Assoc.Prof.Dr.
Pisut	Painmanakul,Assoc.Prof.Dr.Ing.
Phongphaeth	Pengvanich,Dr.
Jittichai	Rudjanakanoknad, Asst.Prof.Dr.

Other Administrative Position

Nisachon	Tangsanggiumvisai,Assoc.Prof.Dr.
Nares	Chankow,Assoc.Prof.Dr.

Head of Department
Head of the Department of Mechanical Engineering
Head of the Department of Electrical Engineering
Head of the Department of Computer Engineering
Head of the Department of Industrial Engineering
Head of the Department of Chemical Engineering

Director
Supot   Techavorasinskun

Associate Director

Ekachai	Leelarasmee,Assoc.Prof.Dr.
Varong	Pavarajarn,Asst.Prof.Dr.
Akawat	Sirisuk,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   (ICE)
   Engineering

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)

Nano Engineering program is a multi-disciplinary scheme in which students learn how to understand and engineer various functional systems at the atomic scale. Sub - microsco - pically the physical, chemical, and biological properties of materials are different those of bulk forms in the macroscopic level from Uncovering these unique characteristics propels the groundbreaking research and development of novel applications, making nano - technology the next industrial revolution.

Nano Engineering program aims to develop produce undergraduate students with strong backgrounds in biomedical chemical, electrical, and materials engineering. Medicine, plastic, materials research, and high performance electronics are just some of the many areas in which development on the nano scale are becoming a major force for technological improvement. Upon completion of their degree, our students form a unique and important human resource pool, capable of driving manufacturing and services industries towards future success.

Nano Engineering curriculum has offered two majors in 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 146 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

Phulporn Saengbangpla	M.Sc (Manchester,UK)
Pramote Dechaumphai	Ph.D. (Virginia)
Ekachai Leelarasmee	Ph.D. (California)
Asi Bunyajitradulya	Ph.D. (California)
Siriporn Damrongsakkul	Ph.D. (London)
Atiwong Suchato	Ph.D. (Massachusetts)
Patama Visuttipitukul	Ph.D. (Tokyo)
Sunhapos Chatranuwathana	Ph.D. (Michigan)
Chaodit Aswakul	Ph.D. (London)
Yan Zhao	Ph.D. (London)
Surapong Sirikulvadhana	M.S (Michigan)
Varong Pavarajarn	Ph.D. (Oregon)

Professors

Electrial Engineering
David	Banjerdpongchai,	Ph.D.(Stanford)

Associate Professors

Electrical Engineering
Songphol	Kanjanachuchai,	Ph.D.(Cambridge)
Nisachon	Tangsangiumvisai,	Ph.D.(London)

Mechanical Engineering
Asi	Bunyajitradulya,	Ph.D.(UC, Irvine)

Chemical Engineering
Artiwan	Shotipruk,	Ph.D.(Michigan, Ann Arbor)
Deacha	Chatsiriwech,	Ph.D.(Imperial College)
Tharathon	Mongkhonsi,	Ph.D.(London)
Sarawut	Rimdusit	Ph.D.(U.S.A.)
Anongnat	Somwangthanaroj,	Ph.D.(Michigan)

Metallurgical and materials Engineering
Seksak	Asavavisitchai,	Ph.D.(Nottingham)

Assistant Professors

Electrical Engineering
Arporn	Teeramongkonrasmee,	Ph.D.(Chula)
Widhyakorn	Asdornwised,	D.Eng.(Chula)
Manop	Wongsaisuwan,	D.Eng.(T.I.T.)
Chanchana	Tangwongsan,	Ph.D.(Wisconsin)
Chanchai	Pluempitiwiriyawej,	Ph.D. (Carregie Mellan)
Thavatchai	Tayjasanant,	Ph.D.(Canada)

Mechanical Engineering
Nopdanai	Ajavakom	Ph.D.(UC,Berkeley)
Niphon	Wonsophark	D.Eng.(Chula)
Thanyarat	Singhanart,	Ph.D.(Tokyo)
Alongkorn	Pimpin,	Ph.D. (Tokyo)

Chemical Engineering
Varong	Pavarajarn,	Ph.D.(Oregon State)
Sorada	Kanokpanont,	Ph.D.(Drexel)
Kasidit	Nootong,	Ph.D.(Pennsyvania)
Soorathep	Kheawhom,	Ph.D.(Tokyo)

Metallurgical and materials Engineering
Ittipon	Diewwanit,	Sc.D.(MIT)

Patama	Visuttipitukul,	Ph.D.(Tokyo/Japan)

Industrial Engineering
Daricha	Sutivong	Ph.D.(Stanford)

Lecturer

Electrical Engineering
Chanin	Wissawinthanon	Ph.D.(USA.)
Boonchuay	Supmonchai	B.Eng.(Chula)
Supatana	Auethavekiat	Ph.D. (Tokyo)

Mechanical Engineering
Tawan	Paphapote	M.S.(Llinolis)
Werayut	Srituravanich	Ph.D.(UCLA)

Chemical Engineering
Akawat	Sirisuk,	Ph.D.(Wisconsin)
Varun	Taepaisitphongse,	Ph.D.(UCLA)

Environmental Engineering
Achariya	Suriyawong,	Ph.D.(St.Louis)

Computer Engineering
Chate	Patanothai,	M.Sc.in EE.(Miami)

ISE Staffs
Yan	Zhao,	Ph.D.(London)
Porpin	Pungetmongkol	Ph.D.(Tokyo)
Rehan	Hussain	Ph.D.(Cambridge)

Visiting Professor
Pensri	Thongnopneua	Ph.D.
Suthiluk	Patumraj	Ph.D.(New Jersey)

Assistant Professors
Wuthichai	Wongthatsanekorn	Ph.D.(U.S.A.)

Lecturer
Niti	Yongvanich	Ph.D. (Pennsylvania)
Nuwong	Chollacoop	Ph.D.(U.S.A.)
Pahnit	Seriburi	Ph.D.
Pimporn	Uttayarat	Ph.D. (Pennsylvania)
Yupawadee	Sathirakul	Ph.D.
Wibool	Piyawattanametha	Ph.D. (Los Angeles)
Viriya	Udomphol	Ph.D.
Akarin	Phaibulpanich	Ph.D.(Michigan)
Adisorn	Tuantranont	Ph.D(Colorado)
Anurat	Wisitsoraat	Ph.D.(U.S.A.)
Oratai	Jongprateep	Ph.D.(U.S.A.)
Wuthichai	Wongthatsanekorn	Ph.D.
Benjaratg	Pupacdi	Ph.D.

Curriculum
Total number of credits requirement	146	credits
General Education	30	credits
Core Courses	110	credits
Basic Sciences	22	creditis
Basic Engineering	30	credits
Compulsory	34	credits
Approved Electives	24	credits

Free Electives	6	credits

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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)	
2189336 Materials in Daily Life	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	110	credits

<u>Basic Mathematics and Sciences</u>	22	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)	
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)	

<u>Basic Engineering</u>	30	credits
2140301 Industrial Training	2 (0-6-0)	
2182201 Mathematics for Nano-Engineers	3 (3-0-6)	
2182203 Probability and Statistics for Engineers	3 (3-0-6)	
2183101 Engineering Graphics	3 (2-3-4)	
2184303 Engineering Management	3 (3-0-6)	
2185222 Physical Chemistry for Nano-Engineers	3 (3-0-6)	
2185320 Inorganic Chemistry for Nano-Engineers	3 (3-0-6)	
2189101 Engineering Materials	3 (3-0-6)	
2189201 Introduction to Materials Science and Engineers	3 (3-0-6)	
2190101 Computer Programming	3 (3-0-6)	
2190151 Computer Programming Laboratory	1 (0-3-0)	

<u>Compulsory</u>	34 credits	
2141490 Nano Seminar	4 (1-0-2)	
2141491 Research Methodology	2 (2-0-4)	
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 Electrical Circuit Laboratory	1 (0-3-0)	
2182280 Semiconductor Devices I	3 (3-0-6)	
2182311 Measurement and Instrumentation	3 (3-0-6)	
2183211 Engineering Mechanics	4 (4-0-8)	
2185220 Basic Organic Chemistry	3 (3-0-6)	
2185221 Organic Chemistry Laboratory	1 (0-3-0)	
2185322 Thermodynamics for Nano-Engineers	3 (3-0-6)	
2185333 Transport Phenomena	3 (3-0-6)	

| 2189341 | Materials Characterization | 3 (3-0-6) |

Approved Electives
Approved Elective Level 1
Select 12 Credits from 2 fields in the following list.

Fields Nanoelectronics

| 2182440 | Introduction to Nanoelectronics | 3 (3-0-6) |
| 2183411 | Micro and Nanofabrication Technology | 3 (3-0-6) |

Fields Nano Chemistry

| 2185324 | Molecular Chemistry | 3 (3-0-6) |
| 2185373 | Reaction Engineering | 3 (3-0-6) |

Fields Biomedical Nanotechnology

| 2182441 | Biomedical Electronics | 3 (3-0-6) |
| 2141350 | Biological Interaction with Materials | 3 (3-0-6) |

Fields Nano Materials Science

| 2141400 | Principles of Nanostructured Materials | 3 (3-0-6) |
| 2189301 | Bonding, Crystallography and Defects | 3 (3-0-6) |

Approved Elective Level 2
Select 12 credits from any courses in the following list or from courses in Approved elective level I.

2141331	Quantum Mechanics for Engineers	3 (3-0-6)
2141347	Introduction to Pharmaceutical Nanotechnology	3 (3-0-6)
2141451	Bionanotechnology	3 (3-0-6)
2141474	Introduction to Lab-on-a-Chip	3 (3-0-6)
2141511	Special Topics in Nano Eng I	3 (3-0-6)
2141512	Special Topics in Nano Eng II	3 (3-0-6)
2182330	Linear Control Systems	3 (3-0-6)
2182443	Introduction to VLSI Technology	3 (3-0-6)
2182480	Semiconductor Devices II	3 (3-0-6)
2182580	Optoelectronics	3 (3-0-6)
2183412	Micro and Nano-Electro Mechanical Systems	3 (3-0-6)
2183431	Mechanical Vibrations	3 (3-0-6)
2185323	Intermediate Organic Chemistry	3 (3-0-6)
2185452	Biosystems and Biotransport	3 (3-0-6)
2185479	Nanopolymer Engineering	3 (3-0-6)
2189411	Mechanical Behavior of Materials	3 (3-0-6)
2189417	Composite Materials	3 (3-0-6)
2189450	Materials Design and Selection	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)

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
	FIRST SEMESTER			**FIFTH SEMESTER**	
2190101	Computer Programming	3	2182311	Measurement and Instrumentation	3
2190151	Computer Programming Laboratory	1	2185320	Inorganic Chemistry for Nano-Eng	3
2301107	Calculus I	3	2189341	Materials Characterization	3
2302103	General Chemistry Laboratory	1	2189336	Materials in Daily Life	3
2302105	Chemistry for Engineers	3	xxxxxxx	Approved Electives	6
2304153	Physics for Engineers	3			18
2304193	Physics Lab. For Engineers	1			
5501112*	Communicative English I	3		**SIXTH SEMESTER**	
		18	2184303	Engineering Management	3
	SECOND SEMESTER		2185322	Thermodynamics for Nano-Eng	3
			2185333	Transport Phenomena	3
2140111	Exploring Engineering World	3	xxxxxxx	Approved Electives	6
2183101	Engineering Graphics	3	xxxxxxx	General Education	3
2189101	Engineering Materials	3			18
2301108	Calculus II	3			
2304154	Physics and Electronics for Eng	3		**SUMMER SEMESTER**	
2304194	Physics and Electronics Lab. for Eng	1			
5501123	Communicative English II	3	2140301	Industrial Training	2
		19			2
	THIRD SEMESTER			**SEVENTH SEMESTER**	
2182201	Mathematics for Nano-Engineering	3	2141491	Research Methodology	2
2182210	Electrical Circuit	3	2141498	Nano-Engineering Pre-Project	1
2183211	Engineering Mechanics	4	xxxxxxx	General Education	3
2189201	Introduction to Material Science and Eng	3	xxxxxxx	Approved Electives	9
2185220	Basic Organic Chemistry	3	xxxxxxx	Free Elective	3
2185221	Organic Chemistry Laboratory	1			18
5501214	Communication and Presentations Skills	3			
		20		**EIGTHTH SEMESTER**	
			2141490	Nano Seminar	1
	FOURTH SEMESTER		2141499	Nano Engineering Project	3
			xxxxxxx	Approve Electives	3
2182203	Probability and Statistics for Engineers	3	xxxxxxx	General Education	6
2182213	Electrical Circuit Laboratory	1	xxxxxxx	Free Elective	3
2182280	Semiconductor Devices I	3			16
2303111	Biology for Engineers	3			
2303112	Biology Laboratory for Engineers	1			
2185222	Physical Chemistry for Nano-Eng	3			
5501225	Technical Writing	3			
		17		**TOTAL CREDITS FOR GRADUATION**	**146**

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.

2189336   Materials in Daily Life   3 (3-0-6)
Different aspects of materials as found in daily life, in various occupations and in various applications; environmentally friendly materials; full utilization of materials in both efficient sense and artistic sense; topics related to materials for design.

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 5501123 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 Sciences

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.

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.

Basic Engineering

2140301   Industrial Training   2 (0-6-0)
Condition: PRER 2301108 Calculus II
Engineering practice in related areas under supervision of experienced engineers in private sectors or government agencies.

2182201   Mathematics for Nano-Engineering
3 (3-0-6)
Condition: PRER 2301108 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' Equation, Power Series Solution, Frobenius Method, Partial Differential Equation, Boundary Value Problem, Tensor and its Convention, Indicial Nottation, 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 Maniqulation 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, Overviaw of Nanotechnology, Applications to Scanning Tunneling Microscope Image.

2182203   Probability and Statistics for Engineers
                                       3 (3-0-6)
Condition: PRER 2301108 Calculus II
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.

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.

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.

2185320   Inorganic Chemistry for Nano-Engineering
                                       3 (3-0-6)
Atomic structure and periodicity; molecular geometry and symmetry; introduction to molecular orbital theory; reaction with electron transfer; inorganic solids.

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 structures which are correlating with properties of the engineering materials; production process of products from engineering materials.

2189201   Introduction to Materials Science and Engineering   3 (3-0-6)
Atomic structures and bonding in solids; crystallography; phase, surface and interface; defects and dislocations; diffusion in solids; phase equilibrium diagrams; mechanical properties; relationship between micro-and nano-structures and properties of engineering materials; classes of engineering materials; production and processing of engineering materials.

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
2141490   Nano Seminar   1 (1-0-2)
Seminar on interesting topics related to nano-engineering.

2141491   Research Methodology   2 (2-0-4)
Research Formulation, research objectives, basic procedure for doing research. Statistical method for research, analysis of data and its implication.

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.

2182280   Semiconductor Devices I   3 (3-0-6)
Crystal properties and growth of semiconductors; atoms and electrons; energy band and charge carriers in semiconductors; excess carriers in semiconductors; junctions; field-effect tramsistors; bipolar junction transistors; optoelectronic devices; power devices.

2182311   Measurement 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 discrete systems.

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, bending moment diagram, torsion, buckling of columns, Mohr's circle.

2185220   Basic Organic Chemistry   3 (3-0-6)
CONDITION: PRER 2302105 Chemistry for Engineering
Structure and bonding, stereochemistry, spectroscopy, hydrocarbon, halogen-containing compounds, oxygen-containing compounds, nitrogen-containing compounds, biomolecules.

2185221   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.

2185322 Thermodynamics for Nano-Engineering
3 (3-0-6)

Heat, work, internal energy, enthalpy, and the first law of thermodynamics; entropy and the second law of thermodynamics; the third laws of thermodynamics; application to flow processes and to non-reacting mixtures; chemical equilibrium; phase equilibria; ideal and real solution.

Transport Phenomend Material Charactevization
Approved Elective Level 1

<u>Fields *Nanoelectromics*</u>
2189341   Materials Characterization
          MAT CHARN   3 (3-0-6)

Optical Microscopy, Scanning probe Microscopy (SPM), Field Emission Scanning Electron Microscopy (FE SEM), Transmission Electron 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

2182440   Introduction to Nanoelectronics
          INTRO NANOELEC   3 (3-0-6)
          CONDITION: PRER 2182280* Semiconductor Devices I

Introduction to nanotechnology; nanoscale fabrication; nanoscale characterizations; 1D quantum structure; 0D quantum structure; single electron devices; carbon nanotubes; molecular electronics; DNA chips; quantum dot cellula automata; MEMS/ NEMS; spintronics.

2183411   Micro and Nano Fabrication Tecnology
          MIC/NANO FAB TECH   3 (3-0-6)

Crystal growth: vapor phase epitaxy (VPE), liquid phase epitaxy (LPE), molecular beam epitaxy (MBE), solid-state diffusion, metal-organic chemical vapour deposition (MOCVD), vacuum technology; device fabrication: inversion layer in MOS structure, thermal oxidation, ionimplantation, metallization, optical lithography, electron beam lithography, pattern transfer, wet/dryetching, reactive ion etching.

<u>Fields Nano Chemistry</u>
2185324 Molecular Chemistry
          MOL CHEM   3 (3-0-6)

Fundamental concepts of molecular chemistry and its applications in both organic synthesis and catalysis.

2185373 Reaction Engineering
          REACT ENG   3 (3-0-6)

Fundamentals of reaction engineering; reaction rate laws; kinetics; mechanisms of homogeneous and heterogeneous reactions; analysis of reaction rate data; diffusion limitations; design of industrial reactors.

<u>Fields Biomedical Nanotechnology</u>
2182441   Biomedical Electronics
          BIOMED ELEC   3 (3-0-6)
          CONDITION: Consent of Faculty

Electrical signals in human body; action potential in cells; electrodes; amplifiers; transducers; electronic monitoring systems; ECG, EEG, EMG; blood pressure and blood flow measurement; catheterization electrical hazards and prevention; medical instrumentation; computer in medicine.

2141350   Biological Interaction with Materials
          BIOL INACT MAT   3 (3-0-6)

Basic biological systems that interact with the biomaterials and the range of materials currently used for biomedical applications; appropriate analytical techniques pertinent to biomaterial research and evaluation; selected important medical fields in which biomaterials play a critical role.

<u>Fields Nono Materials Science</u>
2141400   Principles of Nanostructured material
          PRIN NANOSTRUC MAT   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 nanomaterial; diffusional and diffusionless transformations and kinetics.

2189301 Bonding, Crystallography and Defects
          BONDG CRYST DEFEC   3 (3-0-6)

Atomic structure, hybridization, molecular orbital theory; covalency, ioncity, electronegativity; band structures of semiconductors; transition metals and ferromagnetism; crystal structures, group and symmetry and diffractions; structural features of materials; point defects, dislocations, and surfaces; pure elements, solid solutions, compounds and phase diagrams.

<u>Approved Elective Level 2</u>
2141331 Quantum Mechanics for Engineers
          QUANT MECH ENG   3 (3-0-6)

Dual nature of waves and particles; the postulates of quantum mechanics; concepts of function spaces and Hermitian operators; superposition principles and compatible observables; Schrodinger equation and problems in one dimension; hydrogen atom; angular momentum; wavefunctins of electrons in confined potentials.

2141347 Introduction to Pharmaceutical Nanotechnology
          INTRO PHARNANOTECH   3 (3-0-6)

Importance of nanotechnology in enhancing pharmaceutical technology; fundamental pharmacokinetics for engineers; reviews of the types and characteristics of physic-chemical properties of biomaterials properties of biomaterials produced in Thailand; fabrication technology of nanomaterials: nanoparticles, micelles, vesicles, vesicles, liposomes, microemulsions, nanocolloids, polymer multilayers, nanoporous materials and nanocapsules, as well as experimental techniques to characterize these nanomaterials; pharmaceutical technologies.

2141451 Bionanotechnology   3(3-0-6)

Nanosensors and nanodevices for clinical diagnostics; nanostructures for drug delivery; nanoarrays; use of nanoanalytical devices and systems; methods and techniques for modification or functinalization of nanoparticles and nanostructures with biological molecules; potential use of DNA and other biomolecules for computing and ultra high-density data storage.

2141474 Introduction to Lab-on-a-Chip
          INTRO LABCHIP   3 (3-0-6)

Interesting topics in the field of nano-engineering.

2141451 Special Topics in Nano Engineering I
          SPEC NANO ENG I   3 (3-0-6)

Interesting topics in the field of nano-engineering.

2141512 Special Topics in Nano Engineering II
          SPEC NANO ENG II   3 (3-0-6)

Interesting topics in the field of nano-engineering.

2182330 Linear Control Systems
          LIN CTRL SYS   3 (3-0-6)
          CONDITION: PRER 2182210*

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; Body and Nyquist plots; Nyquist stability criterion; Nichols charts; control system design by frequency response method.

2182443 Introduction to VLSI Technology
INTRO VLSI TECH   3 (3-0-6)

Fundamentals of digital and analogue circuits.

2182480 Semiconductor Devices II
SEMICOD DEVI II   3 (3-0-6)
CONDITION: PRER 2182280*
Semiconductor Devices I

Review of physics and properties of semiconductors; compound semiconductor; P-N junction; metal-semiconductor junctions; heterojunctions; MESFET; heterojunction transistors: HEMT and HBT; microwave devices; high speed photonic devices and integrated circuits.

2182580 Optoelectronics
OPTOELECTRONECS   3 (3-0-6)
CONDITION: PRER 2182280

Physics of optical radiation; interaction between optical radiation and matter; principles and applications of optoelectronic devices: sources, detectors as well as other optical materials, devices, components and equipment.

2183412 Micro and Nano-Electro Mechanical Systems
MEMS/NEMS   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; application of MEMs: pressure sensors, accelerometer; micromotors; micropumps and microvalves; thermal sensors and actuators; micromirror.

2183431 Mechanical Vibrations
MECH VIBRATIONS   3 (3-0-6)

Analysis of system with single and multi-degree of freedom; torsional vibration; free and forced vibration; determination of natural frequencies of structures; discrete system; Modal analysis; methods and techniques to reduce and control vibration; Lagrange's equations.

2185323 Intermediate Organic Chemistry
ITMD ORG CHEM   3 (3-0-6)

Basic concept of chemistry, structure, nomenclature and identification of organic compounds: saturated hydrocarbons and petroleum, unsaturated hydrocarbons; free-radical addition and polymerization; aromatic hydrocarbons and electrophilic aromatic substitution; organic halides; alcohols; phenols and ethers; aldehydes and ketones; carboxylic acide and derivatives; fats, oils, waxes, soaps and detergents; stereoisomerism and optical activity; sugars and carbohydrates; amines and diazonium compounds; amino acids and proteins.

2185452 Biosystems and Biotransport
BIOSYS/BIOTRANS   3 (3-0-6)

Definitions and basic concepts; crystalline and glassy polymer; molecular architecture; conformation and morphology; polymer synthesis; transition phenomena; mechanical properties affected by the 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.

2185479 Nanopolymer Engineering   3 (3-0-6)

Definitions and basic concepts; crystaline and glassy polymer; molecular architecture; conformation and morphology; polymer synthesis; transition phenomena; mechanical properties affected by the 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.

2189411 Mechanical Behavior of Materials
MECH BEHAV MAT   3 (3-0-6)

Elastic behavior; 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.

2189417 Composite Materials
COMPOSITE MAT   3 (3-0-6)

Properties of engineering composite materials; types of composite materials; fiber and interfaces with matrix; geometrical properties; elasticity; case studies.

2189450 Materials Design and Selection
MAT DSGN SEL   3 (3-0-6)

Basic materials; concept of materials selection; steps in materials design; case studies.

AUTOMOTIVE DESIGN AND MANUFACTURING ENGINEERING (INTERNATIONAL PROGRAM) (B.ENG)

Automotive design and manufacturing engineering is 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 compornants 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 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

Phulporn Saengbangpla	M.Sc (Machester,UK)
Pramote Dechaumphai	Ph.D. (Virginia)
Ekachai Leelarasmee	Ph.D. (California)
Asi Bunyajitradulya	Ph.D. (California)
Siriporn Damrongsakkul	Ph.D. (London)
Atiwong Suchato	Ph.D. (Massachusetts)
Patama Visuttipitukul	Ph.D. (Tokyo)
Sunhapos Chatranuwathana	Ph.D. (Michigan)
Chaodit Aswakul	Ph.D. (London)
Yan Zhao	Ph.D. (London)
Surapong Sirikulvadhana	M.S (Michigan)
Varong Pavarajarn	Ph.D. (Oregon)

Professors

Mechanical Engineering

Pramote Dechaumphai	Ph.D. (Old Dominion)
Somsak Chaiyapinunt	Ph.D. (Oregon State)
Viboon Sangveraphunsiri	Ph.D. (Georgia Tech)

Associate Professors

Electrial Engineering

Ekachai Leelarasmee	Ph.D. (California)
Chedsada Chinrungrueng	Ph.D. (California Berkeley (U.S.A.)

Mechanical Engineering

Asi Bunyajitradulya	Ph.D. (UC Irvine)
Kuntinee Maneeratana	Ph.D. (London)
Pongtorn Charunyakorn	Ph.D. (Miami)
Kanit Wattanavichien	Ph.D. (Melbourne)
Ratchatin Chanchareon	D.Eng. (Chula)

Industrial Engineering

Somkiat Tangjitsitchareon	D.Eng.(Kobe Japan)

Metallurgical and materials Engineering

Seksak Asavavisithchai	Ph.D. (Nottingham)

Assistant Professors

Electrial Engineering

Wanchalerm Pora	Ph.D. (London)
Suree Pumrin	Ph.D.(Washington)

Mechanical Engineering

Boonchai Lertnuwat	Ph.D. (Tokyo)
Sunhapos Chantranuwathana	Ph.D. (Michigan)
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)
Phongsaen Pitakwatchara	M.S.M.E.
Thanyarat Singhanart	Ph.D. (Tokyo) (Georgia Tech)

Industrial Engineering

Somchai Puajindanetr	Ph.D. (London)
Haruetai Lohasiriwat	MS. (VPI & SU)

Metallurgical and materials Engineering

Itthipon Diewwanit   Sc.D. (MIT)

Lecturer

Electrial Engineering

Boonchuay Supmonchai   M.Eng. (Chula)

Mechanical Engineering

Nuksit Noomwongs   D.Eng. (TUAT)
Chirdpun Vitooraporn   (MIT)
Tawan Paphapote   Ph.D.C.United States
                            of America

Industrial Engineering

Oran Kittithreerapronchai   Ph.D. Georgia

ISE Staffs
Phulporn Saengbangpla   M.Sc.,ME(England)
Yan Zhao   Ph.D.(London)
 Prabhath De Silva   Ph.D.(USA)

Guest lecturer

Suradej Voranutsoontorn   Private Consultant
Somchai Peungperksuk   Ph.D.
Kaukeart Boonchukosol   Poitiers (Frence)

Visiting Professor (USA)

Arthur.J. McEvily Jr.   Emeritus Ph.D.(New York)

Curriculum

Total number of credits requirement	147	credits
General Education	30	credits
Core Courses	111	credits
Basic Sciences	21	creditis
Basic Engineering	31	credits
Compulsory	50	credits
Approved Electives	9	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
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)
General Education (Special)	6	credits
2140111 Exploring Engineering World	3	(3-0-6)
2183281 Introduction to Automotive Eng.	3	(3-0-6)
2. Core Course	111	credits

Basic Sciences		21	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	(0-3-0)
2304193	Physics Laboratory for Eng.	1	(0-3-0)
2304194	Physics and Electronics Laboratory for Engineers	1	(0-3-0)

Basic Engineering		31	credits
2140301	Industrial Training	2	(0-6-0)
2142251	Manufacturing Process for Automotive Eng I	3	(2-3-4)
2142252	Manufacturing Process for Automotive Eng II	3	(2-3-4)
2182210	Electrical Circuit	3	(3-0-6)
2182213	Electrical Circuit Laboratory	1	(0-3-0)
2183101	Engineering Graphics	3	(2-3-4)
2183212	Statics	3	(3-0-6)
2184201	Probability and Statistics for Automotive Engineering	3	(3-0-6)
2184303	Engineering Management	3	(3-0-6)
2189101	Engineering Materials	3	(3-0-6)
2190101	Computer Programming	3	(3-0-6)
2190151	Computer Programming Laboratory	1	(0-3-0)

Compulsory Courses		50	credits
2142201	Engineering First	3	(3-0-6)
2142242	Vehicle Dynamics	3	(3-0-6)
2142498	Automotive Engineering Pre-Project	1	(0-2-1)
2142499	Automotive Engineering Project	3	(0-6-3)
2182310	Electronics and Instrument For Automobile	3	(3-0-6)
2183213	Mechanics of Material	3	(3-0-6)
2183221	Thermodynamics	3	(3-0-6)
2183222	Fluid Mechanics	3	(3-0-6)
2183231	Dynamics	3	(3-0-6)
2183261	Mechanical Engineering Laboratory	2	(1-3-2)
2183271	Automotive Engineering Workshop	1	(0-3-0)
2183272	Automotive Instrument Laboratory	1	(0-3-0)
2183321	Heat Transfer	3	(3-0-6)
2183322	Internal Combustion Engine	3	(3-0-6)
2183331	Mechanics of Machinery	3	(3-0-6)
2183332	CAD/CAM/CAE	3	(2-3-4)
2183351	Machanical Engineering Design	3	(3-0-6)
2183352	Motor Vehicle Design	3	(2-3-4)
2184302	Product Development Process	3	(3-0-6)

Approved Electives		9	credits
2142352	Finite Element Methods and Applications	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	3	(3-0-6)
2142433	Failure Analysis and NDT	3	(2-3-4)
2142461	Automation and Robotics	3	(3-0-6)
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)
2182430	System Dynamics and Controls	3	(3-0-6)
2182442	Embedded Systems in Automotive		
	Engineering	3	(3-0-6)
2183431	Mechanical Vibrations	3	(3-0-6)
2184401	Engineering Experimental Design	3	(3-0-6)
2184404	Process Management and Lean		
	Manufacturing	3	(3-0-6)
2184405	Product Planning and Control	3	(3-0-6)
2184406	Quality Control and Management		
	For Automotive Industry	3	(3-0-6)
2184407	Quality Design and Innovation		
	Management	3	(3-0-6)
2184409	Value Engineering	3	(3-0-6)
2189102	Engineering Materials II	3	(3-0-6)
2190216	Information Techology for		
	Professional Communications	2	(1-3-2)

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)

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
	FIRST SEMESTER			**FIFTH SEMESTER**	
2190101	Computer Programming	3	2182310	Electronics and Instrumentation for Auto	3
2190151	Computer Programming Laboratory	1	2183222	Fluid Mechanics	3
2301107	Calculus I	3	2183261	Mechanical Engineering Laboratory	2
2302103	General Chemistry Laboratory	1	2183272	Automotive Instrument Laboratory	1
2302105	Chemistry for Eng.	3	2183331	Mechanics of Machinery	3
2304153	Physics for Eng.	3	2184302	Product Development Process	3
2304193	Physics Lab for Engineers	1	5501225	Technical Writing	3
5501112	Communicative Eng I	3			30
		18			
	SECOND SEMESTER			**SIXTH SEMESTER**	
2140111	Exploring Engineering World	3	2142424	Vehicle Dynamics	3
2183101	Engineering Graphics	3	2183321	Heat Transfer	3
2189101	Engineering Materials	3	2183332	CAD/CAM/CAE	3
2301108	Calculus II	3	2183351	Mechanical Engineering Design	3
2304154	Physics and Electronics for Eng.	3	2184303	Engineering Management	3
2304194	Physics and Electronics Lab for Eng.	1	xxxxxxx	General Education	3
5501123	Communicative English II	3			18
		19			
	THIRD SEMESTER			**SUMMER SEMESTER**	
2142251	Manufacturing Process for Automotive Eng I	3	2140301	Industrial Training	2
2183212	Statics	3			
2183221	Thermodynamics	3		**SEVENTH SEMESTER**	
2183271	Automotive Engineering Workshop	1	2142498	Automotive Engineering Pre-Project	1
2183281	Introduction to Automotive Eng.	3	2183322	Internal Combustion Engine	3
2184201	Probability and Statistics for Auto Eng.	3	2183352	Motor Vehicle Design	3
2301312	Differential Equations	3	xxxxxxx	Approved Elective	3
		19	xxxxxxx	Approved Elective	3
			xxxxxxx	General Education	3
	FOURTH SEMESTER		xxxxxxx	General Education	3
2142201	Engineering First	3	xxxxxxx	Free Elective	3
2142252	Manufacturing Process for Auto Eng II	3			22
2182210	Electrical Circuit	3			
2182213	Electrical Circuit Laboratory	1		**EIGHTH SEMESTER**	
2183213	Mechanics of Materials	3	2142499	Automotive Engineering Project	3
2183231	Dynamics	3	xxxxxxx	Approve Electives	3
5501214	Communication and Presentation Skills	3	xxxxxxx	General Education	3
		19	xxxxxxx	Free Elective	3
					12

TOTAL CREDITS FOR GRADUATION   **147**

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.

2183281　Introduction to Automotive Engineering
3 (3-0-6)
Basic Principles of automotive systems, components, and design; internal combustion engine; transmission; chassis; suspension; steering; brake; body; vehicle aerodynamics and automotive electronics; basic vegicle dynamics; performance and handling.

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 5501112*
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 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 electromagenetism; optics; modern physics.

2304154　Physics and Electronics for Engineers
3 (3-0-6)
Engctricity 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 ampmeter; voltmeter; oscilloscope; AC circuit; transistor; lenses and mirrors; polarization; interference; diffraction.

2140301　Industrial Training　2 (0-6-0)
Engineering practice in related areas under supervision of experienced engineers in private sectors or government agencies.

2142251　Manufacturing Process for Automotive
Engineering I　3 (2-3-4)
Introduction to the principles of manufacturing as related to automotive engineering; relationship between manufacturing process, material properties and structure; fundamentals of bulk deformation, sheet metal forming processes; fundamentals of solidification processing; fundamentals of metal joining; principles of heat treatment and surface modification.

2142252　Manufacturing Process for Automotive
Engineering II　3 (2-3-4)
Condition: PRER 2142251*
Metal removal and machining processes; processes of non-metallic materials: glass, polymers, and ceramics; surface and tribological characteristics; application of automation and computer integrated manufacturing systems in automotive part manufacturing: fundamentals of automotive part designs and technology management;

supply chains and structure of automotive part manufacturing.

2182210 Electrical Circuit Laboratory   3 (3-0-6)
DC circuit; analysis; Kirchhoff's laws; The venin's abd Birtib's theorem; transistor amplifier circuit; semiconductor devices; op-amp circuits; digital circuits; DC motor.

2182213 Electrical Circuit Laboratory
Eletronic instruments; multimeter; oscilloscope; DC circuit; Voltage regolators; filter circuit; transistor amplifer circuit; op-amp circuits; digital Circuits; DC motor.

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.

2183212 Statics   3 (3-0-6)
Force systems; resultants; equilibrium; structure; distributed force; friction; virtual work; stability.

**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.

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.

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 theengineering materials; production process of products from engineering materials.

2190101 Computer Programming   3 (3-0-6)
Introduction to computer systems; problem-solving using computers; programming in highlevel 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)
          Condition: COREQ 2190101***
Computer programming in Engineering; reviews of computer programming concepts; hands-on experience on computer programming using contemporary Engineering tools.

2142201 Engineering First
3 (3-0-6)
Basic skills in engineering; problem solving, communication skills, team work skills through small class projects; dissection skills.

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.

2142499 Automotive Engineering Project 1 (0-3-0)
Group or individual project on a subject related to automotive engineering and manufacturing.

2182310 Electronics and Instrument for Automobile
**   3 (3-0-6)**
**   Condition: PRER 2182210**
Introduction to digital circuits; introduction to microprocessors and microprocessors based systems; basic instrumentation; application of different types of instrumentations to automotive systems.

2183213 Mechanics 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.

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: pathlines, streamlines, and streaklines; forces and stresses 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; system; external flows, boundary layer, and

aerodynamic force and moment; applications: turbomachines, model testing, piping and pumping system, aerodynamic force and moment.

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.

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.

2183271   Automotive Engineering Workshop
1 (0-3-0)
Hand-on study of automotive systems and components; names and functions of components and parts; basic mechanical parts; engine; electronic systems; power train; brake systems; steering mechanism; basic diagnosis.

2183272   Automotive Instrument Laboratory
1 (0-3-0)
Basic electronics; electronic systems in automobiles; engine performance testing; basic automotive diagnosis.

2183321   Heat Transfer   3 (3-0-6)
Condition: PRER 2183222*
Modes of heat transfer; general forms of heat conduction equations; steady one-dimensional heat conducton; 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.

2183322   Internal Combustion Engine   3 (3-0-6)
Internal combustion engines; basic principles; fluid flow; thermodynamics; fuels and combustion; ideal fuel air cycle; heat transfer; friction and lubrication; efficiency and emission; different types of engines; spark-ignition and compression-ignition; ignition systems; supercharging and scavenging; performance and testing.

2183331   Mechanics of Machinery   3 (3-0-6)
Basic mechanisms; gear trains; displacements; velocity and acceleration in machines; statics and dynamics force analysis; balances of rotating and reciprocating masses; gyroscopic effects.

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.

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.

2183352   Motor Vehicle Design   3 (3-0-6)
Systematic approach to automotive design; space defining components; ergonomics; automotive safety and legal regulations.

2184302   Product Development Process   3 (3-0-6)
Product requirements and specifications; reverse engineering; use of CMM; product design by CAD.

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.

2142422   Vehicle Aerodynamics   3 (3-0-6)
Effects of vegicle 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.

2142461   Automation and Robotics   3 (3-0-6)
Basic automation systems, equipment, sensors, actuators, material handling system, robots and their applications.

**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.

**2182430   System Dynamics and Controls   3 (3-0-6)
                  Condition: PRER 2182210**
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.

2183431   Mechanical Vibrations   3 (3-0-6)
Analysis of system with single and multi degree of freedom; torsional vibration; free and forced vibration; determination of natural frequencies of structures; discrete system; Model analysis; methods and techniques to reduce and control vibration; Lagrange's equations.

**2184401   Engineering Experimental Design
                              3 (3-0-6)**
Factorial design; 2k factorial design; blocking and confound; fractional factorial design; factorial experiments with random factors; nested and split-plot design; non-linear regression analysis; response surface analysis.

**2184404   Process Management and Lean Manufacturing
                              3 (3-0-6)**
Introduction to process management; key techniques and managing approaches commonly used in automotive industry; application and case studies.

2184405   Product Planning and Control   3 (3-0-6)
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.

**2184406   Quality Control and Management for
                  Automotive Industry   3 (3-0-6)**
Introduction to metrology and characterization; principles of destructive and non-destructive 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.

**2184407   Quality Design and Innovation Management
                              3 (3-0-6)**
Kay issues and core concept of quality design and innovation management, innovation strategy; project management, concept fomation and selection, quality design and innovation development processes, business plan, risk management, techniques and tools for effective implementation of innovation.

2184409   Value Engineering   3 (3-0-6)
Introduction to value engineering methodology; application of value engineering techniques to product design; procurement and manufacturing in order to reduce cost without the loss of quality.

2189102   Engineering Materials II   3 (3-0-6)
Condition: PRER 2189101
Advanced topics and other specific applications as related to automative materials; specific automotive materials; introduction to engineered materials specifically developed for automotive applications; composite materials; tyre and rubber technology, modification of surface characteristics as related to tribological and corrosion properties.

**2190216   Information   Technology   for   Professional
                  Communications   2 (1-3-2)**
IT skills in professional communication; presentation skills; use of computer software for effective professional communication.

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.

= 140 Credits

Curriculum Board

Phulporn Saengbangpla	M.Sc (Machester,UK)
Pramote Dechaumphai	Ph.D. (Virginia)
Ekachai Leelarasmee	Ph.D. (California)
Asi Bunyajitradulya	Ph.D. (California)
Siriporn Damrongsakkul	Ph.D. (London)
Atiwong Suchato	Ph.D. (Massachusetts)
Patama Visuttipitukul	Ph.D. (Tokyo)
Sunhapos Chatranuwathana	Ph.D. (Michigan)
Chaodit Aswakul	Ph.D. (London)
Yan Zhao	Ph.D. (London)
Surapong Sirikulvadhana	M.S (Michigan)
Varong Pavarajarn	Ph.D. (Oregon)

Professor

Prabhas Chongstitvattana,	Ph.D.(Edinburgh U.)

Associate Professors

Electrial Engineering

Chedsada Chinrungrueng,	Ph.D.(Berkeley and computer Science)
Lunchakorn Wuttisittikulkij,	Ph.D.(Essex)
Prasit Teekaput,	Ph.D(Virginia)
Watcharapong Khovidhungij,	Ph.D.(UCLA)
Watit Benjapolakul,	D.Eng.(Tokyo)
Nisachon Tangsangiumvisai,	Ph.D.(London)
Duangrudee Worasucheep,	Ph.D.(Stanford)

Industrial Engineering

Parames Chutima,	Ph.D.(Nottingham)

Computer Engineering

Pornsiri Muenchaisri,	Ph.D.(Sydney)
Atiwong Suchato,	Ph.D.(MIT)

Assistant Professors

Electrial Engineering

Chaiyachet Saivichit,	Ph.D.(Communications Networking)
Chaodit Aswakul,	Ph.D.(Communications Networking)
Charnchai Pluempitiwiriyawej	Ph.D.(Carnegie Mellon and Computer Engineering)
Pasu Kaewplung,	Ph.D(Chula)
Supavadee Aramrith,	Ph.D.(Washington)
Tuptim Angkaew,	Ph.D.(Communications Networking)
Widhyakorn Asdornwised,	Ph.D.(Chula)

Computer Engineering

Athasit Surarerks,	Dr.Inf.(Informatique)
Attawith Sudsang,	Ph.D.(Illinois)
Chalermeak Intanakornwiwat	Ph.D.(Southern California)
Chotirat Ratanamahatana	Ph.D.(Roversode)
Krerk Piromsopa	Ph.D.(Michigan State)
Nakornthip Prompoon	M.Sc.(George Washington)
Pizzanu Kanongchaiyos	Ph.D.(Compater Graphies)
Sukree Sinthupinyo	Ph.D. (Chula)
Vishnu Kotrajaras	Ph.D.(London)
Nattee Niparnan	Ph.D.(Chula)

Manufacturing Engineering Opertions Management

Natcha Thaweesaengsakulthai,	Ph.D.(Nottingham)

Industrial Engineering

Wipawee Thammaphornphilas,	Ph.D.(Pittsburgh)
Seeronk Prichanont,	Ph.D.(Biotechnology)
Surapong Sirikulvadhana	M.S.(Michigan-Ann Arbor)
Kultida Rojviboonchai	Ph.D.(Computer Networks)

Lecturer

Electrial Engineering

Boonchuay Supmonchai,	M.Eng.(Chula)

Computer Engineering

Chairat Phongphanphanee,	Ph.D.(Radio Frequenct Telecommunications)
Chate Patanothai,	M.Sc.(Elec&comEng)
Thit Siriboon,	Ph.D.(Oregon State)

Industrial Engineering

Oran Kittithreerapronchai	Ph.D.(Georgia Institute of Technology)

Guest lecture

Pahnit	Seriburi	Ph.D.(Washington)
Thaisiri	Watewai	Ph.D.(Berkeley)
Dechanuchit	Katanyutaveetip,	Ph.D.(Chula)

ISE Staffs

Yan	Zhao,	Ph.D.(London)
Sipat	Triukose	Ph.D.(Ohio)
Derrick	Lim	Ph.D.(Arizona)

Curriculum

Total number of credits requirement	146	credits
General Education	30	credits
Core Courses	110	credits
Basic Sciences	18	credits
Basic Engineering	18	credits
Compulsory	59	credits
Approved Electives	15	credits
Free Electives	6	credits

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1. General Education   **30**   **credits**

	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)
	General Education (Special)	6	credits
2140111*	Exploring Engineering World		3(3-0-6)
2143101	Introduction to ICE		3(3-0-6)

2. Core Courses   **110**   **credits**

	Basic Sciences	18	creditis
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 Lab. For Engineers		1(0-3-0)
2304194	Physics and Electronics Lab. For Engineers		1(0-3-0)

	Basic Engineering	18	credits
2140301	Industrial Training		2(0-6-0)
2182203*	Probability and Statistics for Eng.		3(3-0-6)
2183101	Engineering Graphics		3(2-3-4)
2184202*	Technology and Eng. Management		3(3-0-6)
2189101*	Engineering Materials		3(3-0-6)
2190101*	Computer Programming		3(3-0-6)
2190151*	Computer Programming Laboratory		1(0-3-0)

	Compulsory Courses	59	credits
2143399*	ICE Capstone		3(3-0-6)
2143491*	ICE Pre-Project		1(0-2-1)
2143499	ICE project		3(0-6-3)
2182202*	Advanced Mathematics Methods		3(3-0-6)
2182204*	Signals and Linear Systems		3(3-0-6)
2182211*	Electrical Circuit for ICE		2(2-0-4)
2182212*	Fundamental of Circuit and Digital Electronics Lab.		1(0-3-0)
2182370*	Introduction to Digital Communications		3(3-0-6)
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)
2184304*	Fundamental of Operations Management		3(3-0-6)
2190102*	Advanced Computer Programming		2(2-0-4)
2190152*	Advanced Computer Programming Laboratory		1(0-3-0)

Social Science	3	credits
Humanity	3	credits
Science and Mathematics	3	credits
Interdisciplinary	3	credits

2190200*	Discrete Structures	3(3-0-6)
2190213*	Principles of Information System	3(3-0-6)
2190221*	Fundamental Data Structure and Algorithm	3(3-0-6)
2190250*	Computer Architecture and Organization	3(3-0-6)
2190261*	Fundamental Data Structure and Algorithm Laboratory	1(0-3-0)
2190415*	Enterprise Information System	3(3-0-6)
2190422*	Database Systems	2(2-0-4)

	Approved Electives	15	credits
2143423	High Technology Entrepreneurship		3(3-0-6)
2143480*	Independent Study I		1(0-3-2)
2143481*	Independent Study II		1(0-3-2)
2143482*	Independent Study III		1(0-3-2)
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)
2182420*	Discrete-Time Signal Processing		3(3-0-6)
2182421*	Multimedia Engineering		3(3-0-6)
2182470*	Telecommunication Management		3(3-0-6)
2182471*	Optic Fiber Communications		3(3-0-6)
2182472*	Principle of Wireless Communications		3(3-0-6)
2182473*	Signal Transmission System		3(3-0-6)
2182474*	System Integration		3(3-0-6)
2182475*	Teletraffic 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)
2190317*	Fundamental of Distributed System		3(3-0-6)
2190332*	System Analysis and Design		3(3-0-6)
2190413*	System Security		3(3-0-6)
2190414*	Large Scale Computing System		3(3-0-6)
2190424*	Software Project Management		3(3-0-6)
2190425*	Software Testing and Quality Assurance		3(3-0-6)
2190436*	Data Warehousing		3(3-0-6)
2190442*	Object-Oriented Techniques		3(3-0-6)
2190443*	User Interface Design		3(3-0-6)
2190473*	Ubiquitous Computer and Networking		3(3-0-6)
2190479*	Graphics Computing		3(3-0-6)
2190511*	Game Design and Development Process for International Market		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.

INFORMATION AND COMMUNICATION ENGINEERING CURRICULUM (INTERNATIONAL PROGRAM)

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
	FIRST SEMESTER			**FIFTH SEMESTER**	
2190101*	Computer Programming	3	2182370*	Introduction to Digital Communications	3
2190151*	Computer Programming Laboratory	1	2182371*	Principles of Data communication	3
2301107	Calculus I	3	2184301*	Engineering Economy and Application	3
2302103	General Chemistry Laboratory	1	2190213*	Principles of Information System	3
2302105	Chemistry For Engineers	3	2190472*	Netcentric Architecture	3
2304153	Physics for Engineers	3	5501214	Communication and Presentation Skills	3
2304193	Physics Laboratory for Engineers	1			18
5501112*	Communicative English I	3			
		18			
	SECOND SEMESTER			**SIXTH SEMESTER**	
2140111*	Exploring Engineering World	3	2143399*	ICE Capstone	3
2183101*	Engineering Graphics	3	2182372*	Principles of Telecommunications	3
2189101*	Engineering Materials	3	2184304*	Fundamental of Operations Management	3
2301108	Calculus II	3	2190422*	Database Systems	2
2304154	Physics and Electronics for Engineers	3	2190423*	Software Engineering	3
2304194	Physics and Electronics Lab. for Eng.	1	2190462*	Database Systems Laboratory	1
5501123*	Communicative English II	3	5501225	Technical Writing	3
		19			18
	THIRD SEMESTER			**SUMMER SEMESTER**	
2143101	Introduction to ICE	3	2140301	Industrial Training	2
2182202*	Advanced Mathematics Methods	3			2
2182211*	Electrical Circuit for ICE	2			
2182212*	Fundamental of Circuit and Digital Electronics Lab.	1		**SEVENTH SEMESTER**	
2190102*	Advanced Computer Programming	2	2143491*	ICE Pre-project	1
2190152*	Advanced Computer Programming Lab.	1	2190415*	Enterprise Information Systems	3
2190200*	Discrete Structure	3	xxxxxxx	General Education	3
xxxxxxx	General Education	3	xxxxxxx	Approved Elective	6
		18	xxxxxxx	Free Elective	3
					16
	FOURTH SEMESTER			**EIGHTH SEMESTER**	
2182203	Probability and Statistic for Engineers	3	2143499	ICE Project	3
2182204	Signals and Linear Systems	3	xxxxxxx	Approved Elective	9
2184202	Technology and Eng. Management	3	xxxxxxx	General Education	3
2190221*	Fundamental Data Structure and Algorithm	3	xxxxxxx	Free Elective	3
2190250*	Computer Architecture and Organization	3			18
2190261*	Fundamental Data Structure and Algorithm Lab.	1			
xxxxxxx	General Education	3			
		19	**TOTAL CREDITS FOR GRADUATION**		**146**

COURSES DESCRIPTIONS IN INFORMATION AND COMMUNICATION ENGINEERING (B.ENG)

2140111* Exploring Engineering Word   3 (3-0-6)

Engineering topic related to daily life: energy, resources, environment manufacturing, process, industry, material, automotive, infrastructure, information system and bio engineering.

2143101   Introduction to ICE   3(3-0-6)

Essential basic computer and telecommunication concepts for Information System; 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.

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 5501112*

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 5501113*

Practice using English for social communication and giving oral presentation on engineering related topics.

5501225* Technical Writing   3 (3-0-6)
Condition: PRER 5501113*

Practice in writing summaries composing different types and styles of writing in the field of engineering and writing reports of studies and experiments.

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.

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   Physic 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.   1 (0-3-0)

Resistance and electromotive force measurements; experiments on amp meter, voltmeter, oscilloscope, AC circuit, transistor, lenses and mirrors, polarization, interference, diffraction.

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 Statistic for Engineers
Condition: PRER 2301108   3 (3-0-6)

Engineering basis in statistic 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 application; case studies.

2183101* Engineering Graphics   3 (2-3-4)

Lettering; orthographic projections; sketching and drawing; pictorial drawing; dimensioning; to lerancing and geometrical tolerancing; section; working drawing; mechanical parts drawing; introduction to CAD.

2184202* Technology and Engineering Management
**   3 (3-0-6)**

Technology and engineering management principles; SWOT analysis; operations strategy; organization and process design; cost and budget;

productivity management; marketing concept; quality system; human relationship; risk management; project management; innovation management.

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.

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.

2143399*   Information and Communication Eng. Capstone   3 (3-0-6)
Culminating and applying of knowledge to develop information and communication systems; 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 Eng. 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   Information and Communication Eng. Project   3 (0-6-3)
Condition: PRER 2143491*
Group or individual projects on a subject related to information and communication engineering.

2182202*   Advanced Mathematics Methods   3 (3-0-6)
Condition: PRER 2301108
Complex analysis: complex functions, analytic functions, line integral in complex plane, Cauchy Integral Theorem, Laurent Series, Residue Theorem; advanced matrix algebra: systems of linear equations, linear independence, Eigenvalues, Eigenvectors; Ordinary differential equations (ODE): First-order ODE, Second-order ODE, Higher-order linear ODE; Series solutions to linear ODE.

2182204*   Signals and Linear Systems   3 (3-0-6)
Condition: PRER 2182202* Advanced Mathematics Methods
Classification of Signals and Systems; Linear-Time Invariant (LTI) System; Continuous-Time System; Discrete-time System; Linear Convolution; Frequency Response: Fourier Series, Fourier Transform, Laplace Transform, Z-Transform, Discrete-time Fourier Transform.

2182211*   Electrical Circuit for ICE   2 (2-0-4)
Condition: PRER 2304154
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   1 (0-3-0)
Condition: Co-requisite 2182211*
Electronic instruments: multimeter, oscilloscope, DC circuit, voltage regulators, filter circuit, transistor amplifier circuit, digital circuits.

2182370*   Introduction to Digital Communications
3 (3-0-6)
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 system: 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; examples of communication systems in practice.

2182371*   Principles of Data Communication
3 (3-0-6)
Introduction to data communication and networking: layer modeling protocols and architectural network; basic data transmission, physical layer transmission, data link layer protocols, review on network layer protocols and transport layer protocols, standardization, IP-based network protocols, delay models, performance analysis, system design and implementation issues.

2182372   Principles of Telecommunications
3 (3-0-6)
Introduction to telecommunications; layered communication architectures; transmission medium: wired and wireless; data link layer protocols: flow control and error control; medium access control; circuit switching and packet switching; throughput and delay performance analysis of communication link; introduction to network topology, flows and graph theory; routing principles in circuit-switched and packet-switched networks; introduction to queuing theory and basic simulation techniques; overviews of cellular mobile phone networks, optical networks, Internet and satellite systems.

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.

2184304* Fundamental of Operations Management
3 (3-0-6)

Nature of operations; production capacity management; aggregate planning; master production scheduling; material requirements planning; operation scheduling; inventory and distribution management; project time management; lean management.

2190102* Advanced Computer Programming
2 (2-0-4)
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.

2190152* Advanced Computer Programming Lab.
1 (0-3-0)
CONDITION: Co-requisite 2190102*

Hands-on experience in software development through the application of contemporary development frameworks.

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.

2190213* Principles of Information System
3 (3-0-6)

Information system architecture; internet and web protocols; web application framework; MVC pattern; middleware, remote procedure call, message oriented middleware; authentication, authorization, directory services; information security, basic cryptography, digital signature.

2190221* Fundamental Data Structure and Algorithm
3 (3-0-6)
CONDITION: PRER 2190101*

Basic data types, trees, basic operations on sets, sorting and searching, algorithm design techniques, memory management.

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; super-scalar processors; multi-core computers.

2190261* Fundamtal Data Structure and Algorithm Laboratory
1(0-3-0)
CONDITION: Co-requisite 2190221*

Hands-on programming in high-level language to supplement the theoretical concepts of data structure and algorithm; practical application in writing and analyzing programs; data abstraction, modular program composition.

2190415* Enterprise Information Systems 3 (3-0-6)

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.

2190422* Database Systems 2 (2-0-4)

Database design and implementation: data models, database and schema design, relational algebra, relational calculus, query processing and optimization, constraints; storage and indexing: memory hierarchy, RAID, file organization and indexing, tree-structured/hash-based indexing; database design and tuning; schema refinement, functional dependencies, normal forms, physical design and tuning.

2190423* 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, error and fault estimation, reliability models, availability models; management techniques, cost estimation, software maintenance.

2190462* Database Systems Lab . 1 (0-3-0)
CONDITION: Co-requisite 2190422*

Database design and implementation of Relational Database Management Systems (RDBMS): hands-on introduction to SQL Basics including RDBMS installation, configuration, troubleshooting, basic knowledge of relational databases and how to effectively maintain them.

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 System (DNS), web caching, Content Distribution Networks (CDN) through multi-media, 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 Protrol Protocol (TCP), principles of congestion control; network layer: virtual circuit and datagram networks, internet Protocols (IP), routing in the Internet: multimedia networkins: streaming stored audio and video, protocols for real-time interactive applications; security in computer networks.

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, seting 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.

2143426 Satellite Communications 3 (3-0-6)
Introduction to satellite communication systems; overview of modulation, detection, detection, and coding; satellite channel and link analysis; satellite payload and electronics; frequency-division multiple access; time-division multiple access; code-divesion multiple access; frequency-hopped communications; satellite crosslink; satellite system design.

2143480* Independent Study I 1 (0-3-2)
Independent study and investigation in topics related to information and communication engineering under the supervision of an instructor.

2143481* Independent Study II 1 (0-3-2)
Independent study and investigation in topics related to information and communication engineering under the supervision of an instructor.

2143482* Independent Study III 1 (0-3-2)
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.

2143491 Information and Communication Engineering Pre-project 1 (0-2-1)
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 development 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.

2182420* Discrete-Time Signal Processing 3 (3-0-6)
Condition: PRER 2182204
Discrete-time signal and systems; discrete-time processing of continuous-time signals; Linear Time Invariant (LTI) Systems; sampling Theory; Finite Impulse Response (FIR) filters, Infinite Impulse Response (IIR) filters; signal Flow Graph Representation; Transversal Filters. Discrete-Time Fourier Transform (DTFT), Fast Fourier Transform (FFT) algorithm; Decimation; Interpolation; Sampling Rate Conversion; Filter Bank; Aliasing; Finite Precision Numerical Effects.

2182421* Multimedia Engineering 3 (3-0-6)
Introduction to multimedia engineering; text coding standards image coding standards, video coding standards, audio coding standards; speech coding standards; IP networks, wireless networks; multimedia communication protocols; multimedia communication applications.

2182470* Telecommunication Management 3 (3-0-6)
Telecommunication technology and trends; telecommunication markets; telecommunication economics; telecommunication law and policy; telecommunication licensing; competition in telecommunication business; telecommunication project management.

2182471* Optical Fiber Communication 3 (3-0-6)
Overview of optical fiber communications; wave guiding in optical fibers, mode theory for dielectric circular waveguides; signal distortion in optical fibers due to loss and dispersion; optical sources, laser diodes; modulation techniques; photodetector, optical receiver operation; digital transmission system, power budget analysis; dispersion management; optical fiber amplifiers; principle and components in WDM system.

2182472* Principle of Wireless Communications 3 (3-0-6)
Introduction to design analysis and fundamental limits of wireless transmission systems; wireless channel and system model, multipath fading; equalization, channel coding and diversity; resource management and power control; multiple antenna and MIMO systems; space-time codes and decoding algorithms; multiple-access techniques and multiuser detection; ad-hoc network topologies; OFDM and ultrawideband systems; wireless LANs, MANs and cellular system standards.

2182473* Signal Transmission System 3 (3-0-6)
Transmission lines; transmission line equation; transmission line analysis for sinusoidal waveforms; transmission line analysis for pulse waveforms; basic of planeir wave propagation in free space; basic of signal transmission in optical fiber; signal frequency dispersion in optical fiber, fundamental of antenna; basic antenna parameters; design of transmission link; link budget.

2182474* System Integration 3 (3-0-6)
System integration definition; communication systems; intelligent building automation; networking technology and cabling system management; introduction to communication system design; related standards for communication systems integration; compatibility and interoperability analysis; hardware vs. software integration; network integration; enterprise application integration; management of risk from Integration; interpersonal skills and communications for system engineer; case studies in system integration.

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-tern 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.

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.

2190317*   Fundamental of Distributed Systems
3 (3-0-6)

Interprocess communication and remote procedure call; logical clock and ordering; centralized 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.

2190332*   System Analysis and Design
3 (3-0-6)

Data processing systems and system life cycle; analysis methodology, tools, cost analysis, problem specification; proposal, writing and feasibility study; design methodology; design tools, database approach, system design, file and form design, program design, documentation; implementation methodology: coding, program testing and software maintenance.

2190413*   System Security   3 (3-0-6)

Techniques for achieving security in multi-user computer systems and distributed computer system; physical security; discretionary and mandatory access control; biometrics; information-flow models of security; covert channels; elementary cryptography; public-key cryptography; logic of authentication; electronic money; virus; firewall; electronic voting; risk assessment; secure web browsers.

2190414*   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 for highly competent computers; HPC software development for highly competent computers.

2190424*   Software Project Management   3 (3-0-6)

Essence of software project management; scope of software projects; project management concepts; project estimation; software quality assurance; case studies on project life cycle.

2190425*   Software Testing and Quality Assurance
3 (3-0-6)

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; Quality Principle: Quality Assurance, Quality Control, Cost of Quality and Quality Models.

2190436*   Data Warehousing   3 (3-0-6)

Introduction to data warehouse design including data modeling, database design and database access, issues in data warehouse planning, design, implementation, and administration; overview of OLAP (On-Line Analytical Processing) systems and data marts; components of data warehouse architecture and infrastructure; tools to build data warehouse.

2190442*   Object-oriented Techniques   3 (3-0-6)

Techniques of Object-Oriented Analysis (OOA) and Design (OOD) covering managing complexity, using data and procedural abstraction, encapsulation, hierarchies, and decomposition of problems into classes and objects; concepts about overloading, multiple inheritance and polymorphism; analysis, design, implementation and software development, Use Case Driven object-oriented development methodology; design patterns and Unified Modeling Language (UML).

2190443*   User Interface Design   3 (3-0-6)

Design, implementation, and evaluation of human-computer interfaces; human capabilities, including the human information processing, perception, Fitts's Law, memory, attentions and colors; task analysis, user-centered design, design principles; low-fidelity prototyping; heuristic evaluation; formative evaluation; controlled experiments; model-view-controller; input models, output models; constraints, layout and toolkits; review of current literature, short assignments, and substantial programming projects.

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; wireless ad 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.

2190511*   Game Design and Development Process for
International Market   3 (3-0-6)
Player psychology; brainstorming techniques; game creation process; teamwork; design documentd; setting design; artificial intelligence; storytelling; gaming business in international market.

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

Phulporn Saengbangpla	M.Sc (Machester,UK)
Pramote Dechaumphai	Ph.D. (Virginia)
Ekachai Leelarasmee	Ph.D. (California)
Asi Bunyajitradulya	Ph.D. (California)
Siriporn Damrongsakkul	Ph.D. (London)
Atiwong Suchato	Ph.D. (Massachusetts)
Patama Visuttipitukul	Ph.D. (Tokyo)
Sunhapos Chatranuwathana	Ph.D. (Michigan)
Chaodit Aswakul	Ph.D. (London)
Yan Zhao	Ph.D. (London)
Surapong Sirikulvadhana	M.S (Michigan)
Varong Pavarajarn	Ph.D. (Oregon)

Professors
Electrical Engineering
Pramote	Dechaumphai,	Ph.D.(USA)

Associate Professors
Mechanical Engineering
Asi	Bunyajitradulya	Ph.D.(UC.Lrvine)
Kuntinee	Maneeratana	Ph.D.(London)
Pongtorn	Charunyakorn	Ph.D.(Miami)

Metallurgical Engineering
Seksak	Asavavisithchai	Ph.D.(Nottingham)

Computer Engineering
Atiwong	Suchato	Ph.D.(MIT)

Assistant Professors
Electrical Engineering
Thavatchai	Tayjasanant	Ph.D.(Alberta)
Manap	Wongsaisuwan	Ph.D.

Mechanical Engineering
Niphon	Wansophark,	D.Eng.(Chula)
Chittin	Tangthieng,	Ph.D.(Penn State)
Nopdanai	Ajavakom	Ph.D.(UC Berkeley)
Alongkorn	Pimpin,	Ph.D.(Tokyo)
Phongsaen	Pitakwatchara	Ph.D.(Tokyo)
Thanyarat	Singhanart	Ph.D.(Tokyo)

Metallurgical and materials Engineering
Itthipon	Diewwant,	Sc.D.(MIT)

Lecturer
Mechanical Engineering
Chirdpun	Vitoonraporn	Ph.D.
Tawan	Papapote	Ph.D.(LIinois)
Sawat	Luengruengrit	D.Eng.(Tokyo)

ISE Staff
Prabhath	De Silva	Ph.D.(USA)
Pinunta	Rojratsirikul	Ph.D.(Bath, UK)
Borrdephong	Rattanagraikanakorn	Ph.D.(London)
Joshua	Staubs	Ph.D.(Virginia)

Guest Lecturer
Boonchai	Watjatrakul	Ph.D.
Wasunthara	Manklasavadi	Ph.D.
Pinanta	Rojratsirikul	Ph.D.
Anurak	Athasit	Ph.D.(France)
Jeerasak	Pitakarnnop	Ph.D.(France)
Sant	Sangwornrachasup	Ph.D.
Wicha	Mektrakran	B.Eng(USA)
Agaphas	Teparagul	

Curriculum

Total number of credits requirement	146	credits
General Education	31	credits
Core Courses	109	credits
Basic Sciences	18	credits
Basic Engineering	31	credits
Compulsory	54	credits
Approved Electives	6	credits
Free Electives	6	credits

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1. General Education 31 credits

Social Science	3	credits
Humanity	3	credits
Science and Mathematics	3	credits
Interdisciplinary	3	credits
Foreign Language	16	credits
5501112	Communicative English I	3	3(3-0-6)
5501123	Communicative English II	3	3(3-0-6)
5501213	Technical Communication I	2	2(2-0-4)
5501224	Technical Communication II	2	2(2-0-4)
5501315	Technical Communication III	2	2(2-0-4)
5501326	Technical Communication IV	2	2(2-0-4)
5501417	Technical Communication V	2	2(2-0-4)
	General Education (Special)	3	credits
2140111	Exploring Engineering World	3	3(3-0-6)

2. Core Courses 109 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 31 credits

2140301	Industrial Training	2(0-6-0)
2182203	Probability and Statistics For Engineers	3(3-0-6)
2183101	Engineering Graphics	3(2-3-4)
2183211	Engineering Mechanics	4(4-0-8)
2183231	Dynamics	3(3-0-6)
2189101	Engineering Materials	3(3-0-6)
2190101	Computer Programming	3(3-0-6)
2190151	Computer Programming Laboratory	1(0-3-0)
2301215	Multivariable Calculus	3(3-0-6)
2301216	Linear Algebra and Differential Equations	3(3-0-6)
2301317	Methods of Applied Mathematics	3(3-0-6)

Compulsory 54 credits

2145211	Introduction to Aerospace Engineering	3(3-0-6)
2145221	Introduction to Aircraft Design	1(1-0-4)
2145230	Aircraft Electricity and Electronics	3(3-0-6)
2145290	Aerospace Engineering Seminar I	1(1-0-2)
2145311	Aerodynamics I	3(3-0-6)
2145312	Aerodynamics II	3(3-0-6)
2145321	Aircraft Structure I	3(3-0-6)
2145322	Aircraft Structure II	3(3-0-6)
2145324	Modeling and Control of Dynamic Systems	3(3-0-6)
2145325	Flight Mechanics	3(3-0-6)
2145361	Aerospace Engineering Experimentation and Laboratory I	2(1-3-2)
2145362	Aerospace Engineering Experimentation and Laboratory II	2(1-3-2)
2145363	Aerospace Engineering Experimentation and Laboratory III	2(1-3-2)
2145390	Aerospace Engineering Seminar II	1(1-0-2)
2145402	Aircraft Propulsion	4(4-0-8)
2145451	Aircraft Design	4(4-0-8)
2145490	Aerospace Engineering Seminar III	1(1-0-2)
2145499	Aerospace Engineering Project	3(3-0-6)
2183221	Thermodynamics	3(3-0-6)
2183222	Fluid Mechanics	3(3-0-6)
2183381	Numerical Methods for Engineers	3(3-0-6)

Approved Electives 6 credits

2145420	Avionics	3(3-0-6)
2145421	Introduction to Computational Fluid Dynamics	3(3-0-6)
2145422	Gas Dynamics	3(3-0-6)
2145495	Independent Studies	3(0-6-3)
2145497	Selected Topics in Aerospace Engineering I	3(2-3-4)
2145498	Selected Topics in Aerospace Engineering II	3(2-3-4)
2183431	Mechanical Vibrations	3(3-0-6)
2184303	Engineering Management	3(3-0-6)

3. Free Electives 6 credits

Any two subjects at the university level that are taught in English

AEROSPACE ENGINEERING CIRRICULUM

OURSE 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 Engineers	3
2304153	Physics for Engineers	3
2304193	Physics Laboratory for Engineers	1
5501112	Communicative English I	3
		18
SECOND SEMESTER		
2140111	Exploring Engineering World	3
2183101	Engineering Graphics	3
2189101	Engineering Materials	3
2301108	Calculus II	3
2304154	Physics and Electronics for Engineers	3
2304194	Physics and Electronics Laboratory for Engineers	1
5501123	Communicative English II	3
		19
THIRD SEMESTER		
2145211	Introduction to Aerospace Engineering	3
2183211	Engineering Mechanics	4
2183221	Thermodynamics	3
2301215	Multivariable Calculus	3
2301216	Linear Algebra and Differential Equations	3
5501213	Technical Communication I	2
		18
FOURTH SEMESTER		
2145221	Introduction to Aircraft Design	1
2145230	Aircraft Electricity and Electronics	3
2145290	Aerospace Engineering Seminar I	1
2182203	Probability and Statistics for Eng.	3
2183222	Fluid Mechanics	3
2183231	Dynamics	3
2301317	Methods of Applied Mathematics	3
5501224	Technical Communication II	2
		19

COURSE NO.	SUBJECT	CREDITS
FIFTH SEMESTER		
2145311	Aerodynamics I	3
2145321	Aircraft Structure I	3
2145324	Modeling and Control of Dynamic Systems	3
2145361	Aerospace Engineering Experimentation and Laboratory I	2
2183381	Numerical Methods for Engineers	3
5501315	Technical Communication III	2
xxxxxxx	General Education	3
		19
SIXTH SEMESTER		
2145312	Aerodynamics II	3
2145322	Aircraft Sturcture II	3
2145325	Flight Mechanics	3
5501326	Technical Communication IV	2
xxxxxxx	General Education	3
2145362	Aerospace Engineering Experimentation and Laboratory II	2
2145390	Aerospace Engineering Seminar II	1
		17
SUMMER SEMESTER		
2140301	Industrial Training	2
		2
SEVENTH SEMESTER		
2145363	Aerospace Engineering Experimentation and Laboratory III	3
2145402	Aircraft Propulsion	4
2145451	Aircraft Design	4
5501417	Technical Communication V	2
xxxxxxx	Approved Elective	3
xxxxxxx	General Education	3
		18
EIGTHTH SEMESTER		
2145499	Aerospace Engineering Project	3
xxxxxxx	Approved Elective	3
xxxxxxx	Free Elective	3
xxxxxxx	Free Elective	3
xxxxxxx	General Education	3
2145490	Aerospace Engineering Seminar III	1
		16

TOTAL CREDITS FOR GRADUATION	**146**

COURSES DESCRIPTIONS IN
AEROSPACE ENGINEERING
(B.ENG)

1. General Education
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 5501112*
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.

5501213 Technical Communication I 2(2-0-4)
Students are to practice academic writing at paragraph level. Selected readings in the related field are included. Discussion and presentation skills are to be taught including listening input.

5501224 Technical Communication II 2(2-0-4)
CONDITION: PRER 5501213
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.

5501315 Technical Communication III 2(2-0-4)
CONDITION: PRER 5501224*
Students are to develop ability in technical writing and academic essay writing. Selected readings in the related field are included. Academic presentation skills are to be taught including listening input in the related field.

5501326 Technical Communication IV 2(2-0-4)
CONDITION: PRER 5501315*
Students are to write technical reports and do academic presentations. Selected readings in technical discourse and listening input are included.

5501417 Technical Communication V 2(2-0-4)
CONDITION: PRER 5501326*
Students are to write academic articles and do academic presentations. Students are to develop their writing processes and presentation skills to bring their proficiency to the highest level in the related field.

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 bio engineering

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 (55)

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.

2183101　Engineering Graphics　3 (2-3-4)
　　Lettering; orthographic projections; sketching and drawing; pictorial drawing; dimensioning; to lerancing and geometrical tolerancing; section; working drawing; mechanical parts drawing; introduction to CAD.

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.

2189101　Engineering Materials　3 (3-0-6)
　　Important engineering materials: metals, plastics, asphalt, wood and concrete; macroscopic and microscopic structure which are correlating with properties of the engineering materials; production process of products from engineering materials.

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.

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 axic theorem; higher-order linear differential equations; method of variation of parameters; system of first-order linear differential equations; qualitative analysis and dynamical system.

2301317　Methods of Applied Mathematecs　3 (3-0-6)
CONDITION: PRER 2301215
　　Series solution; special functions; Laplace transforms; Fourier series and Fourier transforms; convergence theory; boundary value problems; linear partial differential equations; introduction to tensors; complex variables; analytic functions; line and contour integral; Laurent series; residue theorem.

Compulsory

2145211　Introduction to Aerospace Engineering　3 (3-0-6)
　　Basic aerodynamic phenomena and simplified theory, elementary aerospace vehicle performance, stability and control, and design.

2145221　Introduction to Aircraft Design　1(1-0-4)
　　Introduction to aircraft systems, fundamental to aircraft systems, elements of aerodynamics, airfoils, and wings, aspect of vehicle conceptual design.

2145230　Aircraft Electricity and Electronics　3 (3-0-6)
　　DC and AC circuits analysis, electrical control devices, analog and digital electronics, electric measuring instruments, electric motors, aircraft electrical systems, radio theory, aircraft communication and navigation systems, autoflight systems.

2145290　Aerospace Engineering Seminar I　1 (1-0-2)
　　Discussion on the topics of aerospace engineering

2145311　Aerodynamics I　3 (3-0-6)
CONDITION: PRER 2183222*
　　Properties of air, standard atmosphere, conservation principles, continuity, momentum, Euler's Equation, rotationality, circulation, vortex, lift, drag, potential flow, airfoil characteristics, thin airfoil theory, cambered and flapped airfoil, high lift devices, finite wing theory, panel and vortex lattice methods.

2145312　Aerodynamics II AERODYNAMICS II 3 (3-0-6)
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.

2145321　Aircraft Structure I　3 (3-0-6)
　　Introduction to design of aerospace structures, review of concepts of stress, deformation, strain, and displacement and the equations of elasticity, two-dimensional problems in elasticity, energy methods of structural analysis, principles of virtual displacements and virtual forces, bending of thin plates, structural instability, introduction to finite element.

2145322　Aircraft Structure II　3 (3-0-6)
CONDITION: PRER 2145321
　　Principles of stressed skin construction, thin-walled beam, bending, shear and torsion of open and closed thin-walled beam, stress analysis of aircraft components, tapered beam, fuselage, wings, fuselage frames and wing rib, airworthiness and aeroelasticity, factors of safety flight envelop, load factor determination, fatigue.

2145324   Modeling and Control of Dynamic Systems
                                        3 (3-0-6)
Introduction to modeling, analysis, and control of dynamic systems; modeling of mechanical, electrical and electromechanical system; Laplace Transforms and transfer function techniques; frequency response and Bode diagrams; analysis and design of feedback control systems; control system representation and characteristics; system performance specifications; stability analysis and conditions; Root-Locus and frequency response analysis and design; systems compensation and controller design.

2145325   Flight Mechanics   3(3-0-6)
            CONDITION: PRER 2183231
            and 2145324
Performance, stability, and control of aircraft; general equations of motion for rigid aircraft, aerodynamic forces and moments; flight paths; small disturbance theory, stability derivatives, longitudinal and lateral stability; response to control inputs and to atmospheric disturbances; automatic flight control.

2145361   Aerospace Engineering Experimentation
            and Laboratory I   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 instrument; uncertainty analysis; basic experiments and laboratories in thermodynamics; fluid mechanics and aerodynamics; dynamics; solid mechanics.

2145362   Aerospace Engineering Experimentation
            and Laboratory II   2 (1-3-2)
            CONDITION: PRER 2145361
Experiments and laboratories in aerodynamics, structure, propulsion, performance, dynamics and control.

2145363   Aerospace Engineering Experimentation and
            Laboratory III   2 (1-3-2)
            CONDITION: PRER 2145362
Concepts in experimentation and design of an experiment; setting up specifications and objectives of an experiment; systematic design of an experiment according to the specifications and objectives using different kinds of tools; outlining the process of extracting experimental results and conclusions from the designed experiment; outlining data collection and data analysis schemesl outlining experimental project phases, tasks, and schedule; design documentation and review by oral and written presentation; practices in the design of an experiment in the project-based setting; introduction to modern instrumentation and data acquisition through demonstration.

2145390   Aerospace Engineering   1(1-0-2)
            Seminar II
Discussion on the topics of aerospace engineering.

2145402   Aircraft Propulsion   4 (4-0-8)
            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 engines; Brayton cycle, propellers, momentum theory and blade element theory; gas turbine component performance, inlet, compressor, turbine and nozzle; cycle analysis of gas turbine engines, ramjet, turbojet, turbofan and turboprop.

2145451   Aircraft Design   4 (4-0-8)
            CONDITION: PRER 2145221
Fundamentals of aircraft design process, wing design consideration, tail design consideration, undercarriage arrangement consideration, initial take-off mass estimation, detailed mass calculation, mission fuel requirement; 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.

2145490   Aerospace Engineering Seminar III
                                        1 (1-0-2)
Discussion on the topics of aerospace engineering.

2145499   Aerospace Engineering Project   3 (0-6-3)
Group or individual projects on a subject related to aerospace engineering.

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: pathlines, streamlines, and streaklines; 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 folws 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 methods for obtaining numerical solutions by a digital computer, including methods for the solutions of

algebraic and transcendental equations, simultaneous linear equations, ordinary and partial differential equations, and curve fitting techniques, comparison of various methods with respect to computational efficiency and accuracy.

Approved Electives

2145420   Avionics   3 (3-0-6)
Basic avionic system, air data systems, flight instruments, terrestrial en-route - radio navigation systems, terrestrial landing aids, satellite navigation system, radar systems, indicators and displays, airborne radio communications, autopilot and flight-management system, avionic systems integration.

**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.

**2145497   Selected Topics in Aerospace
              Engineering I   3 (2-3-4)**
Selected interesting topics in aerospace engineering.

**2145498   Selected Topics in Aerospace
              Engineering II   3 (2-3-4)**
Selected interesting topics in aerospace engineering.

2183431   Mechanical Vibrations   3 (3-0-6)
Analysis of system with single and multi degree of freedom; torsional vibration; free and forced vibration; determination of natural frequencies of structures; discrete system; Modal analysis; methods and techniques to reduce and control vibration; Lagrange's equations.

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.

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 score of 550 or with the certificate of proficiency in English (IELTS 6.0) 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: 4 credits for required courses, (non-credit) 24 credits for elective courses, 18 credits for thesis.

PROFESSORS :

Parames	Chutima,	Ph.D. (Nottingham)

ASSOCIATE PROFESSORS :

Damrong	Thaveersaengsakuthai,	
		B.Eng. Hons. (Chula)
		M.Eng. (A.I.T)
Jeerapat	Ngaoprasertwong,	
		B.Eng. Hons. (Chula)
		M.S. M.A. (Iowa)
Manit	Thongprasert,	Ph.D. (Texas tech.)
Parames	Chutima,	Ph.D. (Nottingham)
Viboon	Sangveraphunsiri,	
		Ph.D. (Georgia Tech.)

ASSISTANT PROFESSORS :

Boonwa	Thampitakkul,	B.E. (N.S.W.)
		M.S. (Iowa)
		D.E.A., Docteur de3e cycle (Sciences de gestion) AIX-SEILLE III)
Manop	Reodecha,	B.E. Hons
		M.Eng. Sc. (Newcastle)
		Ph.D. (North Carolina State)
Napassavang	Osothsilp	Ph.D. (Wisconsin-Madison)
		Ms. (wisconsin-adison)
		B.Eng. (Chula)
Prasert	Akkharaprathomphong,	
		M.Eng. (Keio)
Praveena	Charalitnsngse	Ph.D. (Florida)
Rein	Boondiskulchok,	
		B.Eng. Hons. (Chula)
		M.Eng. D.Eng. (AIT)
Suthas	Ratanakuakangwan,	
		License es Sciences, Maitrise es Sciences, Economiques (D.E.S.S Toulouse)
Somchai	Puajindanetr,	Ph.D. (Imperial London)

INSTRUCTORS :

Jirdsak	Tscheikuna,	Ph.D. (OklahomaState)
Somboon	Chongchaikit,	B. Eng. Hons
		M.Eng. (Chula)
		D.E.S. (ESE France)
		Dr.Ing. (Electronique) (Paris XI)

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 10 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)

3) 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.

2146813   Thesis   18 Credits

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 involved in application of principle and practice for engineer in order to create the novel knowledge for medicine purposes and to develop the diagnosis and the treatment of diseases. For examples, the applications of sound wave and electromagnetic wave for diagnosis, the applications of nanotechnology for tissue transplantation and artificial organs.

After year 2010, BME was transferred the administration from 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:

Siriporn	Damrongsakkul,	Ph.D. (London)

PROFESSORS:

Areerat	Suputtitada	M.D. (Mahidol)
Prabhas	Chongstitvatana,	Ph.D. (Edinburgh)
Suthiluk	Patumraj	Ph.D. (New Jersey)

ASSOCIATE PROFESSORS :

Chedsada	Chinrungrueng,	Ph.D.
Mana	Sriyudthsak,	D.Eng. (T.I.T.) (U.C.Berkeley)
Siriporn	Damrongsakkul,	Ph.D. (London)
Sompol	Sanguanrungsirikul	M.D., M.Sc. (Chula)
Watcharapong	Khovidhungij,	Ph.D. (UCLA)

ASSISTANT PROFESSORS :

Arporn	Teeramongkonrasmee, Ph.D. (Chula)	
Charnchai	Pluempitiwiriyawej,	Ph.D.(Carnegie Mellon)
Cherdkul	Sopavanit,	M.Eng. (Chula)
Sorada	Kanokpanont,	Ph.D. (Drexel)
Tanom	Bunaprasert	M.D. (Prince of Songkla)
Tayard	Desudchit	M.D. (Chula)

INSTRUCTORS :

Apiwat	Lek-Uthai	Dr.Ing. (Karlsruhe)
Bunchauy	Supmonchai,	M.Eng. (Chula)
Juthamas	Ratanavaraporn	Ph.D. (Chula)
Pakpum	Somboon	Ph.D. (T.I.T)
Pairat	Tangpornprasert	D.Eng. (Tokyo)

NAME OF THE DEGREE

: Master of Science
: M.Sc.

ADMISSION

The applicants must hold a Bachelor degree in any fields of Science, Health Science (Medicine, Dentistry, Veterinary Medicine, Pharmacy, Nursing, or Allied Health Sciences), or Engineering 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 6 credits of required course, 12 credit of elective courses, and 18 credits of 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 was presented in an academic conference having proceedings.
3. The degree will be awarded for the student who has fulfilled the requirements as followed; G.P.A. not less than 3.00, and period of study not less than 4 semesters and not more than 8 semesters.

STUDY PROGRAM

The First Semester

2100600	Introduction to Biomedical Engineering	3
2100601	Basic Engineering Knowledge for Biomedical Engineering	3
XXXXXXX	Free Elective	3
2100791	Biomedical Engineering Seminar I	(2)*
		9

The Second Semester

XXXXXXX	Free Elective	9
2100792	Biomedical Engineering Seminar II	(2)*

Remarks:
* No credit will be granted, evaluation will be only S/U

The Third Semester

2100813	Thesis	9
		9

The Fourth Semester

2100813	Thesis	9
		9

COURSE REQUIREMENTS

1) Required Courses   6 credits

2100600	Introduction to Biomedical Engineering	3(2-3-7)
2100601	Basic Engineering Knowledge for Biomedical Engineering	3(2-3-7)
2100791	Biomedical Engineering Seminar I	2(2-0-6)
2100792	Biomedical Engineering Seminar II	2(2-0-6)

2) Elective Courses 12credits

3017767	Human Body for Biomedical Engineering	3(2-3-7)
2100603	Research Methodology and Research Instrumentation	3(3-0-9)
2109556	Biomaterials	3(3-0-9)
3000748	Tissue and Cell Engineering	3(3-0-9)
3000749	Biosystems and Biotransport	3(3-0-9)
3000750	Drug Delivery System	3(3-0-9)
2102611	Medical Instrumentation	3(3-0-9)
2102646	Power Electronics for Biomedical Engineering Applications	3(3-0-9)
2100623	Technology for Seniors and the Disabled	3(3-0-9)
2102631	Mathematical Modeling and Analysis of Physiological Systems	3(3-0-9)
2102523	Biomedical Signal Processing	3(3-0-9)
2102524	Medical Imaging Technology	3(3-0-9)
2110675	Biomedical Information and Communication Systems	3(3-0-9)
3016725	Biomechanics	3(3-0-9)
2100636	Biomedical Analytical Technique	3(3-0-9)
2100696	Special Problems in Biomedical Engineering	3(0-0-12)
2100697	Individual Study	3(0-0-12)
2100796	Advanced Topics in Biomedical Engineering I	3(3-0-9)
2100797	Advanced Topics in Biomedical Engineering II	3(3-0-9)
2102505	Introduction to Optimization Techniques	3(3-0-9)
2102507	Computational Techniques for Engineers	3(3-0-9)
2102531	System Identification	3(3-0-9)
2102635	Control System Theory	3(3-0-9)
2102668	Biosensors	3(3-0-9)
2102546	Analog Integrated Circuits	3(3-0-9)
2102784	Measurement System Design and Simulation	3(3-0-9)
2102785	Advanced Sensor Theory	3(3-0-9)
2102876	Adaptive Signal Processing	3(3-0-9)
2105641	Biodegradable Material Engineering	3(3-0-9)
2111602	Radiation Physics for Medical Science	2(2-0-6)
2100604	Strategic Tssue Engineering and Controlled Release System	3(3-0-9)
2100605	Biomedical Embedded System	3(3-0-9)

3) Thesis

2100813	Thesis	18 credits

NAME OF THE DEGREE

: Master of Engineering
: M.Eng.

ADMISSION

The applicants must hold a Bachelor degree in Engineering 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 6 credits of required course, 12 credit of elective courses, and 18 credits of 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 was presented in an academic conference having proceedings.
3. The degree will be awarded for the student who has fulfilled the requirements as followed; G.P.A. not less than 3.00, and period of study not less than 4 semesters and not more than 8 semesters.

STUDY PROGRAM

The First Semester

2100600	Introduction to Biomedical Engineering	3
3017767	Human Body for Biomedical Engineering	3
XXXXXXX	Free Elective	3
2100791	Biomedical Engineering Seminar I	(2)*
		9

The Second Semester

XXXXXXX	Free Elective	9
2100792	Biomedical Engineering Seminar II	(2)*
		9

Remarks:
* No credit will be granted, evaluation will be only S/U

The Third Semester

2100813	Thesis	9
		9

The Fourth Semester

2100813	Thesis	9
		9

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)
2100791	Biomedical Engineering Seminar I	2(2-0-6)
2100792	Biomedical Engineering Seminar II	2(2-0-6)

2) Elective Courses 12 credits

2100601	Basic Engineering Knowledge for Biomedical Engineering	3(2-3-7)
2100603	Research Methodology and Research Instrumentation	3(3-0-9)
2109556	Biomaterials	3(3-0-9)
3000748	Tissue and Cell Engineering	3(3-0-9)
3000749	Biosystems and Biotransport	3(3-0-9)
3000750	Drug Delivery System	3(3-0-9)
2102611	Medical Instrumentation	3(3-0-9)
2102646	Power Electronics for Biomedical Engineering Applications	3(3-0-9)
2100623	Technology for Seniors and the Disabled	3(3-0-9)

2102631	Mathematical Modeling and Analysis of Physiological Systems	3(3-0-9)
2102523	Biomedical Signal Processing	3(3-0-9)
2102524	Medical Imaging Technology	3(3-0-9)
2110675	Biomedical Information and Communication Systems	3(3-0-9)
3016725	Biomechanics	3(3-0-9)
2100636	Biomedical Analytical Technique	3(3-0-9)
2100696	Special Problems in Biomedical Engineering	3(0-0-12)
2100697	Individual Study	3(0-0-12)
2100796	Advanced Topics in Biomedical Engineering I	3(3-0-9)
2100797	Advanced Topics in Biomedical Engineering II	3(3-0-9)
2102505	Introduction to Optimization Techniques	3(3-0-9)
2102507	Computational Techniques for Engineers	3(3-0-9)
2102531	System Identification	3(3-0-9)
2102635	Control System Theory	3(3-0-9)
2102668	Biosensors	3(3-0-9)
2102546	Analog Integrated Circuits	3(3-0-9)
2102784	Measurement System Design and Simulation	3(3-0-9)
2102785	Advanced Sensor Theory	3(3-0-9)
2102876	Adaptive Signal Processing	3(3-0-9)
2105641	Biodegradable Material Engineering	3(3-0-9)
2111602	Radiation Physics for Medical Science	2(2-0-6)
2100604	Strategic Tssue Engineering and Controlled Release System	3(3-0-9)
2100605	Biomedical Embedded System	3(3-0-9)

3) Thesis

2100813	Thesis	18 credits

NAME OF THE DEGREE

: Doctor of Philosophy
: Ph.D.

ADMISSION

The applicants have to pass the following basic requirements:

For Pattern 1:
For applicants who held the Master degree in Biomedical Engineering and have got the thesis qualification as the excellence level and also passed the requirements of the Graduate School or got approval from the program committee for admission.

For Pattern 2:
Pattern 2(1) for applicants who held a Master degree in Biomedical Engineering, Master degree in Engineering or Science and have got the thesis qualification as the good level, and also passed the requirements of the Graduate School or got approval from the program committee for admission.

Pattern 2 (2) for applicants who held a Bachelor degree in Engineering or Science and have got the

second honor degree or have G.P.A. 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 Pattern 1:
The students have to get 60 credits, also passed an oral examination and some part of thesis has to be published or accepted for publication in a journal of 2 papers, at least 1 paper has to be published in an international journal.

For Pattern 2(1):
The students have to get 12 credits of elective courses and 48 credits of thesis, 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 Pattern 2(2):
The students have to get 24 credits of elective courses and 48 credits of thesis, 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:
For Pattern 1 may require additional courses or other academic activities (no credit will be granted, evaluation will be only S/U) that will benefit for the thesis, under consent of the advisor and the program committee.

STUDY PROGRAM

Pattern 1

The First Semester

2100791	Biomedical Engineering Seminar I	(2)*
2100829	Dissertation	12
		12

The Second Semester

2100792	Biomedical Engineering Seminar II	(2)*
2100829	Dissertation	12
		12

The Third Semester

2100793	Biomedical Engineering Seminar III	(2)*
2100829	Dissertation	12
		12

The Fourth Semester

2100794	Biomedical Engineering Seminar IV	(2)*
2100829	Dissertation	12
		12

The Fifth Semester

2100894	Doctoral Dissertation Seminar	(0)*
2100829	Dissertation	<u>12</u>
		12

The Sixth Semester

-

Remarks:
* No credit will be granted, Evaluation will be only S/U

Pattern 2(1)

The First Semester

2100791	Biomedical Engineering Seminar I	(2)*
XXXXXXX	Free Elective	<u>9</u>
		9

The Second Semester

2100792	Biomedical Engineering Seminar II	(2)*
2100828	Dissertation	6
XXXXXXX	Free Elective	<u>3</u>
		9

The Third Semester

2100793	Biomedical Engineering Seminar III	(2)*
2100828	Dissertation	<u>9</u>
		9

The Fourth Semester

2100794	Biomedical Engineering Seminar IV	(2)*
2100828	Dissertation	<u>9</u>
		9

The Fifth Semester

2100894	Doctoral Dissertation Seminar	(0)*
2100828	Dissertation	<u>12</u>
		12

The Sixth Semester

2100894	Doctoral Dissertation Seminar	(0)*
2100828	Dissertation	<u>12</u>
		12

Pattern 2(2)

The First Semester

2100791	Biomedical Engineering Seminar I	(2)*
XXXXXXX	Free Elective	<u>9</u>
		9

The Second Semester

2100792	Biomedical Engineering Seminar II	(2)*
XXXXXXX	Free Elective	<u>9</u>
		9

The Third Semester

2100793	Biomedical Engineering Seminar III	(2)*
2100828	Dissertation	3
	Free Elective	<u>6</u>
		9

The Fourth Semester

2100794	Biomedical Engineering Seminar IV	(2)*
2100828	Dissertation	<u>9</u>
		9

The Fifth Semester

2100894	Doctoral Dissertation Seminar	(0)*
2100828	Dissertation	<u>9</u>
		9

The Sixth Semester

2100894	Doctoral Dissertation Seminar	(0)*
2100828	Dissertation	<u>9</u>
		9

The Seventh Semester

2100894	Doctoral Dissertation Seminar	(0)*
2100828	Dissertation	<u>9</u>
		9

The Eighth Semester

2100894	Doctoral Dissertation Seminar	(0)*
2100828	Dissertation	<u>9</u>
		9

COURSE REQUIREMENTS

Elective Courses
Pattern 2.1 = 12 credits and Pattem 2.2
=12 credits

2100600	Introduction to Biomedical Engineering	3(2-3-7)
2100601	Basic Engineering Knowledge for Biomedical Engineering	3(2-3-7)
2111602	Radiation Physics for Medical Science	2(2-0-6)
2100604	Strategic Tssue Engineering and Controlled Release System	3(3-0-9)
2100605	Biomedical Embedded System	3(3-0-9)
2100791	Biomedical Engineering Seminar I	2(2-0-6)
2100792	Biomedical Engineering Seminar II	2(2-0-6)
3017767	Human Body for Biomedical Engineering	3(2-3-7)
2100603	Research Methodology and Research Instrumentation	3(3-0-9)
2109556	Biomaterials	3(3-0-9)
3000748	Tissue and Cell Engineering	3(3-0-9)
3000749	Biosystems and Biotransport	3(3-0-9)
3000750	Drug Delivery System	3(3-0-9)
2102611	Medical Instrumentation	3(3-0-9)
2102646	Power Electronics for Biomedical Engineering Applications	3(3-0-9)
2100623	Technology for Seniors and the Disabled	3(3-0-9)
2102631	Mathematical Modeling and Analysis of Physiological Systems	3(3-0-9)
2102523	Biomedical Signal Processing	3(3-0-9)
2102524	Medical Imaging Technology	3(3-0-9)
2110675	Biomedical Information and Communication Systems	3(3-0-9)
3016725	Biomechanics	3(3-0-9)
2100636	Biomedical Analytical Technique	3(3-0-9)
2100696	Special Problems in Biomedical Engineering	3(0-0-12)
2100697	Individual Study	3(0-0-12)
2100796	Advanced Topics in Biomedical Engineering I	3(3-0-9)
2100797	Advanced Topics in Biomedical Engineering II	3(3-0-9)
2102505	Introduction to Optimization Techniques	3(3-0-9)
2102507	Computational Techniques for Engineers	3(3-0-9)
2102531	System Identification	3(3-0-9)
2102635	Control System Theory	3(3-0-9)
2102668	Biosensors	3(3-0-9)
2102546	Analog Integrated Circuits	3(3-0-9)
2102784	Measurement System Design and Simulation	3(3-0-9)
2102785	Advanced Sensor Theory	3(3-0-9)
2102876	Adaptive Signal Processing	3(3-0-9)
2105641	Biodegradable Material Engineering	3(3-0-9)

2) Thesis

2100828	Thesis	48 credits
2100829	Thesis	60 credits

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

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.

2100791   Biomedical Engineering Seminar I 2(2-0-6)
Current topics in biomedical engineering.

2100792   Biomedical Engineering Seminar II2(2-0-6)
Current topics in biomedical engineering.

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.

2100603   Research Methodology and Research Instrumentation   3(3-0-9)
Experimental and research methods; experimental design; statistics analysis of experimental results; operating principles of biomedical engineering tools and equipment.

2100604 Strategic Tssue 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.

2109556　Biomaterials　3(3-0-9)
Biological system that interacts with materials, types of materials currently used for biomedical applications; appropriate analytical techniques pertinent to biomaterial research and evaluation; selected important medical fields in which biomaterials play a critical role.

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.

3000749　Biosystems and Biotransport　3(3-0-9)
Applications of fundamental chemical engineering principles to the study of biological systems with emphasis on current bioengineering research.

3000750　Drug Delivery System　3(3-0-9)
Applications of physical principles and modern methods of analysis to pharmaceutical systems; a conceptual introduction to the way that drugs act and are processed in vivo, including receptor theory, ligand-macromolecule binding, biopharmaceutics, drug metabolism, pharmacokinetics and pharmacodynamics.

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.

2102646　Power Electronics for Biomedical Engineering Applications　3(3-0-9)
Fundamental theories of power electronics for biomedical equipment; ac-dc and dc to dc converters as well as inverters circuit topologies and operations; converter and inverter control techniques and circuits; switching and control characteristics of semiconductor power devices: diodes, transistors and thyristors; power and control circuit components: inductors, transformers, capacitors, resistors; converter and inverter applications for biomedical equipment: switching power supplies, dc and ac motor drive.

2100623　Technology for Seniors and the Disabled　3(3-0-9)
Limitations of the seniors and the disabled; geriatric ergonomics and ergonomics of the disabled; classification of tools and equipment for seniors and the disabled; design and construction technology of tools and equipment for daily life, education and work of the seniors and the disabled.

2102631　Mathematical Modeling and Analysis of Physiological Systems　3(3-0-9)
Cellular physiology; biochemical reactions and enzyme kinetics; cellular homeostasis; ion channel; cell excitation; electrical conductions in nerve cells and cardiac muscles; mathematical modeling and analysis of physiological systems.

2102523　Biomedical Signal Processing　3(3-0-9)
Nature of biomedical signals; impulse response; frequency response; noise removal and signal compensation; modeling of continuous-time signals, discrete-time signals and stochastic signals; non-linear models of signals.

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.

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.

3016725　Biomechanics　3(3-0-9)
Review of basic solid and fluid mechanics: statics and dynamics, strength of material and basic of rheology: characteristics of skeletal system, muscular system, blood circulation system: modeling in biomechanics, with applications in various areas: human movement, artificial organs, sports, sports science; applications of biomechanics in human system and prosthetics.

2100636　Biomedical Analytical Technique 3(3-0-9)
Principles of analytical techniques for Biomedical samples related to drug delivery system.

2100696　Special Problems in Biomedical Engineering　3(0-0-12)
Literature review in the field of interest from basic to new innovation, summarizing and presenting reports.

2100697　Individual Study　3(0-0-12)
Literature review, asking research questions, conducting preliminary studies, summarizing and presenting reports.

2100796　Advanced Topics in Biomedical Engineering I　3(3-0-9)
Interesting problems or new development in Biomedical Engineering I

2100797　Advanced Topics in Biomedical Engineering II　3(3-0-9)
Interesting problems or new development in Biomedical Engineering II

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.

2102531 System Identification 3(3-0-9)
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.

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.

2102668 Biosensors 3(3-0-9)
Necessary concepts relevant to the principle of measuring chemical and biological phenomena with emphasis on integrating these concepts of development to apply and to construct novel instruments for observing, examining and controlling various phenomena in the field of biotechnology, medical sciences and chemical engineering for both fundamental research and process development in 'industrial production.

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.

2102784 Measurement System Design and Simulation 3(3-0-9)
Analysis of measuring system; design of measuring system for sensors; remote sensing and non-invasive measurement; automation system; flow injection analysis; modeling of sensor system; numerical modeling; simulation of the sensor response.

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.

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.

2111602 Radiation Physics for Medical Science 2(2-0-6)
Atomic structure and atomic radiation, and particles, radioisotope, radioactivity, interaction of radiation and particles with matters, principles of radiation dosimetry, exposure dose, absorbed dose, radiation protection radiation effects on humans, X-ray equipment, radiation measurement radiation counting statistics phosphorescence and fluorescence screen, factors affecting radiation image quality, calculation of X-ray room shielding.

2100894 Doctoral Dissertation Seminar 0(0-0-0)

2100897 Qualifying Examination 0(0-0-0)

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 7 majors; Civil Engineering and Explosives, Electrical Engineering for Defense, Mechanical Engineering for Defense, Metallurgy Engineering for Defense, Computer Engineering for Defense, Environment Engineering for Defense, and Nuclear Engineering for Defense.

HEAD:

Withit	Pansuk,	Ph.D. (Hokkaido)
Col.Chuan	Chuntavan	Ph.D. (Cincinnati)

ASSOCIATE PROFESSORS:

Withit	Pansuk,	Ph.D. (Hokkaido)
Sunchai	Nilsuwankosit,	Ph.D. (Wisconsin)

ASSISTANT PROFESSORS:

Col.Chuan	Chuntavan	Ph.D. (Cincinnati)
Widhyakorn	Asdornwised	Ph.D. (Chula)
Suebskul	Phiphobmongkol	Ph.D. (AuBurn)
Chaodit	Aswakul	Ph.D. (London)
Alongkorn	Pimpin	D.Eng. (Tokyo)
Pichaya	Rachdawong	Ph.D. (Wisconsin-Milwaukee)
Panyawat	Wangyao	Ph.D. (Kosice)
Krerk	Piromsopa,	Ph.D. (Michigan)
Col.Phaderm	Nangsue	Ph.D. (Clarkson)
Col.Anotai	Suksangpanomrong	Ph.D. (Victoria)
Col.Preecha	Apiwantragoon	Ph.D. (Wisconsin)
Col.Nuthaporn	Nittayasakol	Ph.D. (Virginia Polytechnic)

INSTRUCTORS:

Kanok	Weerawong	Ph.D. (Purdue)
Maj.Banchachit	Saensunon	Ph.D. (New South Wales)

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/ Metallurgy Engineering for Defense/ Computer Engineering for Defense/ Environment Engineering for Defense
   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) Metallurgy Engineering for Defense Engineering — 15 credit
   7) Computer Engineering for Defense Engineering — 15 credit

   Students in Electrical Engineering for Defense/Mechanical Engineering for Defense/Metallurgy Engineering 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 — **9 credits**

Engineering

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/ Metallurgy Engineering for Defense/ Computer Engineering for Defense/ Environment Engineering for 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/Metallurgy Engineering 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.

2.3.1) 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)
2102601	Electrical Power and Energy Technogy in Smart Grids	3(3-0-9)
2102602	Information and Communication Technologies in Smart Grids	3(3-0-9)

2102620	Electromagnetic Theory	3(3-0-9)
2102623	Antennas and Rader Systems	3(3-0-9)
2102627	Reliability and Survivability of Communication Networks and Systems	3(3-0-9)
2102631	Optimal Control Systems	3(3-0-9)
2102635	Control System Theory	3(3-0-9)
2102642	Computer Vision and Video Electronics	3(3-0-9)
2102645	Embedded System Design	3(3-0-9)
2102668	Biosensors	3(3-0-9)
2102675	Pattern Recognition	3(3-0-9)
2102676	Digital Image Processing	3(3-0-9)

2.3.2) Mechanical Engineering for Defense 15 credits Engineering

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)
2107661	Fundamental Chemistry for Environmental Engineering	3(3-2-7)
2127675	Military Waste Management	3(3-0-9)
2107676	Management of Environmental Emergencies	3(3-0-9)

2.3.4) Metallurgy Engineering for Defense 15 credits Engineering

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 15credits

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)
2110622	Data Management	3(3-0-9)
2110639	Computer System Security	3(3-0-9)
2110661	Computer Network	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)
2110741	Robotics	3(3-0-9)
2110743	Machine learning	3(3-0-9)
2110745	Cryptography	3(3-0-9)

Other Free Elective Courses

2120602	Advanced Topics in Defense Engineering and Technology	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

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
2100829	Thesis	9
		9

The Third Semester

2120816	Thesis	9
		9

The Fourth Semester

2120816	Thesis	9
		9

Remarks:
* No credit will be granted, Evaluation will be only S/U

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.

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.

2102601 Power and Energy Technology in Smart Grids 3(3-0-9)
Condition: Consent of Faculty

Introduction to Smart Grids; fundamentals of power system operation and control; distributed generation, microgrid and active networks; introduction to wide area monitoring and wide area protection systems; renewable energy generation; grid connection codes; renewable energy policy and regulation; energy storage; electric vehicle.

2102602 Information and communication technologies in Smart Grids 3(3-0-9)
Condition: Consent of Faculty

Substation operation and related communication within substation; equipment in distribution system; communication between control center Architecture and components of AMI/AMR including phasor measurement unit, digital fault recorder and interoperability. Energy efficiency within home, building and factory. Communication channels in smart grid: wire, wireless, optical fiber, including network layer, sensing/control and control protocol. Database management and cyber security.

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.

2102623 Antennas and Radar Systems 3(3-0-9)
Condition: Consent of Faculty

Introduction and fundamental parameters of antennas; Transmitting and receiving antennas; Friis transmission equation; Basic antenna types; Phased array antennas; Smart antennas and multiple-input/multiple-output (MIMO) systems; Introduction and basic principle of radar systems; Radar cross section; Radar equation; Continuous wave radar; Pulsed radar; Target tracking radar.

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.

2102631   Optimal Control Systems   3(3-0-9)
Condition: PRER 2102505 or Consent of
Faculty
Discrete-time linear quadratic; calculus of variations; continuous-time linear quadratic regulator; time-optimal control; constrained control input problem; the Pontryagin's maximum principle; singular control; dynamic programming; optimal controller design; computational methods in optimal controller synthesis.

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
Condition: Consent of Faculty   3(3-0-9)
Human vision; geometric camera models; image segmentation; object recognition; video signals and standards; video input and output circuits; computer vision and digital video applications.

2102645   Embedded System Design   3(3-0-9)
Condition: Consent of Faculty
Practical examples; performance evaluation; complex system designs: automotive, multimedia, biomedical instrumentation, measurement instrumentation, and robot.

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.

2102675   Pattern Recognition   3(3-0-9)
Condition: PRER 2102282 or Consent of
Faculty
Statistical pattern recognition: linear discriminant functions, Bayesian decision theory, maximum-likelihood and Bayesian parameter estimation.

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.

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.

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.

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.

2107661　Fundamental Chemistry for Environmental
Engineering　3(2-3-7)
Chemical and physical characteristics of water and wastewater, general considerations, methods for determination and application of date to environmental engineering practice; instrumentation; sample collection and preservation; laboratory analysis of water; interpretation of water analysis results as related to their treatment; neutralization, precipitation, coagulation, water softening, ion exchange, corrosion, absorption, chlorination; determinations of solids, Do, BOD, COD, nitrogen (in all forms related to environmental engineering practice), phosphorus and phosphates, grease and oil, volatile acids, sulfides and gas analysis.

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.

2110622 Data Management 3(3-0-9)

List structures: list, stacks, queues; table and hash in tree structures: binary search trees, AVL trees, B-trees, heaps; searching and sorting; fundamental of file structures.

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.

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 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; 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.

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.

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.

2110745 Cryptography 3(3-0-9)

Introduction; symmetric encryption; block ciphers; 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.

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.

APPENDIX

FOUNDATION ENGLISH COURSES

5500111   Experiential English I   3(2-2-5)
Practice language skills in acquiring information and knowledge from different sources and media in subjects of student' interest under selected themes collecting information summarizing and presenting important issues.

5500112   Experiential English I   3(2-2-5)
Condition : Prerequisite 5500111
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.

5500208   Communication and Presentation
**   skills   3(2-2-5)**
Condition : Prerequisite 5500116,500112
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.

5500115   Foundation English I   3(2-2-5)
Practice in reading and writing based on selections of about 300 words from newspapers, encyclopedias, magazines, announcements, handbooks, notes and letters for general purposes as well as dialogues and   materials from other sources such as tape recordings, radio, and television.

5500116   Foundation English II   3(2-2-5)
Condition : Prerequisite 5500115
Practice in reading and writing based on selections of about 450 words from newspapers, encyclopedias, magazines, announcements, handbooks, notes and letters for general purposes as well as dialogues and materials from other sources such as tape recordings, radio, and television.

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
Lines; planes; quadric surfaces; normal lines and tangent planes to a surface, are length; calculus of real-valued functions of several veriables; Taylor's formula and its applications.

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 2301106 or 2301118 or 2301241
Existence and uniqueness theorems for first-order equations, numerical methods, general linear equations, solution in series form, linear partial differential equations, boundary value problems.

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 and basis of the atomic theory. Properties of gas, liquid, solid and solution. Chemical equilibrium. Ionic equilibrium   Chemical kinetic. Electronic structures of atoms. Chemical bonds. Periodic properties. Representative elements, nonmetal and transition metals. Basic organic chemistry.

2302163   General Chemistry Laboratory   1(0-3-0)
Qualitative analysis techniques, Graham's law of gas diffusion, structure of metals and crystals, chemical equilibrium, indicators, acidbase titration, pH of solution and hydrolysis.

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; experiments on simple harmonic motion and physical pendulum, elasticity of springs and rubber bands, module of metals, rolling and radius of gyration, dynamics of rotation, velocity of sound and Meld's experiment, viscosity of fluids.

2304184 General Physics Laboratory II 1(0-3-0)
Resistance and electromotive force measurements; experiments on ammeter, voltmeter,oscilloscope, AC circuit, transistor,lenses and mirrors, polarization, interference, diffraction, and radioactivity.

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

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.

GENERAL EDUCATION, SPECIAL

2100111 Exploring Engineering World 3(3-0-6)
Engineering topics related to daily life: Energy, Resources, Environment, industrial, automotive, manufacturing, infrastructure, process, material, Information System and bio engineering

2100303 Creative Design for Community 3(2-3-4)
Creative design for community, creating concepts in design processes by taking need users and community into consideration; design for sustainability; prototyping, testing and refining of the prototype, project management; case studies.

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.
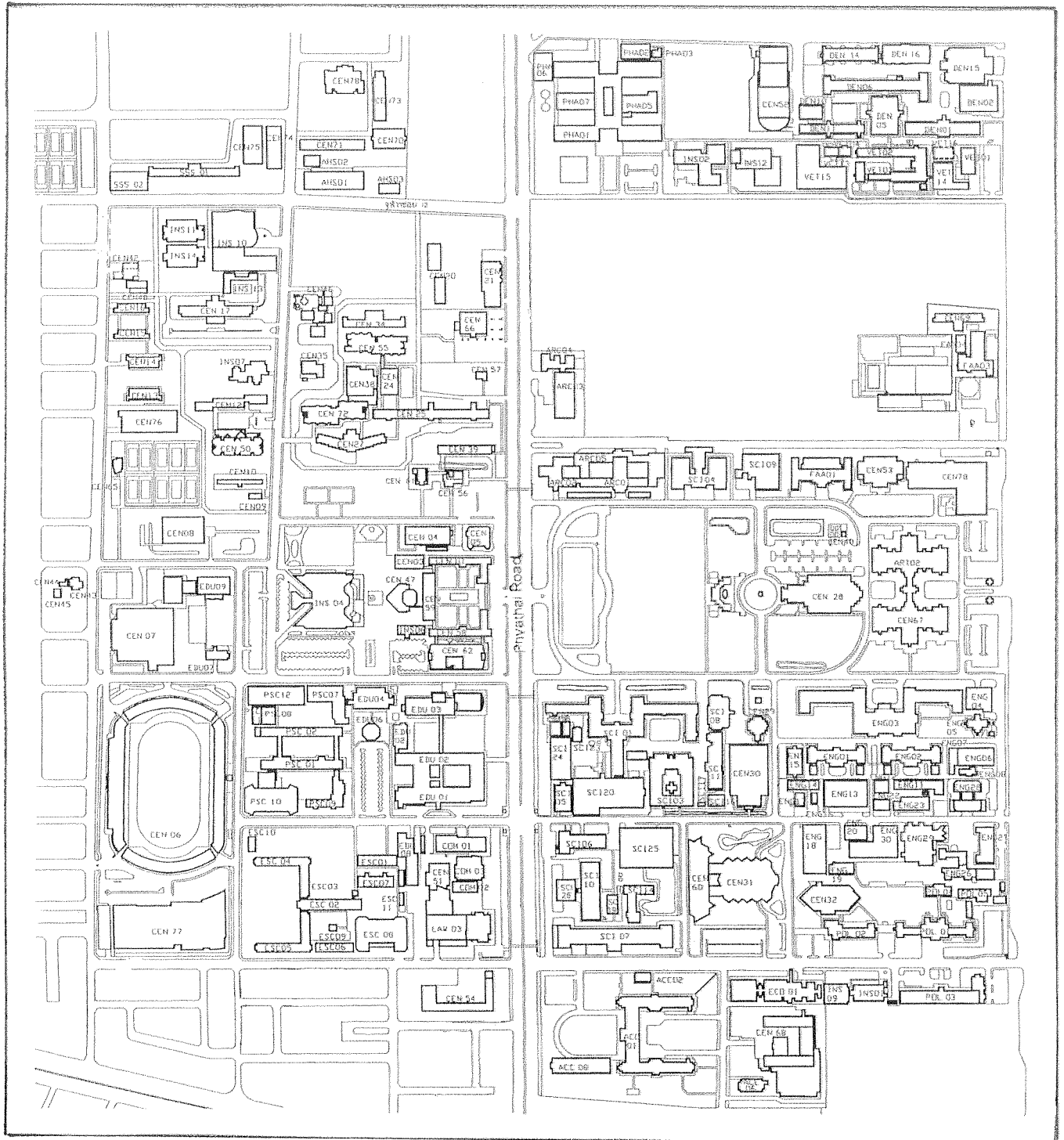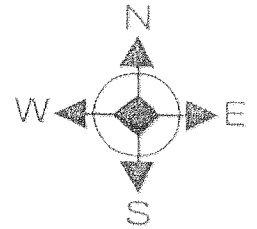
รายวิชาศึกษาทั่วไป จุฬาลงกรณ์มหาวิทยาลัย

	กลุ่มวิชามนุษยศาสตร์		กลุ่มวิชาวิทยาศาสตร์และคณิตศาสตร์		กลุ่มวิชาสหศาสตร์		กลุ่มวิชาสังคมศาสตร์	
1	0123101 PARAGRAPH WRITING	3(1-4-4)	0201152 PROD PROMOTION SCI	3(3-0-6)	0201102 THAI WISDOM	3(1-12-0)	0201170 MILITARY SCIENCE	3(3-0-6)
2	0123104 UNIV THAI READING	3(1-4-4)	2100111 EXPL ENG WORLD	3(3-0-6)	0201103 OUR CU	3(2-3-4)	0201171 EFFECT CAREER MGT	3(3-0-6)
3	0123105 THAI WRIT WORK	3(1-4-4)	2101251 CE PROF CONDUCT	3(3-0-6)	0201106 ART SCI FIND HAP	3(3-0-6)	0201172 SELF/CAREER MGT	3(3-0-6)
4	0201105 CU SMART BUD GRAD	3(3-0-6)	2102041 ICT TELECOM MGT	3(3-0-6)	0201107 LRN STUD ACT	3(1-6-2)	2400104 GOVT POL THAI	3(3-0-6)
5	0201211 MEDITAT LIFE DEV	3(2-2-5)	2100311 ENG ESSENTIALS	3(3-0-6)	0201108 FAMILY RELATIONS	3(3-0-6)	2403183 SOCIETY & CULTURE	3(3-0-6)
6	2200222 VERN ARCH TH SOC	3(3-0-6)	2105261 CHEM PROD IND	3(3-0-6)	0201109 INTRO EU INTEGRAT	3(3-0-6)	2403184 SOC DIVER JUS THAI (inter)	3(3-0-6)
7	2200223 PNTG TH SOC	3(3-0-6)	2107219 URBAN ENVIRONMENTS	3(3-0-6)	0201110 SICHANG STUDY	3(2-2-5)	2403284 CROSS CULT MGT	3(3-0-6)
8	2200226 FOLK MUS TH SOC	3(3-0-6)	2107220 ENV DAILY LIFE	3(3-0-6)	0201111 WISDOM LIVING	3(3-0-6)	2403185 JUV DEL	3(3-0-6)
9	2200227 TH CL MUS DRAM	3(3-0-6)	2107221 ENV STUD	3(3-0-6)	0201117 ART RATANAKOSIN	3(2-3-4)	2403471 ANTH RSRCH METH	3(3-0-6)
10	2200183 THAI CIV	3(3-0-6)	2110191 INNOV THINK	3(3-0-6)	0201121 LIFE REFL FILM	3(3-0-6)	2404300 IT/SOC	3(3-0-6)
11	2200185 SURV ART ARCH THAI	3(2-4-3)	2110221 COMP ENG ESS	3(3-0-6)	0201122 MGT PUB DISASTER	3(3-0-6)	2404301 SEL TOP PAX DIGI	3(3-0-6)
12	2200201 ACAD REPORT WRI (inter)	3(2-2-5)	2111201 GEN RAD NUCLEAR	3(3-0-6)	0201123 CULT TRAD TH LIFE	3(2-2-5)	2541160 CREAT URB LIVING (inter)	3(3-0-6)
13	2200330 TIPITAKA LIFE	3(3-0-6)	2111330 MOD MAP PROT RAD	3(3-0-6)	0201125 MGT DIFF CULT	3(3-0-6)	2601111 BUS ACCTG	3(3-0-6)
14	2200387 ARCHAEO THAI	3(2-3-4)	2112210 WATER / SOC	3(3-0-6)	0201127 QUAL WORK MGT	3(3-0-6)	2602121 INTRO BUSINESS	3(3-0-2)
15	2200389 ICONOGRAPHY	3(3-0-6)	2142109 AUTO STUDIES (Inter)	3(3-0-6)	0201129 UNDERWATER WORLD	3(2-2-5)	2602171 BUS CPTS/ETHICS (inter)	3(3-0-6)
16	2200390 FOR CULT TH ART	3(3-0-6)	2300150 NATURAL SCIENCE	3(3-0-6)	0201130 IND BUS MGT	3(3-0-6)	2602241 INTRO IT/IS (inter)	3(3-0-6)
17	2200391 CONT ART TH SEA	3(3-0-6)	2300152 SCIENCE TODAY	3(3-0-6)	0201131 THAI COAST COM DEV	3(2-3-4)	2603244 GEN PRIN INSURANCE	3(3-0-6)
18	2200392 ANC ART SIAM SEA	3(3-0-6)	2300200 SCI TECH SOC	3(3-0-6)	0201141 COAST ENV	3(2-3-4)	2604362 PERSONAL FINANCE	3(3-0-6)
19	2200393 Language and Culture for Art and Archaeology	3(3-0-6)	2301170 COMP PROG	3(3-0-6)	0201151 OUR ENVIRONMENT	3(3-0-6)	2604364 FIN COMM	3(2-3-4)
			2302190 Chemistry for Modern Life (inter)	3(3-0-6)	0201153 WASTE MANAGEMENT	3(3-0-6)	2605311 PRINC MKTG	3(3-0-6)
20	2200394 CUST/FEST TH SOC	3(3-0-6)	2303150 BIRDWATCH CONSERV	3(3-0-6)	0201154 URB GLOB WRMG	3(3-0-6)	2722178 THAI CULTURE	2(2-0-4)
21	2200395 ROY TRAD/CERE	3(3-0-6)	2303165 MAN & ENVIRONMENT	3(3-0-6)	0201200 STUD PROC THAI SOC	3(2-3-4)	2800210 ART APPRE COMM (inter)	2(2-0-4)
22	2200396 REL RIT TH SOC	3(3-0-6)	2304274 PHYS BIO SYS	3(3-0-6)	0201201 IDEAL GRADUATE 1	3(3-0-6)	2800211 THAI CULT/COMM (inter)	3(3-0-6)
23	2204180 CIVILIZATION	3(3-0-6)	2305103 PL BETTER LIFE	3(3-0-6)	0201202 IDEAL GRADUATE 2	3(3-0-6)	2800212 HUMAN COMM	3(3-0-6)
24	2206101 RES ACAD REP WRIT	3(3-0-6)	2305107 PLANT WORLD	3(3-0-6)	0201203 IDEAL GRADUATE 3	3(3-0-6)	2800218 VIS MED STUDIES (inter)	3(3-0-6)
25	2206248 BSC RES SKILLS (inter)	3(3-0-6)	2305108 BIOTECH DAILY LIFE	3(3-0-6)	0201204 IDEAL GRADUATE 4	3(3-0-6)	2800219 CROSS CULT COMM (inter)	3(3-0-6)
26	2206247 ONLINE INFO COMM (inter)	3(3-0-6)	2305109 PL GROW TECH	3(3-0-6)	0201205 IDEAL GRADUATE 5	3(3-0-6)	2800221 INTER COMM ETI PRO (inter)	3(3-0-6)

กลุ่มวิชามนุษยศาสตร์			กลุ่มวิชาวิทยาศาสตร์และคณิตศาสตร์			กลุ่มวิชาสหศาสตร์			กลุ่มวิชาสังคมศาสตร์		
27	2207103 PHILOS LOGIC	3(3-0-6)	2305151 ORGANIC GARDENING	3(3-0-6)		0201206 THAI IDEAL GRAD	3(3-0-6)		2800314 ART PUB SPKG (inter)	3(3-0-6)	
28	2207143 REASONING	3(3-0-6)	2305161 GENETICS FOR LIFE	3(3-0-6)		0201209 VALUE URB ENV	3(2-3-4)		2801321 NEWS INFO/SOC	3(3-0-6)	
29	2207201 HIST WEST PHILOS	3(3-0-6)	2306416 MGT SYS TECH	3(3-0-6)		0201210 MAT MGT GREEN	3(3-0-6)		2900151 FOUNDATION ECON	3(3-0-6)	
30	2207203 PHILOS FILMS	3(3-0-6)	2307205 INTRO GEM SCI	3(3-0-6)		0201230 MAN/PEACE	3(3-0-6)		2900152 INTRO THAI ECON	3(3-0-6)	
31	2207341 SYMBOLIC LOGIC	3(3-0-6)	2307206 EARTH SCIENCES	3(3-0-6)		0201231 URB COMM STUD	3(2-3-4)		2900154 ECON INNO	3(3-0-6)	
32	2207361 AESTHETICS	3(3-0-6)	2308200 SCI LOGIST SYS	3(3-0-6)		0201232 MULTI STUD RUR DEV	3(3-0-6)		3401124 INTRO IP LAW	3(3-0-6)	
33	2207363 ETHICS	3(3-0-6)	2308303 HISTORY OF SCI	3(3-0-6)		0201234 LOCAL GLOB ISS	3(2-3-4)		3402103 INTRO CRIM LAW	3(3-0-6)	
34	2207365 POLITICAL PHILOS	3(3-0-6)	2308354 STRATEGY OF LIFE	3(3-0-6)		0201251 P2 CONTROL	3(3-0-6)		3404103 LAW LAND MGT	3(3-0-6)	
35	2207371 PHILOS LITERATURE	3(3-0-6)	2309201 GEN OCEANOLOGY	2(2-0-4)		0201252 ALT ENGY CONS	3(3-0-6)		3404109 LAW COMP TECH	3(3-0-6)	
36	2207375 INDIAN PHILOS	3(3-0-6)	2310201 HEALTH/BEAUTY	3(3-0-6)		0201254 GLOB WARM ADAP	3(3-0-6)		3404113 INTRO WTO LAW	3(3-0-6)	
37	2207385 AMERICAN PHILOS	3(3-0-6)	2312100 MICROB FRIEND	3(3-0-6)		0201255 ICT STRATEGIC MGT	3(3-0-6)		3404115 INTRO PUBLIC LAW	3(3-0-6)	
38	2207387 PHILOS WOMEN	3(3-0-6)	2313213 DIGITAL PHOTO	3(3-0-6)		0201256 LIV DIGI WORLD	3(3-0-6)		3404117 INTRO TO LAW	3(3-0-6)	
39	2207467 PHILOS LANG	3(3-0-6)	2313221 PHOTO SCI	3(3-0-6)		0201270 NAT SECURITY DEV	3(3-0-6)		3404122 LEGAL LOGICS	2(2-0-4)	
40	2207472 JAPANESE PHILOS	3(3-0-6)	2313226 PRINS MEDIA TECH	3(3-0-6)		0201281 TEAM/ORG DEV	3(3-0-6)		3404123 LEGAL HISTORY	2(2-0-4)	
41	2207474 CHINESE PHILOS	3(3-0-6)	2314255 ELEMENT FOOD TECH	3(3-0-6)		0201282 NAT SKB JOUR	3(3-0-6)		3404124 LAW AND SOCIETY	2(2-0-4)	
42	2207478 PS TOP ETHICS	3(3-0-6)	2314257 INTRO PACK TECH	3(3-0-6)		0201283 BEAUTIFUL DEATH	3(3-0-6)		3404201 LAW ACCTG	2(2-0-4)	
43	2209341 LANG THAI SOC	3(3-0-6)	3010101 DRUG DAILY LIFE	3(3-0-6)		0201284 JWL DES ENTRE	3(3-0-6)		3404202 LAW ECON ANAL	2(2-0-4)	
44	2209373 LANG CULTURE	3(3-0-6)	3141102 ANIMAL BEHAVIOR	2(2-0-4)		2104181 HF ERGO DAILY LIFE	3(3-0-6)		3405102 INTRO INTL LAW	3(3-0-6)	
45	2209375 LANG ASEAN PLUS	3(3-0-6)	3141105 COMP APP PROF	1(0-3-0)		2305100 NATIONAL RESOURCES	3(3-0-6)		3800101 GENERAL PSYCHOLOGY	3(2-2-5)	
46	2210214 LIT/ENVIRON	3(3-0-6)	3141213 BIOSTATISTICS	3(3-0-6)		2305104 MAN/NATURE	3(3-0-6)		3800105 INTRO PSY (inter)	3(3-0-6)	
47	2210215 LIT/WOMEN	3(3-0-6)	3200106 FUN ORAL BIO HLTH	3(3-0-6)		2305106 PLANS/HUMANITY	3(3-0-6)		3800202 PSY LIFE WORK	3(3-0-6)	
48	2210216 MAG REAL LIT	3(3-0-6)	3200109 CALCIUM HLTH	3(3-0-6)		2502390 INTRO PACK DESIGN	3(3-0-6)		3800250 HUMAN RELATIONS	3(3-0-6)	
49	2210217 CONTEM FICT	3(3-0-6)	3200110 TRAV HUMAN BODY	3(3-0-6)		2503216 AMPHAWA STUDIES	3(2-2-5)		3800251 MENTAL HEALTH	3(3-0-6)	
50	2210218 REL/SPIRIT LIT	3(3-0-6)	3301102 COSMETICS DLY LIFE	3(3-0-6)		2504101 LA APPRECIATION	3(3-0-6)		3800351 PSY THINK CREAT	3(3-0-6)	
51	2210219 MYSTERY FICTION	3(3-0-6)	3304102 DRUG EDUCATION	3(3-0-6)		2506504 TRAD TAI SET HSG	3(2-3-4)		4000203 INTRO SUFF ECON	3(3-0-6)	
52	2210235 LITERATURE AND FILM ADAPTATIONS	3(3-0-6)	3306101 USEFUL PLANTS	3(3-0-6)		2750178 LLL	3(1-4-4)		4000204 INTRO AGRO FOOD CH	3(3-0-6)	
53	2210239 LIT/DISABILITY	3(3-0-6)	3307101 BASIC AROMATHERAPY	3(3-0-6)		3018102 SEXUALITY ED	3(3-0-6)		4000206 HIST THAI AGR	3(3-0-6)	
54	2210313 HUMOUR/LIT	3(3-0-6)	3308100 MICRO ORGAN/LIFE	3(3-0-6)		3000106 DOCTOR AND SOCIETY	2(1-2-3)		4000208 INTRO AGR ECON	3(3-0-6)	
55	2210314 JUVILE LIT	3(3-0-6)	3308101 HYG ENV MICROBIO	3(3-0-6)		3000257 CRIT THK ETH/LAW	2(1-2-3)		4000209 INTRO AGR RES MGT	3(3-0-6)	

ศูนย์การศึกษาทั่วไป ปรับปรุงล่าสุด สิงหาคม 2559 ดูรายละเอียดได้จาก www.gened.chula.ac.th

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56	2210315 LIT/ETHN IDENTITY	3(3-0-6)	3309101 LIFE/HEALTH	3(3-0-6)	3000281 HUMAN LIFE	1(1-0-2)	5100101 POP DEV	3(3-0-6)
57	2210316 LIT/SOC-POL CONS	3(3-0-6)	3309102 OUR BODY	3(3-0-6)	3000396 HLTH PROM	1(0.-3-0)		
58	2210323 LIT/HUM RIGTHS	3(3-0-6)	3310101 MAN & TOXIC SUBS	3(3-0-6)	3300100 HEALTH CONS PROT	3(3-0-6)		
59	2210420 MAJOR WRITER WORK	3(3-0-6)	3600202 NUTRITION	2(2-0-4)	3303100 Q LIFE	3(3-0-6)		
60	2210423 LIT/PSYCHO	3(3-0-6)	3600204 HLTH SEXUALITY	3(3-0-6)	3303191 CHEM DRUG DAILY	3(3-0-6)		
61	2221433 BUDDHIST TEACHING	3(3-0-6)	3600205 FAM HLTH CARE	3(3-0-6)	3305101 FOOD FOR HEALTH	3(3-0-6)		
62	2221485 BUDDHIST CIV	3(3-0-6)	3600206 COM HLTH DEV	3(3-0-6)	3800252 LEADER PER DEV	3(3-0-6)		
63	2223243 JAPAN TODAY	3(3-0-6)	3600207 HLTH LIVING	3(3-0-6)	3800309 PSY CONSERV NATURE	3(3-0-6)		
64	2226001 INTRO VIET CULTURE	3(3-0-6)	3600208 TOB ALC HLTH	3(3-0-6)	3914101 REC QUAL LIFE DEV	3(3-0-6)		
65	2231255 FR LIT WRKS	3(3-0-6)	3600209 EMER DISAS CARE	3(2-2-5)				
66	2232241 GER CH JU LIT	3(3-0-6)	3640203 MTRNL CHILD HEALTH	2(2-0-4)				
67	2232253 GER-SPK CNTR TODAY	3(3-0-6)	3700104 INI HC NEW GEN	3(3-0-6)				
68	2235320 CONTEMP PORT BRAZ	3(3-0-6)	3700105 FOOD SCI ART	3(3-0-6)				
69	2234482 INTRO ITAL CINEMA	3(3-0-6)	3700107 SEXUAL DEVELOPMENT	3(3-0-6)				
70	2236103 RUS LANG CULT	3(3-0-6)	3700108 HLTH PREV INFC DIS	3(3-0-6)				
71	2236204 RUS LIT WORKS	3(3-0-6)	3700109 IMMUNTY OF LIFE	3(3-0-6)				
72	2244151 INTRO CAMBO CULT	3(3-0-6)	3700110 GOOD HEALTH	3(3-0-6)				
73	2501191 HIST ART ARCH	3(3-0-6)	3700113 BLOOD ESS LIFE	3(3-0-6)				
74	2501292 INTRO HSE DSGN	3(3-0-6)	3700114 INTRO ENVI TOX	3(3-0-6)				
75	2501295 INTRO DESIGN	3(3-0-6)	3705102 RADIA DAILY LIFE	3(3-0-6)				
76	2501296 THAI ARCH HERITAGE	3(3-0-6)	3705103 PREP DIAG RAD PROC	3(3-0-6)				
77	2501297 ENJOY ARCH SKETCH	3(2-2-5)	3741101 COMP HLTH SCI	2(1-3-2)				
78	2501298 UNDERST ARCH	3(2-3-4)	3741102 LIVE SMART HLTHY	2(2-0-4)				
79	2501299 BUDDHIST ART/ARCH	3(3-0-6)	3741207 MOD TECH	2(2-0-4)				
80	2502291 DESIGN EVERYDAY	3(3-0-6)	3742100 PHY THR DAILY LIFE	3(3-0-6)				
81	2502292 CULTINARY DESIGN	3(2-2-5)	3742102 EXERCISE THERAPY	3(3-0-6)				
82	2502330 DSGN TH CULT HER	3(3-0-6)	3742106 BLC BODY MIND QOL	3(3-0-6)				
83	2502378 JWL APPRECIAT	3(3-0-6)	3743422 WEIGHT CONTROL	3(3-0-6)				
84	2502379 APPRE CER	3(3-0-6)	3900200 EX/PS HLTH	3(2-2-5)				

กลุ่มวิชามนุษยศาสตร์		กลุ่มวิชาวิทยาศาสตร์และคณิตศาสตร์		กลุ่มวิชาสหศาสตร์	กลุ่มวิชาสังคมศาสตร์
85	2502393 CONT JP DSGN 3(3-0-6)	4000205 ORG AGR 3(3-0-6)			
86	2502430 DSGN ENTREPRN 3(3-0-6)	4000210 QUAN ANAL AGRI BUS 3(3-0-6)			
87	2541151 SPARK CREAT (Inter) 3(1-4-4)				
88	2541152 C/C PROB SOLV (Inter) 3(1-4-4)				
89	2541154 COLOR AESTHETICS (Inter) 3(1-4-4)				
90	2541155 VIS CULT (Inter) 3(2-2-5)				
91	2541156 ARCH ENV FILM (Inter) 3(3-0-6)				
92	2541157 PERSPEC EU ARCH (Inter) 3(3-0-6)				
93	2541158 LAND/LANDSCAPE (Inter) 3(3-0-6)				
94	2541159 UNDST/BSC IA DSGN (Inter) 3(2-2-5)				
95	2541162 POSTMOD PHOTO (Inter) 3(3-0-6)				
96	2541163 FML ANAL/PRES ARCH (Inter) 3(3-0-6)				
97	2541168 DSGN ASIAN PESSP (Inter) 3(3-0-6)				
98	2541169 HIST ANIMATION (Inter) 3(3-0-6)				
99	2542001 ART DSGN FLD (inter) 3(0-9-0)			กลุ่มวิชาภาษาต่างประเทศ	
100	2542002 COMM DSGN PROJ (inter) 3(3-0-6)			1. 2232009 GER COMM 3(3-0-6)	
101	2722272 DHAMMAVIDYA 2(2-0-4)			2. 5500111 EXP ENG I 3(2-2-5)	
102	2722288 DHAMMA SELF 3(3-0-6)			3. 5500112 EXP ENG II 3(2-2-5)	
103	2736101 ART APPRECIATION 2(2-0-4)			4. 5500193 GRAMMAR & WRITING 3(2-2-5)	
104	2737110 MUS APPRECIATION 2(2-0-4)			5. 5500194 LISTEN ENG 3(2-2-5)	
105	3500111 INTRO FINE APP ART 3(3-0-6)			6. 5500200 SPK COMM 2(1-2-3)	
106	3501120 HIST WEST ART I 3(3-0-6)			7. 5500295 ENG ARTS ENG 3(2-2-5)	
107	3501214 THAI ARTS I 3(2-2-5)			8. 5500492 PROF ENG TRAV 2(1-2-3)	
108	3501217 EAR MOD ART 3(3-0-6)			9. 5500495 ENG IN ACT 3(2-2-5)	
109	3501222 HIST ORNTAL ART I 3(3-0-6)				
110	3501224 HIST THAI ARTS 3(3-0-6)				
111	3502222 HIST CREAT ART 3(3-0-6)				
112	3502271 HIST FASHION 3(3-0-6)				
113	3502272 HIST GRAPH DSGN 3(3-0-6)				

Chulalongkorn University Map

1: 10000

CEN O1	Jamjuree Building 1		INS 01	Visid Prachuabmoh Building
CEN 03	Office of the President's Canteen		INS 02	Institute Building 2
CEN 04	CU Printing House		INS 04	Center of Academic Resources
CEN 05	Jamjuree Building 7		INS 06	Graduate School Building
CEN 06	CU Stadium		INS 07	Sasaniwes Building
CEN 07	CU Indoor Stadium		INS 09	Prajadhipok - Rambaibami Building
CEN 08	Dhamma Center Building		INS 11	Petroleum and Petrochemical Collage Building
CEN 09	Department of Botany Laboratory Building		INS 12	Institute Building 3
CEN 10	Chulaniwet Residence Halls 1		EDU 01 - EDU 10	Faculty of Education
CEN 12 - CEN 16 Chulaniwat Residence Halls			DEN 01 - DEN 16	Faculty of Dentistry
CEN 17	Witthayaphatthana Building		LAW 03	Faculty of Law
CEN 21	CU Alumni Association Building Office		COM 01 - COM 03	Faculty of Communication Arts
CEN 24	Student Dormitories's Indoor Stadium		ACC 01 - ACC 09	Faculty of Commerce and Accountancy
CEN 25	Student Dormitories 1		PHA 01 - PHA 07	Faculty of Pharmaceutical Science
CEN 27	Student Dormitories 5		POL 01 - POL 05	Faculty of Political Science
CEN 28	CU Main Auditorium		SCI 01 - SCI 26	Faculty of Science
CEN 29	Chakrabongse Building		ENG 01 - ENG 30	Faculty of Engineering
CEN 30	Swimming Pool		ECO 01	Faculty of Economics
CEN 31	Sala Phra Kieo		FAA 01 - FAA 04	Faculty of Fine and Applied Arts
CEN 32	Prempurachatra Building		ARC 01 - ARC 05	Faculty of Architecture
CEN 34	Student Dormitories (Men)		VET 01 - VET 16	Faculty of Veterinary Science
CEN 38	Student Dormitories's Canteen		ART 01 - ART 04	Faculty of Arts
CEN 41	Tennis Court			
CEN 42	Wankeaw Building			
CEN 45	Center of Arts and Culture Building 2			
CEN 46	Center of Arts and Culture Building 3			
CEN 47	Jamjuree Building 4			
CEN 50	Witthayaniwet Residence Hall			
CEN 51	Pinitphrachanart Building			
CEN 52	Wittayakitt Building			
CEN 53	Borommaratchakumari Building			
CEN 55	Student Dormitories (Men)			
CEN 58	Jamjuree Building 2			
CEN 59	Jamjuree Building 3			
CEN 60	Chalachakrabongse Building			
CEN 61	Chulanarumit Building			
CEN 62	Jamjuree Building 5			
CEN 66	Jamjuree Building 8			

important