



Bachelor of Engineering in  
Semiconductor Engineering  
(International Program)

by

the Department of Electrical Engineering (CUEE)

in Collaboration with

the International School of Engineering (ISE),

Faculty of Engineering, Chulalongkorn University

**CHULA ENGINEERING**  
Innovation toward Sustainability | ACTNEW



**SEMICONDUCTOR ENGINEERING CURRICULUM STRUCTURE  
FOR STUDENT ID 683XXXXX21 – ONWARDS**

<b>Total Course Credits</b>	<b>131 Credits</b>
1. General Education	24 Credits
1.1. General Education	12 Credits
1.2. Foreign Language	12 Credits
2. Core Courses	101 Credits
2.1. Basic Sciences	18 Credits
2.2. Engineering Specialization	83 Credits
2.2.1. Semiconductor Engineering Compulsory	59 Credits
2.2.2. Compulsory Electives in Multidisciplinary and 21st Century Skills	6 Credits
2.2.3. Compulsory Electives in Information Technology	6 Credits
2.2.4. Semiconductor Engineering Electives	12 Credits
3. Free Electives	6 Credits

**SEMICONDUCTOR ENGINEERING STUDY PLAN  
FOR STUDENT ID 683XXXXX21 – ONWARDS**

YEARS	SEMESTERS	SUBJECTS	CREDITS
4	9	48	131

**YEAR 1 - SEMESTER I**

<b>Course</b>	<b>Subject</b>	<b>Credits</b>
2189202	Fundamental of Materials Science and Engineering	3
2190101	Computer Programming	3
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
		17

**YEAR 1 - SEMESTER II**

<b>Course</b>	<b>Subject</b>	<b>Credits</b>
2182101*	Programming for Semiconductor Engineering	3
2301108	Calculus II	3
2304154	Physics and Electronics for Engineers	3
2304194	Physics and Electronics Laboratory for Engineers	1
XXXXXXX	Language Elective I	3
XXXXXXX	General Education	3
		16

### YEAR 2 - SEMESTER I

<b>Course</b>	<b>Subject</b>	<b>Credits</b>
2182206*	Mathematics for Semiconductor Engineering I	3
2182208*	Probability and Statistics for Semiconductor Engineering	3
2182218*	Circuit Theory I	3
2182219*	Electric Circuit Laboratory	1
2182241*	Digital Systems	3
2182285*	Semiconductor Devices I	3
XXXXXXX	Language Elective II	3
		19

### YEAR 2 - SEMESTER II

<b>Course</b>	<b>Subject</b>	<b>Credits</b>
2182207*	Mathematics for Semiconductor Engineering II	3
2182209*	Chemistry for Semiconductor Engineering	3
2182221*	Engineering Electromagnetics	3
2182222*	Electronic Circuits	3
2182281*	Properties of Electrical and Electronic Materials	3
2182282*	Semiconductor Technology: Fabrication and Characterization	3
		18

**YEAR 3 - SEMESTER I**

<b>Course</b>	<b>Subject</b>	<b>Credits</b>
2182300*	Introduction to Smart Electronics	1
2182313*	Characterization Methods for Semiconductor Engineering	3
2182361*	Fundamentals of Thermo-Fluid Engineering	3
2182389*	Principles of Analog Circuit Design	3
5501214	Communication and Presentation Skills	3
XXXXXXXX	Semiconductor Engineering Elective	3
XXXXXXXX	General Education	3
		19

**YEAR 3 - SEMESTER II**

<b>Course</b>	<b>Subject</b>	<b>Credits</b>
2182345*	Introduction to Embedded Machine Learning	3
2182452*	Digital Circuit Design	3
5501225	Technical Writing	3
XXXXXXXX	Interdisciplinary or 21st Century Skill Course	3
XXXXXXXX	General Education	3
		15

**YEAR 3 - SEMESTER III (SUMMER)**

<b>Course</b>	<b>Subject</b>	<b>Credits</b>
2182301*	Industrial Training	2
		2

**YEAR 4 - SEMESTER I**

<b>Course</b>	<b>Subject</b>	<b>Credits</b>
2182400*	Semiconductor Engineering Capstone	3
2182490*	Semiconductor Engineering Pre-Project	1
XXXXXXXX	Semiconductor Engineering Elective	3
XXXXXXXX	Semiconductor Engineering Elective	3
XXXXXXXX	Free Elective I	3
		13

**YEAR 4 - SEMESTER II**

<b>Course</b>	<b>Subject</b>	<b>Credits</b>
2182499*	Semiconductor Engineering Project	3
XXXXXXXX	Semiconductor Engineering Elective	3
XXXXXXXX	Free Elective II	3
XXXXXXXX	General Education	3
		12



2304154      Physics and Electronics for Engineers      3 (3-0-6)  
Electrostatic; direct current; alternating current: electrical circuits; electromagnetism and magnetic materials; mechanical and electromagnetic waves; modern physics; nuclear physics; relativity.

2304193      Physics Laboratory for Engineers      1 (0-3-0)  
Measurement and precision; experiments on simple harmonic motion; radius of gyration; dynamics of rotation; velocity of sound; viscosity of fluids.

2304194      Physics and Electronics Laboratory for Engineers      1 (0-3-0)  
Resistance and electromotive force measurements; experiments on ammeter; voltmeter; oscilloscope; AC circuit; transistor; lenses and mirrors; polarization; interference; diffraction.

### **Core Courses (Engineering Specialization - Compulsory)**

2189202      Fundamental of Materials Science and Engineering      3 (3-0-6)  
Atomic structures and bonding in solids; Crystallography; Surfaces and interfaces; Crystal defects; Phase equilibrium diagrams; Solid solution and compounds; Polymeric materials; Amorphous materials; Material properties; Relationship between micro- and nano-structures and properties of engineering materials; Classes of engineering materials, material processing and real-world applications.

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.

2182206\*      Mathematics for Semiconductor Engineering I      3 (3-0-6)  
First-order and higher-order ordinary differential equations; Fourier series; Fourier integral and transform; Laplace transform; partial differential equations; boundary-value problems; applications in semiconductor engineering.

2182207\*      Mathematics for Semiconductor Engineering II      3 (3-0-6)  
Systems of linear equations; matrix algebra; eigenvalues and eigenvectors; vector spaces and subspaces; linear transformation; similarity transformation; complex numbers; complex-valued function; applications in semiconductor engineering.

2182208\*      Probability and Statistics for Semiconductor Engineering      3 (3-0-6)  
Elements of probability; conditional probability; Bayes' theorem; random variables: discrete and continuous random variables; sampling; parameter estimation; hypothesis testing of one and two populations; applications in semiconductor engineering.

2182209\*      Chemistry for Semiconductor Engineering      3 (3-0-6)  
Basic theory of electrochemistry; Faraday law, double layer; overvoltage, electrode dynamics and thermodynamics; electroplating technology - application and testing; chemistry of batteries; metal electrodeposition; corrosion.



- 2182218\*      Circuit Theory I      3 (3-0-6)  
DC concepts; Ohm's law; Kirchhoff's laws; circuit components; passive sign convention; node and mesh analysis; superposition theorem; source transformation; Thevenin and Norton theorem; maximum power transfer; transient in first order and second order circuits; periodic function; sinusoidal steady state; phasor representations; impedances and admittances; phasor diagram; AC power analysis; polyphase circuits.
- 2182219\*      Electric Circuit Laboratory      1 (0-3-0)  
Laboratory works on electrical circuits and measurements; oscilloscope, multimeter; DC circuits; first order and second order transient responses; resonance; AC circuits; three-phase circuits.
- 2182221\*      Engineering Electromagnetics      3 (3-0-6)  
Vector analysis; electrostatic fields in materials; Laplace's equation; energy in electrostatic fields; convection and conduction currents; magnetostatic fields; magnetic forces; energy in magnetostatic fields; electromagnetic induction and Maxwell's equations.
- 2182222\*      Electronic Circuits      3 (3-0-6)  
Course Condition: 2182218  
Current-voltage characteristics of diode BJT and FET; circuit models; transistor amplifiers; transistor biasing; analysis of transistor circuits; frequency responses; operational amplifier and its applications in linear and nonlinear circuits.
- 2182281\*      Properties of Electrical and Electronic Materials      3 (3-0-6)  
Structures of solids; practical determination of structures; preparation of materials; mechanical, thermal, electrical, magnetic and optical properties of materials; superconductivity.
- 2182282\*      Semiconductor Technology: Fabrication and Characterization      3 (3-0-6)  
Material and device requirements of electronic and MEMS industries; wafer fabrication process overview; MEMS process overview; lithography; etching; metallization; thermal oxidation; diffusion; ion implantation; passivation; contacts; electron and force microscopies (SEM, TEM, AFM); electronic and optical spectroscopies (4PP, VdP, IV, CV, PL, Raman); semiconductor nanomaterials.
- 2182285\*      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.
- 2182300\*      Introduction to Smart Electronics      1 (0-3-0)  
Introduction to smart electronics industry; present trends of smart electronics technology; hands-on laboratories; studying trip.
- 2182301\*      Industrial Training      2 (0-6-0)  
Engineering practice in related areas under supervision of experienced engineers in private sectors or government agencies.

2182313\* Characterization Methods for Semiconductor Engineering 3 (3-0-6)  
Units and standard instruments; accuracy; precision; voltage current, and power measurements, impedance measurement at low and high frequencies; digital techniques in measurement; noises; shielding; signal-to-noise ratio enhancement techniques; transducers; hot-point probe; electron and force microscopies (SEM, TEM, AFM).

2182361\* Fundamentals of Thermo-Fluid Engineering 3 (3-0-6)  
Energy sources and energy conversion devices; properties of pure substances and ideal gases; first and second laws of thermodynamics; entropy; efficiency of engineering devices, power and refrigeration cycles, fluid statics, momentum and energy equations, fluid machinery, internal flows, external flows, basic heat transfer, heat exchangers.

2182389\* Principles of Analog Circuit Design 3 (3-0-6)  
Transistor modeling in integrated circuits; passive devices in integrated circuits; transistor amplifiers; voltage and current references; output stages; operational amplifier analysis; feedback, stability, and compensation; basic operational amplifier design.

2182400\* Semiconductor Engineering Capstone 3 (0-6-3)  
Utilization and application of knowledge in semiconductor engineering by using scientific research, problem analysis, design, and development to determine possible solutions, question reviews, team collaboration and communication. Apply the project to the real-world problem in the form of group projects.

2182452\* Digital Circuit Design 3 (3-0-6)  
Introduction to digital circuit design; synthesis of logic circuit; CAD tool and VHDL; standard chips, programmable logic devices and gate arrays; optimized implementation of logic function; combinational circuit design; synchronous sequential circuit design; system controller; digital system design; microcontroller-based design.

2182490\* Semiconductor Engineering Pre-Project 1 (0-2-1)  
Problem-solving framework; guidelines for problem solving and solution from Semiconductor Engineering project.

2182499\* Semiconductor Engineering Project 3 (0-6-3)  
Course Condition: 2182490  
Group or individual project on a subject related to semiconductor engineering.

### **Core Courses (Engineering Specialization - Compulsory Electives in Multidisciplinary and 21st Century Skills)**

2100201 Introduction to Artificial Intelligence 3 (2-2-5)  
Introduction to artificial intelligence related to scope, historical background; Concept for design; knowledge representation; memory structures; probabilistic reasoning; decision making; fuzzy logic; genetic algorithm; chaotic.

2182241\* Digital Systems 3 (3-0-6)  
Number systems and codes; Boolean algebra; two-level and multi-level gate circuits; medium-scale combinational circuits; combinational circuit design; sequential circuits; circuits for arithmetic operations; CMOS logic; VHDL; logic simulation and FPGA programming.

2182385\* Introduction to Lab-on-a-Chip 3 (3-0-6)  
Definition and history of lab-on-a-chip; differences between lab-on-a-chip and conventional lab equipment at present; scaling laws and theoretical effects of small devices; key building blocks of lab-on-a-chip; microfabrication and design of lab-on-a-chip; relationship between nanotechnology and lab-on-a-chip; applications of lab-on-a-chip.

2182453\* Advanced Embedded Systems 3 (3-0-6)  
Hardware and software platforms for embedded systems; devices and buses; embedded programming; real time operating system; hardware-software codesign in an embedded system; testing.

2182479\* 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; modulation techniques; digital transmission systems; principle and components in WDM systems; introduction to FTTX.

### **Core Courses (Engineering Specialization - Compulsory Electives in Information Technology)**

2182101\* Programming for Semiconductor Engineering 3 (3-0-6)  
Programming methods; program analysis; semiconductor engineering-oriented programming.

2182345\* Introduction to Embedded Machine Learning 3 (3-0-6)  
Course Condition: 2182241  
Embedded system architecture; microprocessor/microcontroller; I/O and peripherals; machine learning algorithms; machine learning on embedded devices; machine learning accelerator; machine learning system implementation.

### **Core Courses (Engineering Specialization - Electives)**

2182332\* Linear Control Systems I 3 (3-0-6)  
Course Condition : 2182206  
Open-loop and closed-loop control systems; mathematical models of physical systems; linearization; compensations; time-domain responses; Routh-Hurwitz stability test; Bode and Nyquist plots; Nyquist stability criterion; control system design; control system design.

2182423\* Digital Signal Processing 3 (3-0-6)  
Continuous-time and discrete-time signals and systems; spectral analysis; discrete-Fourier transform (DFT) and fast Fourier transform (FFT); design of FIR, IIR digital filters; decimation and interpolation; sampling rate conversion; multirate systems and filter banks.

- 2182435\* Industrial Automation 3 (3-0-6)  
Thermal sensors; mechanical sensors; optical sensors; signal conditioning; final control elements; programmable logic control (PLC); distributed control system (DCS); communication modules; human machine interface (HMI); alarm management systems; selected applications to factory automation and process automation.
- 2182446\* Fundamentals of Power Electronics 3 (3-0-6)  
Basic principles of power electronics for electrical power processing and control; basic power converters: AC-to-DC converter, DC-to-DC converter, AC-to-AC converter, DC-to-AC converter and their operations; basic characteristics of semiconductor power devices: diodes, transistors and thyristors.
- 2182447\* Electronics Engineering Laboratory 1 (0-3-1)  
Course Condition: 2182219  
Experimental topics related to analog and digital electronic circuits.
- 2182488\* Semiconductor Devices II 3 (3-0-6)  
Course Condition: 2182285  
Review of physics and properties of semiconductors; compound semiconductors; metal-semiconductor junctions; heterojunctions; MESFET; heterojunction transistors (HEMT and HBT); microwave devices; introduction to quantum and nano-electronic devices.
- 2182494\* Study Abroad I 3 (3-0-6)  
Study additional courses abroad according to the requirement of the program.
- 2182495\* Study Abroad II 3 (3-0-6)  
Study additional courses abroad according to the requirement of the program.
- 2182496\* Study Abroad III 3 (3-0-6)  
Study additional courses abroad according to the requirement of the program.
- 2182497\* Study Abroad IV 3 (3-0-6)  
Study additional courses abroad according to the requirement of the program.
- 2182545\* Digital Integrated Circuits 3 (3-0-6)  
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.
- 2182547\* Analog Integrated Circuits 3 (3-0-6)  
MOS transistor models; operational amplifier design; stability and frequency compensation of feedback amplifiers; bandgap references; switched-capacitor circuits; effect of nonlinearity and mismatch; oscillators and phase lock loops.

- 2182582\* Photonic Devices in Optical Communication Systems 3 (3-0-6)  
Wave nature of light; dielectric waveguides and optical fibers; semiconductor science; operating principles, structure and properties of LEDs, laser diodes, photodetectors, optical modulators, and optical amplifiers.
- 2182583\* Introduction to Quantum Mechanics 3 (3-0-6)  
Wave and particles; Schroedinger equation; tunneling; periodic potentials; harmonic oscillators; operators and bases; perturbation theory; motion in centrally symmetric potentials; spin angular momentum; introduction to quantum computing.
- 2182585\* Solar Cell Technology 3 (3-0-6)  
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; photovoltaic system design; concentrated sunlight system; photovoltaic system applications.
- 2182586\* Electron Microscopy 3 (3-0-6)  
Wave nature of electron beam; electron optics; scanning electron microscopy; transmission electron microscopy; spectroscopies with electron beam.
- 2182587\* Sensor Technology and Applications 3 (3-0-6)  
Sensor characteristics: static and dynamic characteristics, sensor fabrication technology; Microelectromechanical systems (MEMs); sensor operations; Interface circuits.
- 2182588\* Solid-State Physics for Semiconductor Engineering 3 (3-0-6)  
Crystal structures and lattices; lattice vibration and thermal properties of crystals; crystalline defects; modern theory of solids; quantum theory of metals; quantum theory of electrons in periodic lattices; semiconductors and their electrical and optical properties; dielectric materials and insulation; optical properties of materials; magnetism and magnetic resonances; superconductivity; introduction to nanostructures.
- 2182589\* Laser Engineering 3 (3-0-6)  
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.
- 2183412 Micro and Nano-Electro Mechanical Systems 3 (3-0-6)  
Overview of MEMs; scaling of micromechanical devices; behavior and modeling of micromechanical devices; mechanical properties of MEMs materials; review of microfabrication; bulk and surface micromachining; applications of MEMs: pressure sensors, accelerometer; micromotors; micropumps and microvalves; thermal sensors and actuators; micromirror.