INFORMATION AND COMMUNICATION ENGINEERING CURRICULUM (INTERNATIONAL PROGRAM)

ICE is a new and exciting integration of Computer Engineering, Electrical Engineering, and Industrial Engineering, key subjects at the very core of Chulalongkorn's Engineering School. You will learn the fundamental of computing, become equipped with skills in communication, and complement all this with a solid grounding in management science. Our combination will prepare you for the many stimulating challenges of the IT world.

The ICE program offers students a chance to become hardcore programmers, serving the international community with IT architecture for enterprises, software on mobile devices, satellite communications, game programming, computer networking, and software engineering, to name but a few. The discipline will be strengthened with training in management science that will heighten your competency to an international level. ICE is your future.

Each student is required to accumulate a minimum of 140 credits to graduate for Bachelor of Engineering Program in Information and Communication Engineering (International Program) which has already includes 2 credits of industrial training and 3 credits of senior project.

Curriculum Board

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

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)

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)

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

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)
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)
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	1(0-3-0)
2190415	Enterprise Information System	3(3-0-6)
2190422	Database Systems	2(2-0-4)
2190423	Software Engineering	3(3-0-6)
2190462	Database System Laboratory	1(0-3-0)
2190472	Netcentric Architecture	3(3-0-6)

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.

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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 Lab. for Eng.	1
5501123*	Communicative English II	3
		19
	THIRD SEMESTER	
2143101	Introduction to ICE	3
2182202*	Advanced Mathematics Methods	3
2182211*	Electrical Circuit for ICE	2
2182212*	Fundamental of Circuit and Digital Electronics Lab.	1
2190102*	Advanced Computer Programming	2
2190152*	Advanced Computer Programming Lab.	1
2190200*	Discrete Structure	3
xxxxxxx	General Education	3
		18
	FOURTH SEMESTER	
2182203	Probability and Statistic for Engineers	3
2182204	Signals and Linear Systems	3
2184202	Technology and Eng. Management	3
2190221*	Fundamental Data Structure and Algorithm	3
2190250*	Computer Architecture and Organization	3
2190261*	Fundamental Data Structure and Algorithm Lab.	1
xxxxxxx	General Education	3
		19

COURSE NO.	SUBJECT	CREDITS
	FIFTH SEMESTER	
2182370*	Introduction to Digital Communications	3
2182371*	Principles of Data communication	3
2184301*	Engineering Economy and Application	3
2190213*	Principles of Information System	3
2190472*	Netcentric Architecture	3
5501214	Communication and Presentation Skills	3
		18
	SIXTH SEMESTER	
2143399*	ICE Capstone	3
2182372*	Principles of Telecommunications	3
2184304*	Fundamental of Operations Management	3
2190422*	Database Systems	2
2190423*	Software Engineering	3
2190462*	Database Systems Laboratory	1
5501225	Technical Writing	3
		18
	SUMMER SEMESTER	
2140301	Industrial Training	2
		2
	SEVENTH SEMESTER	
2143491*	ICE Pre-project	1
2190415*	Enterprise Information Systems	3
xxxxxxx	General Education	3
xxxxxxx	Approved Elective	6
xxxxxxx	Free Elective	3
		16
	EIGHTH SEMESTER	
2143499	ICE Project	3
xxxxxxx	Approved Elective	9
xxxxxxx	General Education	3
xxxxxxx	Free Elective	3
		18
	TOTAL CREDITS FOR GRADUATION	**146**

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.

2143101 Introduction to ICE 3(3-0-6)
Essential basic computer and telecommunication concepts for Information Systems; Technology and trends underlying current and future uses of information and communication technology; Introduction to engineering management including important aspects of management science; Real-world experience sharing and tools related to each topic.

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.

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.

2182203 Probability and Statistic for Engineers 3(3-0-6)
Engineering basis is 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; tolerancing 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 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)
Computer programming in Engineering; reviews of computer programming concepts; hands-on experience on computer programming using contemporary Engineering tools.

2143399 Information and Communication Engineering 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 Engineering Pre-project 1(0-2-1)

Specifying topics or problems, scope, problem-solving methodologies and expected benefits from projects on information and communication engineering

2143499 Information and Communication Engineering 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*

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 systems: ASK, PSK, FSK, MSK and QAM; information theory: entropy, source and channel models, channel capacity, Shannon's theorem and introduction to source coding, error detection/correction codes; 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 Laboratory 1(0-3-0)

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)
CONDITION:PRER 2190102*

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)

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 Fundamental 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 1(0-2-1)

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 Laboratory 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 Systems (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 Protocol (TCP), 78 principles of congestion control; network layer: virtual circuit and datagram networks, internet Protocol (IP), routing in the Internet; multimedia networking: streaming stored audio and video, protocols for real-time interactive applications; security in computer networks.

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.

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.

2143495 Selected Topics in ICE I 3(3-0-6)

Topics of current interest and in new developments in information and communication engineering

2143497 Selected Topics in ICE II 3(3-0-6)

Topics of current interest and in new developments in information and communication engineering

2143498 Selected Topics in ICE III 3(3-0-6)

Topics of current interest and in new developments in information and communication engineering

2182420 Discrete-Time Signal Processing 3(3-0-6)

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; Aliassing; Finite-Precision Numerical Effects.

2182421 Multimedia Engineering 3(3-0-6)

Introduction to multimedia engineering; text coding standards image codig standards, video coding standards, audio coding standard; 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
82 operation; digital transmission systems, power budget analysis; dispersion management; optical fiber amplifiers; principle and components in WDM systems

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 plan 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-term network planning; application of optimization techniques in network controls; case studies in network design

2184402 Introduction to Stochastic Models 3(3-0-6)

Unconditional and conditional probability; discrete and continuous random variables; moments; Poisson processes; discrete time Markov chain and applications; stochastic analysis and modeling.

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 chanels; 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.