Descriptions of Courses

❑ Undergraduate

ICE100 Calculus Ⅰ
This course aims to introduce concept and applications of calculus that becomes useful in engineering fields. The topics of the course will cover the concepts and applications of the limit and continuity, derivatives, integration, infinite series, vector analysis, multivariable function and their derivatives, and multiple integrals. Basic concepts and complex variables will be also covered at the end of the semester.

ICE102 Linear Algebra
Linear algebra is one of the most fundamental subjects needed in engineering. The basic question in linear algebra is how to solve various systems of linear systems. First, in this course, we introduce the notion of matrix and operations of matrices. Some notion such as Gaussian elimination, orthogonality, eigenvalues, and eigenvectors will also be introduced. These are beyond the high school math scope, but can be learned and understood using basic matrix algebra rather than abstract theorem or proof.

ICE103 Probability and Statistics
In this course, students will learn fundamental concepts of probability and statistics, including combination, sampling, random variables, and probability distributions. Students will learn important probability distributions including binomial, poisson, uniform, and gaussian distributions which are frequently used in engineering and business. Then the course will teach skills of manipulating data for practical applications, such as estimation. hypothesis test, and regression. Students must be familiar to elementary calculus.

ICE107 Differential Equation
This course is meant to develop engineering mathematical concepts with the focus on electrical engineering applications. It is primarily focused on ordinary differential equa-tions (ODEs). This course provides a strong foundation for several courses in Electrical Engineering. Primary topics for the course:
1. First Order Ordinary Differential Equations (Ch. 1)
2. Second Order Ordinary Differential Equations (Ch. 2)
3. Higher Order Ordinary Differential Equations (Ch. 3)
4. Systems of ODEs (Ch. 4)
5. Series Solutions of ODEs (Ch. 5)
6. Laplace Transforms (Ch. 6)

ICE111 Chemistry
The aims of this course includes: 1. providing a firm foundation in concepts and principles of chemistry as the "central science"; 2. introducing real application examples in diverse chemistry topics; 3. helping students visualize atomic and molecular structures as the basis of chemical reaction; 4. increasing students' awareness how significant the knowledge of chemistry can be in academic and industry life.

ICE112 Life Sciences
This course covers the chemical and cellular basis of life, energy transformations, physiology, neurobiology, and behavior (genetics, development, evolution, and ecology). Designed both for students who intend to specialize in biological sciences and for those who want to obtain a thorough knowledge of biology as part of their general education. Each topic is considered in terms of modern evolutionary theory, and discussions of plant and animal systems are integrated.

ICE113 Discrete Mathematics Ⅰ
The main objective of the course is to help students become familiar with essential mathematical tools for taking basic courses in computer science. Topics range from the basic languages of discrete mathematics, such as logics, sets and relations, as well as counting methods, to more advanced topics such as graph theory, Boolean algebra, automata and formal languages.

ICE114 Calculus Ⅱ
This course is an introduction to multi-variable calculus. We focus on various notions of differentiation and

integration of multi-variable functions and their applications. The main goal is to prove and understand Stokes' theorem. Topics include partial derivatives, Lagrange multiplies, implicit function theorem, path and surface integral, Green's theorem, Gauss' theorem and Stokes' theorem.

ICE115 Physics I
This course is intended for teaching basic concepts of physics to college students majoring in engineering. It consists of three parts: classical mechanics, oscillations and waves, and electromagnetism. In classical mechanics part, topics such as Newton's three mechanical laws, momentum/energy conservation law, circular motion, and rotation will be discussed. Simple harmonic motion, wave equation, and propagation of sound waves are main topics of oscillations and waves. Coulomb's law, Gauss' law, Ampere's law and Faraday's law will be taught in electromagnetism part.

ICE116 Physics Ⅱ
Physics II is a continuum of the general physics course offered to undergraduate freshmen and sophomore students. The major contents of the course include analytical introduction of classical Newtonian mechanics, electromagnetic theory, optics, and properties of molecules, atoms and other micro-particles.

ICE120 Introduction to Computer Science
The course primarily provides novices in computer engineering with an introduction to the underlying concepts and functions of computer systems, including the design of algorithms and computer hardware, as well as hands-on experience with well-known applications such as spreadsheets, databases, and the World Wide Web. Therefore, it serves as an introduction to some of the fundamental ideas of the science of computing.

ICE109 Applied Analysis
Vector analysis. Functions of a complex variable; complex algebra and functions; analyticity; contour integration, Cauchy's theorem; singularities, Taylor and Laurent series; residues, evaluation of integrals; multivalued functions, potential theory with Laplace equation in two dimensions. Ordinary differential equations; Bessel and Legendre functions; Sturm-Liouville theory; partial differential equations. Laplace's equation and potential flow, boundary-value problems. Minimum principles and calculus of variations. Integral transforms and Fourier series; discrete Fourier transform, convolution, applications.

ICE124 Programming Fundamental I(JAVA)
This course aims to teach computer programming using the Java programming language. Students are expected to have attended a programming course and to have general skills in mathematics, logic and reasoning. In this course the students will learn concepts of object-oriented programming such as classes, objects, and class hierarchies, and practice problem solving and programming in Java.

ICE125 Programming Fundamental II(C,C++)
Fluency in a programming language is prerequisite to the study of most of computer science and Information Technology. In this course, students learn the basics of C, a most widely used fundamental programming language, and C++, its object-oriented extension. After finishing this course, students should be able to write simple programs in C and C++ and be able to learn advanced programming in C++.

ICC200 Data Structures
This course provides students with fundamental concepts in data structures such as abstract data type, array, queue, stack, tree, and graph. This course also provides students with algorithms in a broad context of solving problems using computers.

ICC202 Software Studio
The objective of this course is to teach the fundamental concepts of software engineering through studio project work. Teamwork, organization, processes, and disciplined techniques of software development will be of the major focus. By the end of the semester the students are expected to have achieved the following goals:
  - To understand the role, rationale and methods of implementation of information systems within organizations
  - To learn various methods and aspects of systems analysis and design
  - To be able to analyze existing information systems and justify for new development
  - To incorporate classroom lessons into their studio projects by teamwork

ICC210   Algorithm Design & Analysis
This course provides an introduction to the basic concepts on design and analysis of computer algorithms: asymptotic analysis of time complexity, proofs of correctness, algorithms and advanced data structures for searching and sorting lists, graph algorithms, numeric algorithms, and string algorithms, dynamic programming, parallel algorithms, polynomial time computation and NP-completeness.

ICC220   Computer Architecture
The course explores the structure and functions of computer in the digital logic gate level. The nature and characteristics of modern computer systems and the operation of individual components such as CPU, control unit, memory units and I/O devices are covered. It also includes addressing methods, machine-program sequencing, microprogramming, complex I/O organization, interrupt systems, multiple-module memory systems and caches, peripheral devices, microprocessors and pipelined computers.

ICC225   Operating System
This course provides an overview of the concept and design principles of operating systems for general-purpose computers such as process scheduling, process synchronization, multi-process computation, deadlock avoidance, file systems, memory management. The concepts will be illustrated with examples taken from a variety of operating systems.

ICC341   Programming Language+Lab.
In this course, we discuss the structures and semantics of programming languages to fortify the basis for the further studies in computer science. The major goals of this course are as follows :
  - study the design of programming languages and discuss their similarities and differences
  - survey the paradigms of procedural, functional, object oriented and programming languages
  - realize the importance of implementation
In this course, control structures, data type, and naming techniques are treated with abstraction techniques. Students can discuss and evaluate the features of new programming languages after taking this class. During the course, students have to conduct term projects, in which a java-based system is given and they have to expand the system. By which students can enhance their implementation capability also.

ICE211   Signal and Systems
In this course, basic signal processing techniques and system theory are covered. The topics for this course include linear time invariant system theory, continuous-time signal Fourier analysis, concept of discrete-time signals, Fourier analysis of discrete-time signals, sampling theory, and the z-transform. After finishing each area, program homework will be assigned for more concrete understanding of covered material. And that is why each programming ability is a prerequisite for this course.

ICE231   Introduction to Communication Systems
This course is a general introduction to the main concepts in digital communications. Topics covered will include: signal formats, baseband digital modulation, signal-space representation, detection of signals in noise, intersymbol interference, equalization, passband digital modulation, error probability evaluation, synchronization, block codes, convolutional codes, trellis codes, Viterbi algorithms, and modulation and coding trade-offs. Applications are drawn from broadcasting, telephone networks, digital data storage, satellite communications and wireless communications.

ICE241   Circuit Theory
Study the follow topics: Introduction to linear circuit analysis. Resistive circuits, Kirchoff laws, operational amplifiers, node and loop analysis, Thevenin and Norton theorem, capacitors and inductors, duality, first-order circuits, step response, second-order circuits, natural response, forced response. Sinusoidal excitation and phasors, AC steady state analysis, AC steady state power, network functions, poles and zeros, frequency response, mutual inductance, ideal transformer, application of Laplace transforms to circuit analysis.

ICE243   Digital Logic Design+Lab.
Basic principles of operation about the digital logic circuits on which hardware components of information and communications system are based are studied. And complex digital logic functions and structures are analyzed and their design methods are learned. Also, experiments of digital logic circuit design are conducted for the design experience of basic digital system.

ICE244   Electromagnetics
This course covers the nature and principle of electromagnetic static fields and waves. The topic is included the vector analysis, coordinate systems, gradient, divergence, curl, surface and volume integrals. And the electrostatic and magnetostatic fields and boundary conditions will be focused. Fields in conductors, dielectrics and magnetic materials, time-varying fields and electromagnetic induction are investigated.

ICE310   digital filtering
Digital Signal Processing is the fundamentals of many advanced courses in Electrical Engineering areas. It provides the basis of digital image processing, image/video coding, digital communications, detection and estimation theory, stochastic process, spectral analysis, audio/speech signal processing, speech recognition and synthesis etc. Through the course, the students will
   1. Understand the sampling theorem and representation of discrete-time signal in both time and frequency domains;
   2. Learn the LTI (Linear Time-Invariant) system analysis by difference equations;
   3. Learn Z-transform and its applications to analyze the characteristics of discrete time systems;
   4. Understand the DFT (Discrete Fourier Transform) and FFT (Fast Fourier Transform); and
   5. Learn digital filter design for FIR and IIT filters.
Though the course will focus on the study of theoretical concepts, methods and algorithms, the student will be confronted with application and implementation issues, through various examples and assignments requiring some personal computer work.

ICC201   Abstract Algebra
In this course we study the basic notion of abstract algebra and its applications. In science and engineering, various algebraic structures play crucial roles --- from numbers and equations which have been studied since ancient times, to more sophisticated structures such as polynomial rings and finite fields which have important applications to coding, communication, and cryptography. In order to establish a concrete understanding of the subject, we will cover the fundamental ideas in algebra, namely groups, rings, and fields. This course is also meant to introduce students to methods of expressing abstract ideas in a rigorous way with logic.

ICC212   Introduction to Information Security
This course introduces the importance and role of information security technology for the advance of information society and executes case studies on real applications of information security technologies. Moreover, it gives various discussion on social, cultural, and legal issues to provide information security services.

ICC222   Microprocessor+Lab
The course covers internal architecture, peripherals, and software development environment of microprocessor. It also emphasizes practical experiences by letting students implement special microprocessor functions, microprocessor based systems, and various embedded software.

ICC230   Computer Networks
This course covers principles underlying the interconnection of large numbers of computers. The main topics of this course are transmission technologies(Ethernet, optical fiber, gigabit networks, cellular transmission, infrared), intranet, internet, reliable message passing, interoperability, and client/server model.
After completing this course, students will be able to :
  - understand the hardware and interface components of a computerized
    communications network
  - understand the software required support a network

ICC235   Multimedia System

ICC250   Human-Computer Interaction
Human-Computer Interaction(HCI) is a study of efficient communication between people and computers via diverse perceptual channels. This definition means that HCI is an intensively interdisciplinary study that requires understanding of different subjects from diverse disciplines. This course consists of the following three parts: 1) Capabilities and constraints of perception and expression processes, in both human and computer perspectives; 2) Implementation and evaluation techniques for diverse interaction methods; 3) Some software engineering issues and social issues related with HCI.

ICC255   Computer Graphics
This course aims at providing a broad introduction to the field of Computer Graphics. Topics include geometric objects and transformation, viewing, shading, rendering, modeling, texture mapping, animation and visualization. Through a series of programming assignments, students will become familiar with interactive 2D and 3D graphical display concept.

ICC270   Database
The objective of this course is to give students the understanding of basic database management concepts. This course will mainly focus on the database management techniques especially for e-Commerce, digital library and Internet-based information systems.

ICC293   Introduction to Software Engineering
Software engineering encompasses the issues that arise during the creation and use of large software applications, which include not only technical issues but also organization, personnel and managerial issues. In this course, we will study: (1) organization and management in software development; (2) software development processes and techniques including software life cycle models and various methods and technologies useful at each lifecycle stage.
After finishing this course, students should be able to work as a team member on large complex software projects and should be able to:
  - Understand the overall management concepts and issues of large software projects.
  - Specify the requirements for a software product
  - Design a software system at architecture level. Architecture design will incorporate multiple views and analysis.
  - Test software systems.
  - Manage software projects and the evolution of software systems.

ICC300   Wireless and Mobile Internet
This course is intended for graduate students who want to understand the technologies and issues on Wireless Mobile Internet. It provides a comprehensive guide covering introductory concepts, fundamental techniques, recent advances and open issues in ad hoc networks and wireless mesh networks. The course consists of lectures, exams and term project.

ICC301   Artificial Intelligence
Knowledge representation, heuristic search, machine learning, problem solving, and logic deduction are introduced. Based on these concepts, students learn how to build the artificial intelligence application systems such as intelligent agent systems, data mining systems, intelligent information retrieval systems.

ICC311   Automata & Language Theory
This course provides introduction to fundamental ideas and models underlying computing mainly focusing formal language and automata theory. Course contents include finite automata, regular sets, pushdown automata, context-free grammars, Turing machines, undecidability, and complexity theory. The contents of this course is basis for other courses such as digital circuit design, programming language, compiler and etc.

ICC330   Networked Computing
Networked computing introduces a wide range of content, such as networked applications and distributed computing. Since the networked computing has transformed it from devices for computation and individual productivity into devices for communication and coordination, we are beginning to see profound effects of this transformation in Internet. Networked computing includes not only a study of novel brings applications but also of the technologies that make such applications possible. For this reason, this lecture brings together many topics studied in diverse parts of computer science and engineering.

ICC338   Programming for WWW
In this course, students will learn the core concepts and technologies of the World Wide Web (the Web), and practice the languages and tools required to build Wed-based contents and services -- HTTP, HTML, CGI, XML, Semantic Web, and Web Services are among the technologies that will be covered in this course. In addition, students will gain knowledge on various software engineering concepts and techniques to efficiently develop Web-based software. Students are expected to work on a team project to build a Web-based information integration application by utilizing the Web-based technologies learned in the course.

ICC339   Multimedia Communication Middleware
Communication middleware is a distributed software layer that sits above the network operating system and below the application layer and abstracts the heterogeneity of the underlying environment. The role of middleware in communications systems will become increasingly important, especially in emerging technology areas such as mobile computing where the integration of different applications and services from different wired and wireless networks becomes important. Since a middleware is represented with providing useful building blocks for the construction of software component, the lecture on communication middleware will introduce basic principles, architectures, and interactions specifically in Java environments, and regarding computing architecture and middleware in future Grid computing infrastructure.

ICC340   Compiler Construction
In this course, students learn the basic compiler construction. Course contents include the followings :
  - Formal translation of programming languages
  - program syntax and semantics
  - Finite state recognizers and regular grammars
  - Context-free parsing techniques such as LL(k) and LR(k)
  - Code generation, improvement, syntax-directed translation schema
This course focuses on compilation techniques needed to translate programs written in a standard programming language into executable code on microprocessor architectures. Program analysis and optimization

ICC350   Introduction to Biomedical Engineering
This course will introduce fundamental medical technology based on electrical engineering disciplines. Topics include anatomy and physiology related to important human diseases and biomedical engineering principles focusing on instrumentation, sensors, imaging, and ubiquitous healthcare services.

ICC355   Computer Animation
This course is designed to cover both the theory and practice of the 3D computer graphics techniques focusing on modeling and rendering. We will also touch on animation, dynamics and simulation. Students will learn the technical background in lecture time and practice the subjects in lab sessions under Maya environment. As a term project, all students are expected to create a 3D CG scene and generate an animation.

ICC380   Biochemistry
Biochemistry is the study of the molecular basis of life. This course includes the principles of biomolecules and molecular processes that are fundamental for the functioning and maintenance of cell, tissues and organs.

ICC382   Molecular Genetics
This course provide detailed description of molecular basis of inheritance in prokaryotic and eukaryotic organisms. This include classical genetic theory, control of gene expression, chromosome structure and evolution, immunogenetics, population genetics.

ICC402   Problem Solving

ICC403   Data & Text Mining
This course will introduce the essential techniques of text miming, understood as the process of deriving high-quality information from unstructured text. The techniques include: the process of analyzing and structuring the input text with natural language processing methods, deriving patterns with machine learning methods, and evaluating and interpreting the output. The course will cover some typical text mining tasks such as text categorization, text clustering, document summarization, and relation discovery between entities.

ICC404   Embedded Processor Design
This course studies fundamentals of designing embedded systems. The following topics will be covered in the course:
  - Review of combinational and sequential logics
  - Datapath components such as adders, shifters, counters, etc
  - Introduction to VHDL
  - Custom single-purpose processor design

- General-purpose processor design
- Application-specific processor design
- Commercial processors-ARM processor, Intel 871 microcontroller, DSP processor
- Peripherals
- Memory
- Interfacing
- Example- digital camera
- Concurrent process models
- Example- Wireless sensor node
- Power/Reliability issues

Throughout the course, students will be asked to apply their understanding of the above topics on homework assignments and tests. We will use VHDL to implement simple single-purpose and general-purpose processors.

ICC480   Bioinformatics
This is an introductory course of bioinformatics. The general objective of the course is to provide a one semester introduction and overview to the fields of bioinformatics and genomics. This includes practical knowledge in biology general, genomics, functional genomics, proteomics, structural genomics, and various algorithms and computational tools in bioinformatics fields.

ICC482   Experimental Methods in BT+Lab
This course provide principles and practical knowledge on biotechnology accompanied with laboratory work. Laboratory work includes the experiments on modern molecular biology, biochemistry, and several topics in genomics and proteomic.

ICE245   Electronic Circuits(I)+Lab.
This course is designed to study the terminal characteristics, appropriate models, design and analysis of the fundamental circuit configuration using semiconductor devices such as diode, bipolar junction transistors(BJT), and field effect transistors(FET). Operational amplifier is also an important circuit element to treat in this class. As an example of analogue circuit, differential amplifiers and multistage amplifier, the widely used amplifier configurations, also will be studied. Also the major contents of the circuit design will be experimented.

ICE251   Modern Physics
Especially development and basic principles of quantum theory are studied. With these concepts fundamental physical properties of atoms, molecules, and solid-state materials are understood, and the background understanding of semiconductor physics are prepared. Modern relativity theory is also studied.

ICE312   Introduction of Multimedia +Lab
In this course, multimedia systems are introduced; they include the contents generation of multimedia, delivery protocol, Internet video and digital broadcasting system. Student will learn multimedia system architecture, its theory and characteristics.

ICE323   IPTV Technology
To give students deep insights on IPTV-related fundamental technologies, concepts, protocols, implementation and issues, this course covers the state-of-the-art technologies to build end-to-end IPTV systems including IPTV network distribution technologies, IPTV real-time encoding and transportation, broadcasting linear programming over IPTV, IPTV consumer devices, IPTV conditional access and DRM systems.

ICE325   Audio&Speech Coding Theory and Convergence
This course offers the basic mathematical backgrounds and implementation techniques of not only audio coding techniques such as MP3 and AAC but also recent mobile speech coding methods including CELP. In addition, we study the trends of convergence of audio and speech coding techniques.

ICE331   Digital Communication Theory
Basic concepts for transmitting digital information over the channel will be covered: Source Coding/Decoding, Modulation/Detection, and Channel Coding/Decoding under noisy environments. Principles of signal theory will be adopted in representing modulation signals. Various modulation techniques for power-efficient and bandwidth

efficient schemes are covered. Optimal detection/estimation techniques are introduced in theory as well as in implementation. Coding schemes such as block, convolutional, and TCM are also treated in this subject. Term project on the topics covered and will be presented by the student in class.

ICE341   Electromagnetic Wave
This course mainly deals with theories and applications of electromagnetics, towards the detail study of nature through electromagnetic waves propagation. Electrical properties of matter, time harmonic electromagnetic fields, boundary condition, waveguides, transmission line, resonator, radiation by currents and charges will be mentioned.

ICE342   Microprocessor+Lab.
The course covers internal architecture, peripherals, and software development environment of microprocessor. It also emphasizes practical experiences by letting students implement special microprocessor functions, microprocessor based systems, and various embedded software.

ICE343   Electronic Circuits(II)+Lab.
Characteristics of digital circuits are studied. Covered topics include : 1) basic functional blocks such as basic logic circuits, operational circuits, memory circuits 2) datapath such as ALU and memory, and control part like sequencer, 3) simple programmable and application-specific processors.

ICE350   Embedded Programming for Multimedia Broadcasting + Lab

ICE351   Solid State Electronics

ICE352   Broadcasting Engineering

ICE361   Introduction to SoC
This course is to define SOC design and present the basics of SOC design methodologies. Topics to be covered include: specification & modeling, communication-based design, and the validation & performance analysis of embedded systems.

ICE362   Quantum Electronics
Quantum mechanics and electronics are at the heart of modern science and engineering. In engineering, especially in the fields of semiconductors, optics, and electronic devices, all the fundamental theories originate from the quantum mechanics. Therefore, for advanced and creative research, quantum mechanics is a must-to-be-learned subject for engineering majors. This course aims at providing the basic quantum mechanics concepts and problem-solving skills in applications to electronic devices to undergrad seniors and first-year graduate students. In this course, the basics of quantum mechanics will be first discussed, and then the Schrodinger equation which is considered as the master equation in quantum mechanics will be introduced. The problems in modern electronic and optoelectronic devices will be then formulated in the framework of the quantum mechanics and their solution will be sought through the solution of the Schrodinger equations.

ICE411   Introduction to Video Engineering
This lecture provides basic concept of digital image processing and visual information. Students will learn various techniques for the image processing, which could be applied to multimedia processing in the Internet, digital broadcasting and video telephony. Students are required to practice the technique learned in the lecture through some experiments including computer simulations. This is very helpful to learn the core of the lecture. The practices include the development of algorithms or demonstration of tasks using image processing tool such as Matlab. General topics which will cover in the lecture are as follows :
  - Human Visual Perception, Sampling and quantization
  - Image Enhancement and restoration
  - Image transformation and Compression
  - Image segmentation and understanding

ICE412   Introduction to Speech Engineering
In this course, human speech learning process such as how we become to speak and listen, is briefly introduced firstly. Then, the characteristics of human speech with their roles in speech communication are explained with their effects on real human speech sound. The features representing human speech sound are introduced with their

usefulness in speech recognition and synthesis. Finally, utilizing the acquired knowledge on human speech through this course, students will implement a simple speech recognizer and a synthesizer as term projects.

ICE421 Introduction to Network
With a focus on the most current technology, this course offers a clear and comprehensive survey of the entire data and computer communication networks. Emphasizing both the fundamental principles as well as the critical role of performance in driving protocol and network design, it covers in detail all the critical technical areas in data communications, wide-area networking, local area networking, and protocol design. The first part deals with fundamentals of data networking including protocol architecture, digital data transmission techniques in wired and wireless networks, signal coding. The second part covers WAN technology such as circuit switching, packet switching, ATM, routing, congestion control, and LAN technology including high-speed LAN and wireless LAN. The third part exploits interworking protocols, transport protocols and network security.

ICE422 Network Protocol+Lab.
In this lecture, Internet Protocol and application including TCP/IP are studied. In particular, the course mainly focuses on the real experience of the TCP/IP Networking. The lecture includes discussions of theoretical concept of TCP/IP protocols. Practical experience will be applied on a local area network using 10/100 Mbps Ethernet where students will learn how to install Operating Software(e.g., Window and Linux) in the PC environment. As well, some socket programs(i.e. web chatting and multicast applications) will be learned. The same TCP/IP applications are also studied to run a Linux-based embedded system. Students will garner real-world experience in their term project which consists of performing multimedia Internet programming like web hosting, web broadcasting center, and various clients/server applications, etc. As well, students can gather some experiences in network programming in the embedded Linux platform. Based on this lecture, students will receive a theoretical background on the TCP/IP network and real-world experience. In addition, the course briefly introduce recent trends in the new IP version 6 Protocol and Mobile IP Protocol, etc. Finally, some invited speakers will lecture on specific topics.

ICE431 Wireless Communication+Lab.
Digital communications is one of the most important fields of telecommunications, and this reliable efficient means of transmitting information is now widely used in domestic, military and space communications systems. In this course, with the Lab-Volt Digital Communication Training System, students will be able to configure, operate, and troubleshoot major components of the digital communication system. i.e., PAM, PCM, ASK, FSK, BPSK etc.

ICE440 Digital Color Processing
In our daily lives, color images surround us in print, TV, computer displays, photographs, and movies. While these color images are taken for granted by a majority of readers and viewers, their production engages an entire industry of scientist, engineers and practitioners. The purpose of this course is to provide a introduction to some of fundamentals of color science, colorimetry, color technology, and color systems.

ICE441 Radio Electronics+Lab.

ICE451 Laser Electronics
In this course you will develop a working knowledge of the physical principles of ray optics, laser operation, laser optics, semiconductor lasers and atom-field interaction. The first part of the course will cover fundamental electromagnetics and related ray optics. The second part will cover the laser optics including laser beams and optical resonators. The third part will cover the semiconductor lasers and their applications. The final part will cover interaction of radiation and matter, which determine the lasting characteristics and spectroscopy.

ICE452 Introduction to Optical Communication
Optical communications play a key role as a physical infrastructure in telecommunication netwrok. The goal of this course aids students to understand basic principles of optical fiber and optical communication systems. So, the coursetopics will covers principles of light propagation and characteristics of optical fiber, especially in single mode optical fiber. It also covers basic theory and characteristics of light launching and coupling between sources and optical fibers or fibers to fibers. Light sources and photodetectors will be also touched. This course covers the basic design principle of digital optical communication systems and advanced optical communication techniques such as WDM.

ICE465   Digital Radio
This course is uniquely designed for students who want to gain insight on the basics of digital baseband and RF transceivers in modern digital wireless communication systems. The course provides fundamental concepts and an overviews of the practical engineering of modern digital radio transceiver technologies including channel coding, architecture. Systematic analyses form source data to RF signal, and from digital baseband to RF circuits which an example standard are also provided.

ICE466   Numerical Methods for Engineers
This course is presenting broad overview of numerical methods for students who need to apply computer solutions in many practical applications.
There are many existing application packages available for students to learn just how to use it, and to apply to real problems without basic numerical knowledge. No wonder why one cannot explain about the validity of the results, as well one feels difficulty to try new strange problem for which the existing package cannot handle. With proper understanding of basic numerical procedure, one can enhance one's usage of computers and will be prepared for the new challenging problems.
The course will cover some important numerical aspects of linear equations, nonlinear equations, interpolation, numerical integration, ordinary differential equations, and some of eigensystems.
This course is recommended for both upper undergraduates and graduate students.

ICC495~6/ICE495~6   Independent Study for Undergraduate Project
  - Preparation for the Undergraduate Project
  - 3 credits
  - Choose a topic provided by an ICU faculty member
  - The topic selection process is supervised by the Undergraduate Project Committee
  - Interim process reports may be requested by the UPC
  - Submit 10-page written final report with a signature from your research supervisor by the last day of the class of the enrolled term
  - Each research supervisor is also required to submit an evaluation on the performance of the students by the last day of the final exam week to UPC.

ICC497/ICE497   Undergraduate Project
  - Prerequisite :   Independent Study for Undergraduate Project
  - 6 credits
  - Propose your own research topic and find a research supervisor. Submit a proposal with the supervisor's name by the end of the Add/Drop period of the term.
  - Submit the final research report with the signature from your research supervisor by the last day of the final exam week.
  - Presentation of your work may be required.

ICC498/ICE498   Internship Research for Bachelor
Internship Research for Bachelor provides undergraduate students with opportunities to gain a pre-professional research experience in particular research fields. This opportunity will motivate undergraduate students to get interested in realistic research works through which they are expected to learn the how to handle and solve the IT related engineering problems and to get experience on collaboration with other co-works in real fields.
Students can get earn up to 12 cumulative credits which are parts of the required credits for Bachelor degree. Students are required to consult the vice dean of School of Engineering about the research works and organizations before starting their internship. The internship students are requested to make regular progress reports on their research work and are supposed to present their final work at the ends of internship periods.

❑ **Graduate**

ICE502   Computer Architecture
Covers modern computer architecture, focused on instruction set design, pipelining (hazards, instruction-level parallelism, branch prediction) and memory hierarchy (cache, main memory, virtual memory). System issues such as storage systems (I/O device, I/O performance, RAID, File system) and parallel computer architectures are also studied.

ICE503   Operating System
This course is concerned with the principles and practice of modern operating systems. We will study core operating system principles: processes and threads, kernel design and protection, concurrency and synchronization, memory management, disk and I/O systems, networking and distributed systems, and possibly security. The course goals are to give you a strong foundation in the key concepts of operating systems and to help your understandings on current hot topics with respect to modern operating systems, such as real-time operating systems, multimedia operating systems, system-level quality-of-service provisioning as well as middle-ware support for soft-real time applications. You will work in groups of 2 or 3 for writing a term (survey) paper. You will present your term papers in presentation sessions with myself. If time permits, we will use an instructional operating system, such as Nachos, for hands-on exposure to operating system design and implementation issues. In that case, a strong C/C++ Unix background

ICE504   Probability & Random process
This course covers not only the basic theoretical concepts but also how to solve problems in engineering and management practices. This course requires that the students develop problem-solving skills and understand how to make transition from a real problem to a probability model for that problem.

ICE505   Digital Signal Processing
In this course, the basic ideas of digital signal processing techniques are covered. The techniques to be dealt with in this course include the sampling theory, the Z-transform, the Fourier transform, the analog-to-digital filter design techniques, the digital filter design techniques, spectral analysis, and cepstral analysis. Homework will include problem solving, programming, and the summary of a related research paper. Students who are willing to major in multimedia, digital and mobile communication, and coding algorithms are strongly encouraged to take this course as a base for their future research.

ICE506   Digital Communication Theory
Basic concepts for transmitting digital information over the channel will be covered: Source Coding/Decoding, Modulation/Detection, and Channel Coding/Decoding under noisy environments. Principles of signal theory will be adopted in representing modulation signals. Various modulation techniques for power-efficient and bandwidth efficient schemes are covered. Optimal detection/estimation techniques are introduced in theory as well as in implementation. Coding schemes such as block, convolutional, and TCM are also treated in this subject. Term project on the topics covered and will be presented by the student in class.
(Prerequisites : ICE504, ICE513)

ICE507   Telecommunication Network Engineering
The lecture on communications network engineering will introduce the key technologies in the communications network and will cover a wide variety of problems encountered in designing communications network and presents common techniques to solve them. The lecture will handle the problems that must be solved during the design of communications network and introduce the basic principles, the theoretical models for networking, and the network capabilities to be needed for the high-speed network services as well. Especially, internetworking and high performance networking also will be handled in the lecture.

ICE508   Numerical Methods for Engineers
This course is presenting broad overview of numerical methods for students who need to apply computer solutions in many practical applications.
There are many existing application packages available for students to learn just how to use it, and to apply to real problems without basic numerical knowledge. No wonder why one cannot explain about the validity of the

results, as well one feels difficulty to try new strange problem for which the existing package cannot handle. With proper understanding of basic numerical procedure, one can enhance one's usage of computers and will be prepared for the new challenging problems.

The course will cover some important numerical aspects of linear equations, nonlinear equations, interpolation, numerical integration, ordinary differential equations, and some of eigensystems.

This course is recommended for both upper undergraduates and graduate students.

ICE509   Electromagnetic Fields and Wave Propagation

This course will try to give clear understanding of Electromagnetic Wave Properties which forms the backbone of modern radio communications. It is dealing with Maxwell equation, boundary value problems, Green's function, waveguides and propagation of radio waves. Some modern computational method to solve the field problems are introduced in along with conventional analytic methods. Applications like mobile communication system, optical communications, antenna design or RF/Microwave circuits will be discussed to help the practicing engineers to gain physical insights. Prerequisite for this course is college level electromagnetic courses, and advanced mathematics.

ICE510   Semiconductor Device Physics

This course provides a fundamental understanding of the semiconductor device physics, operation principles and device characteristics associated with modern microelectronic devices. In particular, fundamental concepts such as the energy-band, carrier distribution, transport properties, basic device technology and p-n junction characteristics are covered. Besides, the important electronic structures and theories associated with bipolar transistors and MOS transistors are also discussed.

ICE512   Wave Optics

This course provides physical principles and applications of modern optics for research in optical communication, optical signal processing and optical devices. The contents of this lecture cover geometrical optics, wave optics, propagation through media, wave-matter interactions, Fourier optics, electro-optics, acousto-optics, nonlinear optics and quantum optics. Basic principles, practical systems and applications are emphasized to understand the optical communication systems and devices.

ICE513   Linear systems

This class is one of the basic courses to study Siganl Processing, Coding and Information Theory, Modulation Theory, Communications Theory, Communications Engineering, Signal Detection and Estimation Theory.

ICE519   Coding Theory

After introducing basic information theory such as entropy theory, mutual information, channel capacity, noisy coding theorem, noiseless coding theorem, this courses introduces basic concepts on coding theory and several famous codes such as block codes, Reed-Muller codes, BCH codes, Reed-Solomon codes, and Golay codes. Basic concepts includes encoding, decoding, syndrome, generating matrix, error detection and correction, probability of error, minimum distance, covering radius, weight enumerator, linear codes, cyclic codes, dual codes, self-dual codes, and perfect codes. This course mainly focuses on cryptographic aspects and usage of the coding theory.(Prerequisite : ICE518)

ICE528   Digital Switching Engineering

This course covers various switching technologies for telecommunication networks such as circuit switching, packet switching, frame relay, ATM, and IP routing technologies in terms of basic concepts, underlying technologies, protocols, and fundamental components and functions of switching systems. It also deals with traffic theory, network architectures as well as implementation examples for switching systems.

ICE531   Wireless Communication Soc I

This course covers the analysis and implementation of a specific wireless communication system. This well-equipped laboratory focuses on the implementation and demonstration of the whole wireless system including source coding, baseband, and RF transceiver. The target system has the OFDM technology, MIMO technology, channel coding, etc. The implementation of the system is processed using pre-implemented IPs and newly designed IPs through the concept of SoC.

ICE534   Web-based Software Development
The World Wide Web (Web) is now considered as a global software engineering environment for collaboratively developing large-scale software systems, and a medium for economically deploying software components and remotely accessing various component services. The main goals of this course are to gain knowledge about various Web-related technologies and software engineering concepts that enable efficient development of large, complex Web-based software, and to practice them by performing a term project. The state-of-the-art technologies, including Internet agents, Web Services, Semantic Web, service-oriented architectures, and service coordination mechanisms, are covered in this course.

ICE539   Software Engineering Economics & Management
As software size is getting bigger and more complex, it is very hard to lead software projects successful. During the course of software development, project managers need to solve various problems related to people, economic values, and software techniques. The primary objectives of this course are to enable the students to understand the fundamental principles underlying software management and economics; to analyze management situations via case studies; to analyze software cost/schedule tradeoff issues via software cost estimation tools and microeconomic techniques; and to apply the principles and techniques to practical situations.

ICE540   Bioinformatics
This is an introductory course of bioinformatics. The general objective of the course is to provide a one semester introduction and overview to the fields of bioinformatics and genomics. This includes practical knowledge in biology general, genomics, functional genomics, proteomics, structural genomics, and various algorithms and computational tools in bioinformatics fields.

ICE541   Biochemistry
Biochemistry is the study of the molecular basis of life. This course includes the principles of biomolecules and molecular processes that are fundamental for the functioning and maintenance of cell, tissues and organs.

ICE542   Molecular Genetics
This course provides integrated molecular and classical genetics. The topics have been chosen to help students achieve the following objectives:
  - Understand the basic processes of gene transmission, mutation, expression, and regulation.
  - Learn to formulate genetic hypothesis, work out their consequences, and test the results against observed data.

ICE543   Experimental Methods in Biotechnology and Lab.
As a Bioinformatics track core course, students will learn the experimental techniques used in Biotechnology relevant to Bioinformatics. The emphasis is on DNA and protein sequencing methods and gene expression analysis to learn how biological data could be obtained by high throughput experiments. There will be also an introduction to protein structure & function analysis, and analysis techniques for cellular biomolecules such as immunohistochemistry and in situ hybridization. For students who do not have a strong biological background, the course shall provide enough knowledge and hands-on experience to understand experimental methods used in Bioinformatics and Biotechnology. Laboratory classes will be carried out at Korea Basic Science Institutes (KBSI) and Korea Research Institutes of Biology and Biotechnology (KRIBB) under the supervision of Drs. Seung Il Kim (KBSI) and Young Il Eom (KRIBB).

ICE545   Data & Text Mining
This course will introduce the essential techniques of text miming, understood as the process of deriving high-quality information from unstructured text. The techniques include: the process of analyzing and structuring the input text with natural language processing methods, deriving patterns with machine learning methods, and evaluating and interpreting the output. The course will cover some typical text mining tasks such as text categorization, text clustering, document summarization, and relation discovery between entities.

ICE546 Embedded Processor Design
This course studies fundamentals of designing embedded systems. The following topics will be covered in the course:
  - Review of combinational and sequential logics
  - Datapath components such as adders, shifters, counters, etc
  - Introduction to VHDL

- Custom single-purpose processor design
- General-purpose processor design
- Application-specific processor design
- Commercial processors-ARM processor, Intel 8051 microcontroller, DSP processor
- Peripherals
- Memory
- Interfacing
- Example- digital camera
- Concurrent process models
- Example- Wireless sensor node
- Power/Reliability issues

Throughout the course, students will be asked to apply their understanding of the above topics on homework assignments and tests. We will use VHDL to implement simple single-purpose and general-purpose processors.

ICE552   Computer Science for Engineers
This course offers various background topics for software engineers to start graduate level study of software engineering study. Topics include
- Advanced Discrete Mathematics
- UML and Design Tool
- Probability Model
- Advanced Data Structure and Algorithm
- Object-oriented Systems & Middleware

After successful completion, students will be ready to various graduate level software engineering courses such as models of software systems, analysis of software artifacts, methods of software development and software architecture. The official programming language of the course is Java.

ICE565   Introduction to acoustics

ICE573   Next Generation Display Engineering

ICE574   Introduction to Quantum Electronics
Quantum mechanics and electronics are at the heart of modern science and engineering. In engineering, especially in the fields of semiconductors, optics, and electronic devices, all the fundamental theories originate from the quantum mechanics. Therefore, for advanced and creative research, quantum mechanics is a must-to-be-learned subject for engineering majors. This course aims at providing the basic quantum mechanics concepts and problem-solving skills in applications to electronic devices to undergrad seniors and first-year graduate students. In this course, the basics of quantum mechanics will be first discussed, and then the Schrodinger equation which is considered as the master equation in quantum mechanics will be introduced. The problems in modern electronic and optoelectronic devices will be then formulated in the framework of the quantum mechanics and their solution will be sought through the solution of the Schrodinger equations.

ICE577   Numerical Linear Algebra
Linear algebra is one of the most fundamental subjects needed in engineering. The basic question in linear algebra is how to solve various systems of linear systems. First, in this course, we introduce the notion of matrix and operations of matrices. Some notion such as Gaussian elimination, orthogonality, eigenvalues, and eigenvectors will also be introduced. These are beyond the high school math scope, but can be learned and understood using basic matrix algebra rather than abstract theorem or proof.

ICE578   Estimation Theory
In this course, students can learn theories of optimal estimation and how to design optimal estimation algorithms that may be implemented on a digital computer. The necessary background that has been assumed is an exposure to the basic theory of digital signal processing, probability and random processes, and linear and matrix algebra. The prerequisites are believed to be elementary topics in undergraduate schools of electrical engineering and other related departments. Senior undergraduate students and graduate students in good standing can take this course without any difficulties.

ICE579   Geographic Information Systems

ICE580   Multimedia Communication Middleware
Communication middleware is a distributed software layer that sits above the network operating system and below the application layer and abstracts the heterogeneity of the underlying environment. The role of middleware in communications systems will become increasingly important, especially in emerging technology areas such as mobile computing where the integration of different applications and services from different wired and wireless networks becomes important. Since a middleware is represented with providing useful building blocks for the construction of software component, the lecture on communication middleware will introduce basic principles, architectures, and interactions specifically in Java environments, and regarding computing architecture and middleware in future Grid computing infrastructure.

ICE581   Introduction to SoC
This course is to define SOC design and present the basics of SOC design methodologies. Topics to be covered include: specification & modeling, communication-based design, and the validation & performance analysis of embedded systems.

ICE582   CMOS VLSI Design

ICE584   Introduction to Biomedical Engineering
This course will introduce fundamental medical technology based on electrical engineering disciplines. Topics include anatomy and physiology related to important human diseases and biomedical engineering principles focusing on instrumentation, sensors, imaging, and ubiquitous healthcare services.

ICE585   Introduction to Software Product Line Engineering

ICE600   Computer Networks
This course covers key computer network technologies and especially current issues facing modern computer networks. Network architecture (hardware and software), internetworking using TCP/IP, routing, congestion control and quality of service, ATM networks, high-level network services and Next Generation Internet are major items. Performance modeling and estimation of computer networks also are covered throughout this course.

ICE601   Distributed Systems
This course provides theoretical knowledge and hands-on experience with distributed systems' design and implementation. The course will focus on the principles underlying modern distributed systems such as networking, naming, security, distributed sychronization, concurrency, fault tolerance, etc. along with case studies. Emphasis will be on evaluating and critiquing approaches and ideas.

ICE602   Ubiquitous Networking

ICE605   Modern Cryptography
With the advancement of information infrastructure, the side-effects such as illegal wiretapping, modification, or insertion, etc of information are rapidly increased. This course focuses the student to be capable of designing the theoretical and practical countermeasures against such malicious acts for building secure information society. This course deals with symmetric cryptosystem (conventional cryptosystems, block and stream ciphers), asymmetric cryptosytem (RSA, Diffie-Hellman, etc), digital signature, hash function, identification, zero-knowledge proof, and the latest hot issues by student term projects.(Prerequisite : ICE518)

ICE606   Database Systems
The objective of this course is to give students not only the understanding of rapidly advancing database management techniques but also the capability of applying them to various applications and services, such as e-Commerce, digital library, and Internet-based information systems. The course will cover different approaches to information modeling, languages, query processing, optimization, and data storage and manipulation techniques. Students will experience a real-world design and implementation of class-level information management systems through the term projects.

ICE608 Artificial Intelligence
Knowledge representation, heuristic search, machine learning, problem solving, and logic deduction are introduced. Based on these concepts, students learn how to build the artificial intelligence application systems such as natural language processing, computer vision, intelligent search systems, expert systems.

ICE609 Computer Graphics
This course aims at providing a broad introduction to the field of Computer Graphics. Topics include geometric objects and transformation, viewing, shading, rendering, modeling, texture mapping, animation and visualization. Through a series of programming assignments, students will become familiar with interactive 2D and 3D graphical display concepts.

ICE614 Natural Language Processing
This course provides an introduction to the field of Natural Language Processing (NLP) - the creation of computer programs that can understand, generate, and learn natural language. Three major subfields of NLP, syntax, semantics, and pragmatics, are introduced together with morphology. The course will introduce both knowledge-based and statistical methods for NLP, and will illustrate the use of such methods in a variety of application areas such as text mining, information extraction, and conversational agents.

ICE615 Network Security
This course offers how to evaluate a variety of vulnerabilities over the existing network and how to construct security protocols and their applications by using cryptoalgorithms, digital signature and hash function to guarantee integrity of information and authentication of network entities. Moreover, every student can get the knowledge on a typical network authentication protocol like Kerberos, secure e-mailing system like PEM, X.400, S/MIME and PGP, emerging network security protocol like IPSEC and SET protocol and firewall.(Prerequisite : ICE605)

ICE617 Human Computer Interaction
Human-Computer Interaction is a study of efficient communication between people and computers, and the communication usually is via multiple perceptual channels. An important implication of this definition is that HCI is a highly interdisciplinary study that requires understanding of different subjects from diverse disciplines such as psychology, psychophysics, graphics, and software engineering, to name a few. Therefore, the course will be a collection of reference points where students can start their own investigation into subjects in HCI. The course will start with the most basic topics in HCI, such as usability principles, capabilities and constraints of perception and expression processes, in both human and computer perspectives, models of interaction, and prototyping and evaluation techniques. The latter part of the course will deal with special topics, such as interfaces for small computers, virtual reality input/output devices, brain-computer interfaces.

ICE619 Advanced Digital Communication Theory
In this course, we explore basics concepts of detection and estimation theory and their application to digital communications such as optimum detection rule on AWGN and synchronization. Then, we study the theory of efficient digital communication over linear dispersive channels, including adaptive equalization.

ICE623 Data Communications
It studies the computer network architecture based on the OSI 7 layer model. It explains the layer protocol including TCP/IP protocol in detail. The practical experiences of TCP/IP programming are included using the SDL (Specification and Description Language) and socket programming. In addition, the recent trends of Internet protocols are also lectured such as IPv6 and Mobile IP.

ICE625 Telecommunications Network Management
The lecture on network management will introduce the key issues in the communications network management and will cover a new paradigm encountered in managing communications network. Basically lecture will handle the TMN that should be considered in telecommunications network and introduce the basic principles of OSI-based management. And a newer paradigm for managing networks is also treated in the lecture, one that provides a better network-wide view than the legacy approaches. New technology trends will add more intelligence to network management, relieving network managers and how the network is meeting business needs, e.g. policy based networking. By shifting the emphasis of the network management away from devices and interfaces to users and applications, abstracting the details of device configuration, and centralizing the creation and storage of network policies, the policy based networking offers a solution to many of the pressing network management problems.

ICE626 Digital Image Processing
This lecture provides basic concept of digital image processing and visual information. Students will learn various techniques for the image processing, which could be applied to multimedia processing in the Internet, digital broadcasting and video telephony. Students are required to practice the technique learned in the lecture through some experiments including computer simulations. This is very helpful to learn the core of the lecture. The practices include the development of algorithms or demonstration of tasks using image processing tool such as Matlab. General topics which will cover in the lecture are as follows :
  - Human Visual Perception, Sampling and quantization
  - Image Enhancement and restoration
  - Image transformation and Compression
  - Image segmentation and understanding

ICE629 Speech and Audio Coding Theory
The purpose of this course work is to learn the mathematical background and implementation techniques of classical waveform coding methods such as PCM and ADPCM and recent mobile coding methods including MPLPC, CELP, IMBE, so on. Also, we study the audio coding techniques. It includes Sampling & Quantization, LPC modeling and LSF quantization, AbS coding, Low-Delay coding, System Application, etc.

ICE630 Video Coding Theory
Recently video compression becomes reality in digital television and telecommunications areas as well as in multimedia area. The video coding theory class aims at providing students with the comprehensive overview of the principles and algorithms employed in still image and video compression technologies. A particular course objective is an in-depth understanding of the rationale behind the frame-based video coding such as MPEG-2 video coding standard and the object based video coding such as MPEG-4 visual coding standards as well as their related systems issues.

ICE631 Pattern Recognition Theory
The course objective aims at learning pattern recognition theory. The course covers a wide range of pattern recognition techniques in the areas of statistical, neural and syntactic pattern recognitions. The pattern recognition plays an important role in the areas of finger print identification, speech recognition, image understanding, characteristic recognition, target detection/recognition and audio-visual feature extraction and indexing, etc. The major tops include design of parametric and non-parametric classifiers with supervised and unsupervised methods, neural networks for pattern recognition and grammar based approaches to syntactic patterns such as natural languages. Students also experience implementations and simulations of various pattern recognition technologies via the class homework in 4~5 times and a term project assignments.

ICE632 Speech Signal Processing
This course provides DSP-based approaches for solving the problems related to speech signal processing. We deal with speech-specific characteristics, speech analysis and modeling in time and frequency domain, homomorphic processing of speech signal, LPC modeling, and so on. Thus you can get the mathematical basis required to research the speech processing technology and develop the application systems such as speech coding, speech synthesis, and speech recognition.

ICE633 Digital Video Processing
This lecture provides basic concepts of digital video which is becoming popular in the area of Internet and multimedia communication. Topics include digital video formats for Internet and communication, compression, 2-D/3-D motion estimation, frame rate conversion, deinterlacing, MPEG and video enhancement. In addition to the theory, students require to participate in experiments that are related to the above topics. The experiments will be performed by algorithm implementation using C++ or Matlab.

ICE634 Adaptive Signal Processing
Adaptive filters such as LMS algorithm, Kalman Filter, Wiener Filter, RLS adaptive lattice filter will be studied first. And then, active noise cancellation and echo cancellation algorithms will be implemented as a term project.

ICE635 CDMA-based Communication Systems
Basic principles and the operational concepts of spread spectrum communication systems will be covered. How to

make the spectrum spread for use and its properties will be introduced. Multiple access schemes, codes, code acquisition/tracking methods, DS(direct sequence) and FH/TH(frequency/time hopping) systems are dealt comprehensively. Also, the reasoning behind the narrow-band spreading for IS-95A and wideband spreading for IMT-2000 will be introduced.

ICE636   Mobile Communication Systems
In this course, we study the fundamental and advanced topics in wireless and mobile communications systems. Topics include: (1) propagation phenomena, (2) wireless/mobile channel modeling, (3) performance evaluation of modulation schemes on multi-path fading channel, (4) techniques to combat multi-path fading such as multi-carrier modulation, adaptive equalization, and diversity, and (5) multiple access techniques, multi-user detection, and multiple-input and multiple-output (MIMO) signal processing.

ICE638   Optical Communications
This lecture course provides principles and theory of optical communications. The lecture topics will covers principles of light propagation and transmission characteristics of optical fiber, basic theory and characteristics of light sources and photodetectors. It will also cover the basic design principle of digital and analog optical communication systems. Finally advanced optical communication techniques such as WDM, solition, and optical amplifiers will be discussed.

ICE643   Optical Circuit and System Design
Modern optical networks use advanced all-optical transmission technologies. This class teaches optical layer designing rules in a concept of circuit performances and integrated system efficiency.

ICE647   RF IC Design
Study the RF integrated circuit focusing the analysis and practical design techniques. The frequency range of interest will be 10 MHz ~ 10 GHz covering most of the commercial wireless communication systems such as cellular, PCS, GPS, WCDMA, WLAN, Bluetooth, ZigBee, UWB, etc. Topics include brief overview of active and passive RF device design/modeling, and the transistor level circuit designs — low noise amplifiers, up- & down-conversion mixers, and voltage controlled oscillators. Considering the latest technology trends, the low power and ultra wide band aspect of the RFIC design will be discussed as well as the direct conversion receiver issues. State-of-the-art examples of the reported designs will be analyzed emphasizing the silicon technologies, especially the CMOS. Circuit design project (LNA, mixer, and oscillator) using Cadence Spectre (commercial software) will be given for the hands-on experience.

ICE649   Microwave Engineering
The goal of this course is to introduce students to the concepts and principles of the advanced microwave engineering, including the use of computer aided design(CAD) methods. RF/microwave CAD is employed extensively in industry and a knowledge of the principles and methods used is important for anyone who may work in an RF/microwave related field. Theory and design of passive and active microwave components, and microwave circuits including: microstrip line, guided wave device, filter, amplifier, oscillators, and experimental characterization of above components using the network analyzer, spectrum analyzer, power and noise meters. In this course, the theoretical and practical concept of microwave engineering is useful applications to the analysis and design of microwave components, microwave circuits, and optics. The general flow of this class is Application --> System --> Component; individual components are analyzed by Fields --> Modes --> Equivalent Network.

ICE651 MMIC Design
Signal and large-signal models, noise parameters, and load-pull data, the students will design the stability and input and output impedances of the microwave integrated circuits for noise, gain, and output power. The course will cover the 2-ports network, scattering parameters, Smith charts, signal flow graphs, power gains, LNA, broadband amplifier design, power amplifier design, and simulation and analysis. The student will be assigned with term project designing a specific microwave circuit using an ICU-owned CAD tool, and the results will be implemented using an MMIC foundry. This course is designed to provide graduate students with design capability of the microwave integrated circuits such as low noise amplifiers, broadband amplifiers, and power amplifiers. By analysing the scattering matrix, small-(Prerequisites : ICE509, ICE647)

ICE653   Computer   Haptics
The word 'haptic' refers to 'the sense of touch. Computer haptics is the growing discipline that deals with computation of touch sensation by allowing a user to intuitively interact with the virtual world as if the virtual world is tangible. This course covers fundamentals and design for haptic device and current state-of-the-art haptic rendering algorithms, Applications of haptic rendering will be also investigated. Students are expected to present a technical paper or book chapters in class for discussion, and learn haptics programming for application development.

ICE657   VLSI Design
Today's system integration trend is SoC (System-on-Chip) which integrates an information and communication system on a chip. SoC is composed of every kinds of IPs (Intellectual Properties), starting from CPU, DSP, memory up to communication interface, video decoders and peripherals. The requirement of short TTM (Time-To-Market) obliges us to reuse IPs. Accordingly, VLSI Design is to study the generation and integration of IPs and their reuse related issues. Generation and integration of IPs focus on the optimization of algorithm implementation, efficient design methodology and verification. Reuse related issues cover virtual component concept and coding guidelines.

ICE661   Queueing Theory
At the first half of the course we deal with fundamental stochastic processes such as Poisson process, renewal process, discrete-time Markov chain, and continuous-time Markov chain which are necessary to analyze performances of next generation networks. We then study concepts, underlying theories, and applications of IBP, IPP, MMBP, MMPP, QBD, self-similar process which are widely used for traffic modeling in high-speed data networks. We also cover basic queueing theories related to various stochastic processes.

ICE664   Optical Networks
This course converges conventional optical transmission technology into the networking area including Internet. Therefore, after covering transmission aspects of second generation fiber optic networks, this lecture focuses on the networking aspects such as architectures, wavelength routing networks, virtual topology design, deployment consideration, optical Internet, and photonic packet switching at optical layer.

ICE667   Microwave Devices
This course is designed to provide a cohesive overview of the fundamental subjects required for the design and analysis of the RF stages of modern wireless systems, including antenna, propagation, fading, noise, receiver design, modulation methods, and bit error rates. Content is also included on the design of key components used in wireless systems, such as filters, antennas, and mixers. The students are required to participate in design, evaluation, and possibly fabrication that are related to the above topics using microwave CAD tools, measurement tools, and fabrication facilities.

ICE668   RF Devices
Course objective is to provide students with a comprehensive understanding of RF devices and related circuit characteristics particularly for RF system applications. First, several key points such as two-port networks, S-parameters, Smith chart, impedance matching are studied. Then, RF filters, diodes, and field effect transistors and their characteristics will be covered.

ICE669   Wireless Transceiver Design
In this course basic principles of RF transceivers in mobile unit for modern digital communications are covered. Overall view of baseband functions such as channel coding and digital modulation is introduced briefly. The nonlinear and noise characteristics of RF systems are studied, and the architectural characteristics and system-level characterization of the RF transceivers are also studied. RF system design requirements are analyzed from the modern wireless communications standards such as IS-98A/B and 3GPP, and system-level design on the basis of the analysis is performed.

ICE676   Analysis and Design of Antenna
This course mainly deals with general theories and applications for microwave and mobile antennas. The main topics are including an introduction to antennas, analysis and synthesis of antenna elements and arrays, linear antennas, self and mutual impedance, aperture, traveling wave, broadband, and microstrip antennas. Finally antenna measurement techniques, active antenna, and active phase array technology will be mentioned.

ICE677　Wireless Communications SoC Ⅱ
The purpose of this course work is to study the basic theories of the coding and the modulation which are bases of the digital communications. Especially the coding and the modulation algorithm of the hot-issued Bluetooth system will be studied and its operation will be verified.

ICE679　Multimedia Systems

ICE681　Mixed signal circuit design
This course is concerned with data converter design aspects for integrated mixed analog/digital systems. In this course, data conversion principles of various types of ADCs and DACs will be studied. Major sources of performance limitations and their effects on performance metrics will be discussed, and performance enhancing design techniques will be investigated as well from various papers and texts. Selected subjects to be discussed in this course are; Sampling circuits and comparators, various types of ADCs (Flash, Pipeline, SAR, Folding, Time-interleaving, Oversampling), various types of DACs (R-DAC, I-DAC, C-DAC), performance limitations (circuit noise, device mismatch, nonlinearity, jitter, settling speed, switching noise)

ICE683 Wireless Communication Network
Followed by the brief introduction on the evolution of wireless communications from and to future wireless communications, RRM(radio resource management) techniques with through understanding about the physical layer will be comprehensively provided. Topics include: Characterization of wireless traffic (internet traffic), multiple access techniques, call admission control, call processing, scheduling, retransmission, diversity, hand off and cell planning. Also, state-of-the-art network issues including adhoc network and mesh networks will be given. Term projects are required including presentation inclass for discussions.

ICE689　Analogue Integrated Circuits Design
This course is devised to teach graduate level analog circuit analysis and design techniques. The course will provide a general knowledge on analog circuit analysis and design techniques, which become the basics for the various analog circuits such as conventional analog, mixed signal, RF & MMICs, and optical system related circuits. The course will briefly cover the device physics for MOS and bipolar devices. The circuit analysis and design includes single-stage amplifiers, differential amplifiers, current sources and sinks, frequency response of amplifiers, noise, feedback, operational amplifiers, stability and frequency compensation, references, switched-capacitor circuits, etc. Emphasis will be on the CMOS technologies but the bipolar circuit theory would be paralleled. Simulation projects will be assigned.

ICE690　Handset L2/L3 Software
The purpose of this course work is to cultivate the ability on the area of software in wireless communication system based on the CDMA system. This course will cover capacity of system, power control, soft handoff, call admission control, call processing and so on with which the students will gain benefits to understand how to be achieved the improvement of capacity of wireless communication system in the way of software.

ICE695　Machine Learning
The goal of the course is to introduce the key algorithms and theories of machine learning to students from various disciplines. Therefore, the focus will be on the understanding of the main concepts and building the insight into the nature of various machine-learning algorithms rather than on the mathematical foundation and rigorous derivation of learning algorithms. Topics covered include, but not restricted to, concept learning, decision tree learning, multi-layer perceptrons, radial-basis neuron networks, Bayesian networks, genetic algorithms, analytic learning, and reinforcement learning. Homework problems will be biased toward application-minded students while a few reading assignments will be prepared for those who seek mathematical foundation of the learning algorithms.

ICE696　Information Retrieval
It has become a common task to retrieve and extract necessary information from the flood of information in such forms as text, image, and video, available through a variety of computer media and networks. With the advent of Internet, the sheer amount of information has been increasing greatly, which requires automated retrieval techniques to be not only effective but also efficient.
This course covers such techniques, some of which have been evolving for the past decades and others having being around only since the introduction of the Word Wide Web. The main topic areas are: analysis of text and

representation of its content, storage and retrieval models, human-computer interactions, evaluation of systems and algorithms through experiments. In addition, the course will cover more contemporary topics including information organization/presentation techniques such as categorization and summarization, distributed information retrieval, information extraction, and multimedia retrieval.

ICE698   Modeling and Simulation
This is an introductory course on simulation and modeling in graduate level. Modeling and simulation are good tools that provide deeper understanding of systems of interests. The first part will cover mathematical models such as Markov chains, queues in isolation, queueing networks. The second part will cover simulation techniques such as random number generation, and so on. Basic understanding of probability and programming skills are required. Students will be asked to pick a problem of their own interests, to formulate a problem, and to solve it.

ICE702   Statistical Signal Processing
The area of signal processing deals broadly with both signals and systems. Digital Signal Processing you studied previously generally assumes that the signals are deterministic. This course, however, is aim to provide a statistical methodology to analyze and design signals which is inherently random. Topics include signal modeling, optimal filtering, spectrum estimation and adaptive filtering.

ICE711   Human Vision Modeling

ICE714   IPTV Network and Protocol

ICE715   Mobile Computing
Mobile computing attracts tremendous attention recently due to its promise in the next decade. Communication devices such as cellular phones and pagers are merging with portable computing devices such as PDA (Personal Digital Assistant) to provide connectivity as well as productivity on the road. Mobile networking protocols and portable device technologies have been developed for the mobile computing. This course focuses on mobile networking (routing and wireless TCP) and embedded system design (low power software, embedded interfacing and communication, and cross development environment). On the exit of this course, you will have basic concept on mobile networking and extensive experience on embedded system design.(Prerequisites : ICE600, ICE601)

ICE720   Electronic Commerce
With the wide spread of the Internet, E-commerce is becoming a crucial discipline nowadays. In this course, several E-commerce related issues such as techniques, principles, benefits, and perspectives are introduced. Then each subtopic in E-commerce is treated with the introduction of its application areas. The subtopic areas include CRM(Customer Relationship Management), SCM(Supply Chain Management), Data Mining, Agent, Workflow, ERP(Enterprise Resource Planning), Security, etc. Student has to decide one interested subtopic in the course and term projects are given in the topics.(Prerequisite : ICE605)

ICE732   Information Theory

ICE736   Design and Analysis of Broadband Networks
It studies the design and performance analysis for broadband network. It includes the queueing network theory of M/M/1, M/D/1, and M/G/1. The flow control schemes of sliding window protocol are analyzed in detail. The Markovian queueing networks are modeled with operational analysis. The polling system and random access scheme for wireline/wireless Internet are theoretically investigated. The performance of switching network and time division multiplexing system are analyzed in the combination of queueing theory and scheduling algorithm. The analytical results on the broadband network system are compared with simulation results using the OPNET simulation software.

ICE745   Optimization Techniques for Mobile Communications
Fundamental techniques to analyze the communication systems will be provided both static and dynamic optimization methods including stochastic optimization techniques and systems analysis and optimal control techniques for radio environment, most complex time-varying stochastic environment. Case studies and state-of-the art techniques from the most recent journal articles will be treated.

ICE746   Speech Recognition System
The goal of this course is to provide the theoretical and technical basis required to design or implement speech recognition algorithms or systems. The topics included are acoustic-phonetic characterization, speech processing techniques for speech recognition, pattern comparison techniques, theory and implementation of HMMs, searching techniques for continuous speech recognition, and other implementation issues.

ICE753   Software Requirements Engineering
This course is a graduate level advanced course on Requirements Engineering. Software requirements express the need sand constraints that are placed upon a software product. It is widely acknowledged within the software community that software projects are critically vulnerable when requirements engineering is applied poorly.
In this course, key knowledge areas including requirements engineering process, requirements elicitation, requirements analysis, requirements traceability, requirements validation, requirements control, and requirements tools are covered. Then advanced topics on requirements engineering will be discussed. At the end of the semester, students should submit a term project result.

ICE754   Software Process
This course is a graduate level advanced course on software engineering. Software process is a topic of great interest to the software engineering community. A process is an important leverage point from which to address software quality and productivity issues.
The overall goals of this lecture are to understand foundations on software process, concepts of defining process, and how to apply process concepts to improve software quality and productivity. In this course, key knowledge areas including Capability Maturity Model(CMM), Capability Maturity Model Integration(CMMi), Personal Software Process(PSP), Team Software Process(TSP), Process Definition, Process Assessment, and Software Engineering Body of Knowledge(SWEBOK) are covered.

ICE763   Ubiquitous Computing System
This course is intended for graduate students. This course introduces the fundamentals of ubiquitous computing system. It focuses on the main components of a ubiquitous computing system such as location sensing, context management, service discovery, dynamic service reconfiguration, spontaneous networking, and security/privacy. These concepts will be explained by analysis of and discussion on the existing systems. Students will be asked to participate in this and to pursue a term project.

ICE764   Optimal Combining and Detection in Wireless Communications

ICE802   Special Topics on Computer Networks(Pervasive computing)
This course is intended for graduate students. This course introduces the fundamentals of pervasive computing system. It focuses on the main components of a pervasive computing system such as adaptive networks (including sensor & ad-hoc networks), context management, dynamic service reconfiguration, service discovery, and security & privacy. These concepts will be explained by analysis of and discussion on the existing systems. The students will be encouraged to participate in this and to pursue a term project using Active Surroundings, pervasive system.

ICE809   Special Topics on Artificial Intelligence
Special Topics on Artificial Intelligence (ICE0809) focuses on one or two subfields of artificial intelligence, and provides students with the opportunity to learn, discuss, and experiment with the state-of-the-art technologies. The topic areas vary semester by semester, but some of the topics covered recently include "AI and robot programming", where the aim was to let the students get hands-on experience on programming some intelligent systems in the fields of AI and Robotics. Students will generally be asked to perform many examples and projects.

ICE812   Special Topics on Advanced Networks
The objectives of this course are examining and debating the current research topics in broadband communication networks. The subject will be diverse, ranging from new theory and algorithms. With the guidance of the instructor, students are expected to understand some topical areas, find papers in the areas, study, criticize, suggest new ideas, and present in person during the class as a term project. Much learning expected through this process and group discussion in class. Reports are to be written on the basis of the study. The report must reflect coherent view and understanding of the course and well written to publish in journal. Credibility of the technical content in the report is important.

ICE814   Special Topics on Multimedia Systems
This course provides special topics about multimedia system. In this semester, MPEG-7 and its related technology, which is one of active part for the world standardization recently, will be covered. In the lecture, a basic technology for the MPEG-7 description and a prototype system (XMA) of MPEG-7 will be introduced. Student shall have many practices through term projects with the topic of multimedia indexing system.
Overall topics for this course are the following.
  - MPEG-7 Overview
  - MPEG-7 requirement
  - MPEG-7 XM
  - MPEG-7 XMA

ICE815   Special Topics on Image Engineering
This course deals with advanced topics on video coding systems. Topics covered will include: MPEG-4 visual, H.264, SVC (scalable video coding), and their implementation issues. Students are assumed to have taken ICE630: Video Coding Theory or equivalent knowledge. Students completing this course will be able to get the profound knowledge on the most advanced video coding schemes.

ICE833   Special Topics on Optical Internet
This course attempts to cover special topics on optical Internet which marries the next generation Internet and fast evolving DWDM optical network. Examples for the topics are integrated IP/WDM, MPLmS, Routing and wavelength assignment, protection and restoration, traffic engineering and planning, survivability and availability, labeled optical burst switching, optical packet switching, and optical packet Internet.(Prerequisite : ICE 664)

ICE834   Special Topics on Microwave System
The goal of this course is to introduce students to the concepts and principles of the advanced microwave system, including the use of computer aided design (CAD) methods. Theory and design of passive and active microwave components is included such as LNA, PA, mixer, PLL system, antenna and experimental characterization of above components using the network analyzer, spectrum analyzer, power and noise meters. In this course, the theoretical and practical concept of microwave system is useful applications to the analysis and design of microwave components, and microwave systems.

ICE839   Special Topics on Ad Hoc Networks (I)
Students will develop working knowledge of the research problems and applications of ad hoc networks. The course will cover the technologies for constructing ad hoc sensor networks and their applications. Students will be assigned a list of state of the art published papers along the subject. Students will present the papers and discuss with other students as to how to utilize and improve the ideas Students are required to submit progress report each week. It is recommended that students have a good working knowledge of probability and random processes, data communications and network.

ICE840   Special Topics on Ad Hoc Networks (II)
This course is continuation of ICE839 Special Topics on Ad Hoc Networks (1). This course will place emphasis on queueing theory and advanced simulation techniques for ad hoc network systems performance analysis. Students will be asked to pick own project and produce complete results.

ICE846   Special Topics on Network Convergence
Network convergence brings advantages of convenience and cost effectiveness to both users and the service providers. This class teaches the newest fixed and mobile network services and technologies, and the core convergence technologies for networks and services.

ICE847   Special Topics on Wireless Digital Processing
This course covers the digital signal processing technology requires to design digital wireless communication transceiver. Basic building blocks such as digital filter, data conversion, and sampling rate conversion are issued in this lecture. Especially, recent technologies are covered such as delta-sigma modulation, Farrow filter structure, and polar transmitter architectures.

ICE848   Special Topics on Advanced Communication Middleware and Computing system
The lecture about special topic on advanced communication middleware and computing system will introduce the key issues in the advanced communication middleware and will cover a new paradigm encountered in next generation web services and advanced applications, e.g. e-health services. Basically lecture will handle the Grid middleware that should be considered in advanced computing infrastructure and introduce the basic principles of web service architectures and operation frameworks, respectively. And a newer paradigm for advanced applications is also treated in the lecture. New technology trends will add more intelligence to communication middleware, relieving advanced web applications and how the communication middleware is meeting business needs in these areas.

ICE849   WLAN MAC System Design Lab
This course covers all MAC (Medium Access Control) techniques in IEEE 802.11 WLAN standard. All WLAN MAC standards during a decade are covered such as 802.11 legacy, 802.11e, and 802.11n. Based on these knowledges, a real SoC implementation of IEEE 802.11n MAC will be experimented in this class.

ICE851   RFID System Design Lab.
This course covers the understanding and the implementation of various kinds of recent RFID systems such as ISO14443A/B, 15693, and 18000-3 standards. The anticollision techniques in MAC layer and the modulation algorithms are compared for different standards. SW, HW, and reconfigurable implementation are studied and experimented by real implementation of Xilinx FPGA board.

ICE853   Converged Optical and Wireless Access Networks
This course attempts to witness technological challenges in converged optical and wireless networking, which is a key element for next generation broadband network. This course covers transmission aspect of fiber optical network, optical access networks, mobile access, and broadband wireless access. Then, Converged network issues are covered by topical seminars and term- project papers preparations.

ICE852   Special Topics on Future Networks
This course surveys and analyzes in depth R&D activities on future networks being carried by international standardization institutes, universities and leading projects. Analysis will cover trends in newly adopted concepts, new telecommunication services, network architectures, network components and their functions, and embedded technologies which enable visualization of future networks. This course also covers technical issues such as mobility support, E2E QoS, network security, session control, CAC, resource management, and traffic control.

ICE854   Special Topics Commuications Networks
The goal of this course is to understand current research topics in ad-hoc networks. And Through this course, you can improve skills of condensing other's technical works, improving or finding further works of your own, and presenting ideas. The areas of ad-hoc network researches are mostly Relatively Static Mesh and some Mobile Military Tactical Network.

ICE855   Special Topic on Wireless Network

ICE856   A Special Topic on All-Digital PLLs

ICE857   Special Topics on Embedded Systems/Software

ICE858   Special Topics on Digital Transceiver

ICE561   Introduction to Electrical Engineering
This goal of this course to describe how and why common-place information systems works and to illustrate how clever engineering solutions can solve technical problems, with minimal reliance on mathematics and science. This course considers systems students encounter everyday,, including electrical switches, digital scale, air-bag inflation system, CD, encryption method, Fax, bar-codes, desk top computers, WWW, and national IT development programs. This course invites each student to think quantitatively and to design useful systems.

ICE570   Introduction to Computer Science
Despite its short history, computers have changed entire human society. Through this course students will embark

on a comprehensive study of computer concepts, particularly with respect to computer hardware, operating system, internet, database, security, and application softwares.

ICE911   Internship Research for Masters
Master research to be familiar with real world problems. Consent of advisor.

ICE912   Internship Research for Ph.D.
Doctoral research to be familiar with real world problems. Consent of advisor.

ICE931   Research for M.S. Thesis
Master thesis research. Consent of advisor.

ICE932   Research for Ph.D. Dissertation
Ph.D. Dissertation research. Consent of advisor.