# Dept. of Electronics Engineering

Department of Electronics Engineering has been offering one of the most comprehensive research and instructional programs, after initiating Master's and Ph.D. degree programs in 1988 and 1992, respectively. Each year, a large number of students more than 30 succeed in their degrees. Currently, we have 33 members of faculty and 24 laboratories: Broadband Communications Laboratory, Communication Convergence Laboratory, Computer Engineering Laboratory, Control Systems Laboratory, Convergence Bioelectronics Laboratory, Information and Control Laboratory, Integrated Circuit Design Laboratory, Integrated Systems Laboratory, Intelligent Robotics Laboratory, IT Security and Privacy Laboratory, Multimedia Communication Signal Processing Laboratory, Multimedia Laboratory, Multimedia Signal Processing Laboratory, Nano Devices and Systems Laboratory, Network Computing Laboratory, Power Electron Systems Laboratory, Power Electronics Laboratory, Power Electronics System Laboratory, Semiconductor Devices and Integrated circuits Laboratory, Smart Embedded System Laboratory, Smart Grid Laboratory, Ubiquitous Convergence Technology Laboratory, Wireless Network and Communication Laboratory, Wireless Sensing Laboratory.

The department's close ties to industry, coupled to its commitment to engineering research and education, ensure that every student explores his/her professional carrier in the government, research centers, and venture companies.

The goal of the graduate school of electronics engineering is to produce highly trained, competent electrical, electronic and computer engineers, researchers, and scholars to meet the needs of our fast-changing industrial and information society. The areas of active research program and related graduate courses include: Control and Instrumentation, Microwave Engineering, Circuits and Systems, Communication Engineering and Systems, Digital Signal Processing, Computer Engineering, Integrated Circuit Design, Semiconductor Devices, Robotics, Electric Power Systems, Wireless Communication Systems, Microwave and RF Circuits Design, Digital Signal Processing, Speech and Image Processing, Computer Architecture, and VLSI System.

There are two majoring programs: the Electronics Engineering program and the Microwave Communication Engineering program.

### ❑ Electronics Engineering Major

This major division primarily deals with the principal courses and Research topics include Power Electronics, Digital electronics involving the Communication and Signal Processing, Communication system with optics, Automatic and Modern control, Semiconductor with integrated circuit technologies, CAD, intelligent system, and Computer Engineering.

❑ **Microwave Communication Engineering Major**

This division primarily deals with the broad area of microwave communication engineering and communication systems. Of these, microwave communication engineering is a field study which explores electromagnetic waves for mobile communication, satellite communication, astronomy communication, and broadcasting. The communication system seeks more efficient and reliable methods of exchange and/or storage of information and knowledge in the form of audio, video, and data. The curriculum covers a broad spectrum of topics, including: RFIC/MMIC, ultra - high frequency, satellite and mobile communications, digital signal processing, networking technologies, and RFID/USN.

☐ **Courses**

❑ **Core Courses**

· **Advanced Power Electronics (3)**

In this lecture, advanced topics in power electronics, including the design of the high efficient power conversion circuits and magnetics in the power converter, will be discussed.

· **Intelligent System Applications in Power Engineering (3)**

This course provides students with fundamental theories about advanced control and optimization methods based on artificial intelligence for power system applications. This course will cover practical issues on smart grid control and operation such as renewable energy control, microgrids, advanced energy management system, ancillary service and so on.

· **DSP Applications (3)**

This course deals with various kinds of application which uses digital signal processing technology. Topics may include but not limited to data compression, speech/audio processing, DSP in digital communication, image/video processing, biomedical signal processing, and hardware implementation.

· **Embedded Control Systems (3)**

This course covers an overview of embedded control systems based on microcontrollers. Concepts of the microcontrollers, embedded systems, digital control design and embedded control systems are introduced. Also, various applications for embedded control systems such as robot systems and automobile systems are discussed.

· **Semiconductor Physics (3)**

In this lecture, the advanced semiconductor physics will be discussed. Based on the relevant Physics, we will discuss the properties of semiconductor devices including

pn-diodes, BJTs, and MOSFETs. Further advanced device physics will also be discussed.

· **Wireless Networks (3)**

The course includes the wireless networks protocols and physical layers for wireless multimedia applications. It covers WLAN, WPAN, ad-hoc networks, and sensor networks. The course also deals with IPv6, Mobile IP, Cellular IP, and QoS MAC protocols.

· **Nanostructure Semiconductor Device Technology (3)**

The principle and applications of nano-structure, nano-scaled semiconductor devices, includong electrical and optical devices, will be discussed in this lecture, based on the advanced quantum mechanics.

· **SoC Design (3)**

The methodology for the IP-based SoC (system-on a chip) design will be discussed in detail. The hardware-description languages of VHDL or Verilog-HDL as a basic design tool for the SoC design will be studied, and the synthesis of digital circuits, verification methods, an auto-placement and routing technique in the layout design will be taught in hand. Some standards for the coding guideline and mixed-mode specs will be also introduced.

· **Mixed-Mode Integrated Circuits (3)**

Main subsystems of the mixed-mode integrated circuits, based on a standard CMOS process, will be discussed. Issues on the design of analog filters adopting switched-capacitor circuits, A/D converters, D/A converters, PLL (phase-locked loop) and DLL (delay-locked loop) will be studied in depth.

· **Next Generation Internet (3)**

We deals with IPv6-based service, Internet architecture, protocols, and standardization. Internet architecture for convergence with wireless networks and broadcasting networks, will be studied. IPv6-based Mobile IP, TCP, traffic management, security, Internet QoS, traffic modeling, VoIP, Dual IP stack, and media independent handover will be studied.

· **Linear Systems Theory (3)**

The course will address both continuous-time and discrete-time representations and both time-invariant and time-variant systems. Topics covered include: (1) Fundamental linear space and matrix concepts: (2) Signal representations, properties, transforms, and sampling: (3) System representations, properties, and transforms. The goal of this course is to provide the beginning EE graduate student with the foundations and tools of signal and linear system theory, necessary for

subsequent courses in the overall electrical engineering program i.e., the communications and signal processing program, and control program.

· **Digital signal Processing (3)**

The processing of signals by digital techniques. Topics include discrete-time signal and system theory, the design, analysis and implementation of FIR and IIR digital filters, discrete and Fast Fourier Transforms, and applications to speech, picture processing, and data communications.

· **Communication Theory (3)**

This course briefly reviews the mathematical analysis of the signals and systems, focused on the transform domain manipulation of the signals and systems. The main part of the course is the theory and engineering of the analog communication system which include amplitude modulation, Frequency modulation, and phase modulation. It also deals with basic digital communications with channel noise.

· **Digital Control Theory (3)**

This course is intended to facilitate the students in gaining familiarity with sample theory, z-transform, and other analysis tools that are used to analyze and design digital control systems. This course covers the state space and input/output representation, modeling and analysis of digital control systems, the design of digital controller through emulating continuous?->-time controllers, state feedback control, state observer design, observer based compensator design, LQ optimal control, internal model based design, and servo control with digital controller implementation.

· **Network Synthesis and Filter Design (3)**

This course will cover an introduction which explains the differences between network analysis and synthesis. Butterworth, Chebychev and Bessel filter design are studied in depth for given specifications. Synthesis techniques are dealt with to realize the all-pole filters.

· **High-Speed and High-Frequency Semiconductor Devices (3)**

In this lecture, high-speed and high frequency characteristics of microwave- and millimeterwave devices, such as the compound semiconductor devices, i.e., HEMTs (high-electron mobility transistor) and HBTs (heterojunction bipolar transistors), will be discussed in detail. Moreover, design guideline and implementation method, characterization techniques will also discussed.

· **Application Specific Integrated Circuit Design (3)**

Analog and digital IC designs for a single-chip implementation of the

application-specific integrated systems with signal processing, automatic control, artificial intelligence, and image processing.

· **Microwave Circuits Design (3)**

This course focuses on understanding the design theories of impedance transformers, microwave filters, phase shifters, amplifiers, and so on. Furthermore, we lecture the analysis and design methods for various microwave circuits by using computer aided design techniques.

· **Digital Image Processing (3)**

Representation, analysis, and design of two-dimensional signals and systems. Two-dimensional Fourier transform, z-transform, discrete Fourier transform, discrete cosine transform, and fast Fourier transform algorithms. Image processing basics. Image enhancement. Image restoration. Image coding. Additional topics including PC-based image processing systems.

· **Digital Communication System (3)**

This course is devoted to a detailed and unified treatment of digital communication theory as applied to communication system focused on the system reliability. Topics include source coding, signal encoding, representation, and quantization: methods of modulation, synchronization, and transmission: optimum demodulation techniques; and communication through band-limited and random channels.

· **Digital Circuit Design (3)**

Design procedure of the microcomputers based on the synthesis of digital devices will be trained, and its application capability by learning the algorithm of the digital circuit design will be enhanced.

· **Digital Communication Engineering (3)**

This course will deal with PAM, PPM and PDM theory including carrier systems.

· **Parallel & Distributed Processing (3)**

This course covers key concepts and techniques underlying the design and engineering of parallel/distributed processing. The following are the objectives of this course:

- Understanding key concepts of parallel/distributed processing
- Understanding characteristics of parallel/distributed computing architectures.

· **Random Process and Estimation Theory (3)**

Fundamentals of probability and random processes and their applications to information sciences and systems. Topics include linear and nonlinear estimation

theory with special interest on the theory and application of Kalman filters.

· **Information and Coding Theory (3)**

An exploration of the probability theory in information transmission, covering noiseless source coding theory of ergodic sources and channel coding theorems. Advanced topics in selected areas in signal processing, communication and information theory, decision and control, and system theory.

· **Data Structure (3)**

This course emphasizes the concept of abstract data types (ADTs) and object-oriented design paradigms. The course covers common data structures such as lists, trees, heaps, graphs, etc.

· **Operating System (3)**

This course covers in detail many advanced topics in operating system design and implementation. It starts with topics such as operating systems structuring, multi-threading and synchronization and then moves on to systems issues in parallel and distributed computing systems.

· **Network Architecture (3)**

This course discusses about the concepts and mechanism of computer network systematically and hierarchically according to the computer network's architecture. It covers RS232C, X.25, Ethernet, Token Ring, and TCP/IP as a case study.

· **Real Time Processing (3)**

An introduction to the problems, concepts and techniques involved in computer systems that must interface with external devices: computer characteristics needed for real time use, operating system considerations, analog signal processing and conversion, and inter-computer communication.

· **CMOS RF Integrated Circuits (3)**

This course covers CMOS RF device models, RF transceiver architectures, LNA, mixer, VCO, power amplifier, VGA, filter, PLL, RF package modeling, and so on.

· **Characterization of Semiconductor Materials and Devices (3)**

In this lecture, the methods of analysis, modeling, and parameter extraction for the characterization of electrical and optical properties in the semiconductor devices and their applications will be discussed in detail.

· **Antennas Engineering (3)**

This course covers the basic concepts of antenna and propagation, the numerical methods to design an antenna including frequency domain methods (Moment method) and time domain methods (Finite Difference Time Domain method). This

course discuss various antennas in wireless communications, such as small antennas, array antennas, parabolic antennas, planar antennas, etc.

· **RFID System Engineering (3)**

This course covers the basic concepts of RFID system engineering, the RFID system modeling including a reader and a tag, the anti?->-collision algorithm, the RFID reader and tag architecture, the prediction of interrogation range, the frequency interference due to nearby RFID readers. Also, this course discusses the simulation methods of RFID system using MATLAB.

· **Analog Integrated Circuit Design (3)**

Analog signal-processing chip design based on a standard CMOS process will be discussed in this lecture. In the first, the basic concept of analog signal-processing with various transformation techniques including the z-transform and the op-amp, which is a basic building block in the analog signal processing circuits, will be taught in detail. The concept of the switched-capacitor filter for accurate analog signal-processing and its application analog filters will be also considered in the lecture.

· **Digital VLSI Design (3)**

Based on the knowledge on the fundamental digital logic and CMOS technology, this course aims to convey a knowledge of advanced concepts of circuit design for digital LSI and VLSI components in state of the art CMOS technologies. Emphasis in this course is on the circuit design, optimization, and layout of CPU, ALU, register file, digital filter, RAM, ROM, and so on.

· **Theory of Spread Spectrum Communication (3)**

Topics include synchronization techniques in direct sequence and frequency hopping spread spectrum systems.

· **High Power Switching Circuit (3)**

The design and implementation methodologies of high power conversion circuits employing IGBT and SCR will be covered in this course.

· **Power Electronics System (3)**

This course will provide the specific view of designing UPS, AVR and SMPS.

· **High Efficiency Power System (3)**

This course will handle the methodologies of implementing the high efficiency power system employing the soft switching techniques.

· **Signal Detection Theory (3)**

Hypothesis testing: detection and estimation of signals in noise: detection of signals

with unknown parameters: prediction and filtering of stationary time series: detection of stochastic signals: and nonparametric and robust techniques.

· **Optical Communication Engineering (3)**

Principles and applications of LED, LD, optical modulation and demodulation, optical fiber are discussed. Optical communication systems including WDM, SCM, TDM are discussed.

· **Mobile Communication System (3)**

The course deals with fundamental theory and characteristics of analog communications and digital communications. The course introduces basic concept of cellular, roaming, hand off, and PCS.

· **Satellite Communication System (3)**

The course covers system planning, link budgets, modulation, coding, multiple access, VSAT network operation, beam switching, and antenna characteristics. This course discusses OBP, air interface, and networking protocols.

· **Nonlinear Control System (3)**

The objective of the course is to provide an understanding of the behavior of nonlinear dynamic systems and the techniques available for analysis and control of dynamic nonlinear systems: exposure to techniques that are useful in the engineering practice. This course covers phase plane method, Lyapunov stability analysis method, feedback linearization method, sliding mode control method, and adaptive control method.

· **Advanced Topics on Mechatronics (3)**

This course provides a lecture on mechatronics system which is effective combination of mechanical system, control engineering and the newest electronics. This course discusses theory of various actuation systems such as AC, DC electro-magnetic motors, mechanical-electrical system modeling and their digital control techniques.

· **Advanced Vehicle Electronic Control Systems (3)**

The course starts with the outline of automotive electronics and covers basic principles of power train control, vehicle control (chassis control) including brakes, suspension and steering. Body control including wipers, windows, and doors control is studied with microprocessor-based implementation technologies. In-vehicle networking protocols and the standardization on the software platform are also introduced.

· **Advanced Topics on Embedded Software (3)**

This course provides an overview of embedded software design concurrent with the embedded hardware design. It covers basically modern methods of embedded software design based on real-time operating system. Also, various topics on RTOS, UML, MDA, platform abstraction, multi-processor SW and their applications will be discussed.

· **Embedded Real-Time Operating Systems (3)**

This course covers embedded real-time operating system for handset, robot and automobile. Concepts of the embedded real-time operating system will be introduced with embedded system test kits. Also, commercialized embedded real-time operating systems and their applications for handset, robot and automobile will be discussed.

· **Advanced Topics on Intelligent Robots (3)**

This course provides opportunity to understand theory and practice of the latest intelligent robots. Coverage of this course includes robot navigation, robot control, robot sensing, human robot interaction and other topics related to robot technology in daily life. This course encourages multidisciplinary studies and applications in various fields of robotics.

· **Network Simulation (3)**

This course deals with the fundamental concept and principles of discrete event simulation. Network simulation methods including ns-2 will be studied. As a case study, we will implement and evaluate network algorithms such as TCP congestion control, buffer management, WLAN, and ad-hoc networks. Then, the way to show the simulation result will be discussed.

· **Advanced Topics in Wireless Network (3)**

Advanced topics in the state-of-the-art network research areas such as next-generation wireless networks, next-generation IMS, SDR, cognitive radio networks, and cross-layer optimization methods will be discussed.

· **Power Conditioning Systems for Wind Power Systems (3)**

This course provides students with technical knowledge about characteristics of wind turbines and advanced techniques for system design and control schemes for power conditioning systems for wind turbines.

· **LED Drive System (3)**

In this course, we will learn about the fundamental of light-emitting diodes (LED), advanced circuit design and control techniques for LED drive system, and the

advanced system analysis methods for performance evaluation of LED drive system.

· **Advanced Power Converter Design (3)**

The course objective is to introduce students to the basic power converter topologies and to analyze and design advanced power conditioning converters. This course covers power electronic devices, regulated bus converters, unregulated bus converters, AC/DC converters, DC/DC converters, AC/AC converters, and resonant converters.

· **Single-Stage Power Conversion Circuit (3)**

The course objective is to enhance the importance of power factor correction (PFC) by exploring some concepts related to standards, total harmonic distortion (THD) and PFC circuits. The course deals with the concepts and implementation methodology of the single stage PFC converter including analysis, modeling, design, and control.

· **Advanced Microprocessor Design (3)**

This course provides students with understanding of various microprocessor architectures. It is concerned with the hardware design issues of microprocessor systems: instruction set selection, arithmetic/logic unit design, clocking strategy, hardwired and micro-programmed control systems, memory organization, I/O interface design, and computer simulation of digital systems.

· **Advanced Digital System Design (3)**

This course covers basic concepts and design methodology for digital circuits and systems including automatic synthesis at various levels of abstraction, timing analysis and timing closure, and testing and testable design. This course puts emphasis on providing students with hands-on experience on digital systems. The course includes both lecture and laboratory work on the topics of: hardware description language (e.g., Verilog and VHDL), combinatorial logic, synchronous sequential circuits, algorithmic state machine, and asynchronous sequential circuits.

· **Advanced Topics on Computer Engineering (3)**

This course is designed to cover recent developments and research results in computer engineering.

· **Advanced Topics on EMI/EMC (3)**

This course covers the basic concepts of EMI (Electro-Magnetic Interference) and EMC (Electro-Magnetic Compatibility), the analysis methods in time and frequency domain, and the various techniques to resolve EMI/EMC problems, including crosstalk, shielding, PCB artwork, power supply filters, conducted susceptibility, radiated susceptibility, etc.

· **Advanced Topics on MEMS Engineering (3)**

This course covers MEMS (Micro-electromechanical Systems) technology for wireless and RF applications including MEMS switch, MEMS phase shifter, MEMS inductors, etc. Also, this course discusses the electromagnetic modeling for analyzing MEMS circuits, the reliability and packaging issues, the process methods, and various MEMS sensors such as Gyro and accelerometer.

· **Ultra Low Power Communication Engineering (3)**

This course covers the basic concepts of ultra-low power communications, the link budget calculations, the propagation issue, the transmitter and receiver architecture, the Modem architecture. Also this course discusses the recent wireless specifications including IEEE 802.15.4, zigbee and UWB (Ultra-low power), BAN (Body Area Network), etc.

· **Broadband Communication Systems (3)**

A broadband communication system utilizing optical signal and optical fiber are discussed. Asynchronous and synchronous systems, ATM, Ethernet, FDDI, Token Ring are among those systems.

· **Integrated Circuit Process Technology (3)**

Modern CMOS VLSI technology will be covered in-depth in this course to understand the advanced fabrication processes in the current VLSI circuit. In this course, various fabrication processes, including wafering, epitaxial growth, lithography, oxidation, metallization, etchin, and so on will be discussed in detail.

· **Special Topic on Intelligence Systems (3)**

The course will involve (1) gaining an understanding of the functional operation of a variety of intelligent control techniques and their bio-foundations, (2) the study of control-theoretic foundations (e.g., robustness), (3) learning analytical approaches to study properties (especially stability analysis), and (4) use of the computer for simulation and evaluation. The objective will be to gain a practical working knowledge of the main techniques of intelligent control and an introduction to some promising research directions.

· **Information Security (3)**

We cover in this course principles and practice of cryptography and network security: classical systems, symmetric block ciphers(DES, AES, other contemporary symmetric ciphers), perfect secrecy, public-key cryptography (RSA, discrete logarithms), logarithms for factoring and discrete logarithms, cryptographic protocols, hash functions, authentication, key management, key exchange, signature schemes, and other topics.

· **Computer and Network Security (3)**

We introduce network security concepts and mechanisms and foundations of computer and network security. We review commonly-used security mechanisms and techniques, security threats and network-based attacks, applications of cryptography, authentication, access control, security protocols, denial of service, web security, the buffer overflow attack, wireless security and privacy, and other topics.

· **Power System Control and Stability (3)**

This course is concerned with understanding, modeling, and analyzing power system stability and control problems. Students will learn about steady-state and dynamic models of AC machines and power converters in the beginning of the course. Then, they will learn about fundamental theories about various stability issues as well as active and reactive power control schemes in power systems.

· **Special Topics on Smart Grid (3)**

This course covers advanced optimization theories for control and operation of smart grids. Advanced topics about smart grids, economic operation of power grids, and power market will be dealt with in this course.

· **Power Semiconductor Devices (3)**

Course work to understand LDMOS, DEMOS, and ultra high-voltage (higher than 700V) devices; structure, material properties, characteristics for practical applications.

· **Power IC Design (3)**

Principles and techniques of design of power electronic circuits in BCD(Bipolar, CMOS, DMOS) process. Circuit issues and practical designs with focus on semiconductor for vehicles, household AC/DC converters, power supplies, and display drivers will be discussed.

· **Topics on Computer Architecture (3)**

This course provides an overview of the concepts employed in the design of high-performance computer systems, with a focus on quantitative analysis of the implications of design decisions and their effects upon design of efficient compilers and operating systems.

· **Research Ethics & Thesis Study (3)**

Graduate students will develop an understanding of the nature of ethical decision-making and its role in research ethics. They will also acquire an appreciation of the reasons for conducting ethical review of research and an

awareness of some of the international codes of research ethics that have been developed in response to scandals and abuses in research. Finally, they will understand the nature and definition of research ethics and an appreciation of the importance of good research.

· **Bio-System Control (3)**

In this course we first analyze human physiology from a systems perspective based on mathematical methods. The dynamic models discussed in this course are homeostatic control systems, immune response dynamics, mutation, evolution and so forth. To this end mathematical tools are employed including linear and nonlinear ordinary differential equations, Lyapunov stability analysis, mass action kinetics, and numerical analysis. Then we study applications in biomedical engineering from recent research literature.

· **Automotive Embedded Software (3)**

This course deals with automotive SW platforms, which is one of the most important issues in automotive embedded systems. Based on the SW platform running on multicore processors, students will study the basic concept of automotive SW platform and how to design SW components. Also, application to power train, chassis and body systems will be covered.

· **Semiconductor Convergence Engineering (3)**

For the next-generation semiconductor devices, we will discuss the properties of the emerging semiconductor materials. We will also discuss their applications to broad areas including sensors in this lecture.

· **Device-Circuit Codesign (3)**

We will discuss the advanced and optimization methods of the advenced circuit system for novel semiconductor devices and evaluate the performance of the desigend circuit system.

· **Special Topic on IT IPR (3)**

This lecture is intended for the Graduate students major in Electrical and Computer Engineering, Information and Communication Engineering to improve and promote the ability in the areas of IT-convergence as well as information technology. The lecture content include the examination of preceding technology of IP(intellectual property), establishment of a IP-oriented strategy, making patent searches, preparing specifications and patent applications.

· **Creation and Application of IT IP (3)**

This course provides the students in the field of electronics, information and communication, and computer with the creation of IPR(intellectual property rights),

information retrieval, writing patent application specifications, and answering to the refusal from the examiner concerning the patent application. Practical contents such as the basic writing of patent license contract for the technology transfer will be handled as well.

❑ **Electronics Engineering Major Courses**

· **Low-Power Integrated Circuit Design (3)**

Low power circuit technology is strongly required to enhance battery lifetime especially in portable devices such as mobile phone and notebook. This power consumption can be divided into two categories of the dynamic and static consumption. Recently developed logic families and clocking strategy to reduce the dynamic power consumption are discussed in this course. In addition, static-power reduction techniques using dynamic threshold-voltage scheme, power cut-off switch, and so on are covered.

· **Memory-Circuit Design (3)**

Memory devices as a core semiconductor industry, specifically, a circuit design of DRAM will be discussed in the lecture. The principle of the memory cells, cell-arrays, circuit technologies of various peripheral circuits incorporated in the row path, column path, and the performance enhancement strategy of the overall chip in the high-speed DRAMs, including SDRAM (synchronous DRAM) or DDR (dual-data rate) SDRAM, will be considered in detail.

· **Display Engineering (3)**

Operation principle, design method, characterization, and their applications of optical-electrical / electrical-optical semiconductor devices for the absorption and emission of the light will be discussed in this lecture.

· **Advanced Topics in Integrated Circuit Design (3)**

The current research trends and problems in modern CMOS VLSI design are discussed in this course. In modern very deep-submicron VLSI design, high-speed signaling and low power issues such as signal integrity, interconnect, power distribution, power consumption, and timing becomes important, as devices go scaled further down. This course aims to introduce the recent design techniques, the optimization algorithms, and the layout methodologies to solve the signaling and low power issues in modern very deep?->- submicron VLSI design.

· **VLSI System Design (3)**

Digital circuit technology based on the standard CMOS process will be discussed in this lecture. The delta-sigma data converters adopting digital signal-processing theory, in order to achieve a very high resolution, will be intensively considered. For

this purpose, a digital signal-processing, especially the multi-rate sampling frequency system, will be taught in depth. Various types of delta-sigma architectures, digital behavioral blocks and VLSI implementation will be also treated in the lecture.

· **Modeling and Simulation of Discrete Event Systems (3)**

This course covers the modeling and simulation of discrete event systems specific to computer science and computer engineering. The use of general purpose and specialized languages for these systems will be explored.

· **Algorithms (3)**

The course studies standard methods and examples in the design and analysis of algorithms. Topics include some basic paradigms in algorithm design and analysis of the efficiency and optimality of representative algorithms selected from some of graph, pattern matching, numerical, randomized and approximation algorithms.

· **Network Programming (3)**

This course teaches students to use network programming concepts and techniques, including the Open Systems Interconnection (OSI) seven layer model, plus how to write network programs for both stream and datagram communications with both sockets and Transport Level Interface (TLI), how to use the client-server model in network programs, how to write RPC network programs, and how to implement network security. The course covers network programming facilities in Solaris 2.X, including TCP/IP, UDP/IP, sockets, TLI, RPC, UNIX, and Data Encryption Standard (DES) network security facilities. The courses introduces the basic concept of device driver, socket programming, and application programming. It also covers the internal structure of protocols for implementing application programming such as telnet, ftp, and http.

· **Modeling and Analysis of Telecommunication Networks (3)**

The course covers basic queuing theory and tele-traffic theory for telecommunication networks. It also covers analysis of M/G/1 queue, M/D/1 queue, Priority queue, Polling system, and random access systems.

· **Internet Protocol (3)**

The course covers the OSI reference model, TCP/IP protocol, UDP/IP protocol, and various applications. It also deals with internet performance, QoS architecture, traffic management, performance tuning, and QoS engineering.

· **Queuing Theory (3)**

The course deals the probability theory, stochastic processes, Markov chain, and Makov process. The course also covers of analysis of M/N/1, M/M/m, and the network of queues.

· **Advanced Topics on PFC Circuits (3)**

Many countries are legislating for limiting the harmonic contents of current flowing into the electronic systems from the power line. In order to meet this regulation, power supply should have power factor correction circuits. This course will cover the principles of various types of power factor correction circuits.

· **Advanced Topics on Magnetic Devices (3)**

Design techniques for transformers and inductors used for various types of power supply are dealt with. In order to attain this objective, basic understandings of magnetic theory and the characteristics of magnetic materials are given. Also, winding techniques for minimizing the leakage inductance and winding loss are covered.

· **Special Topics on Power Converter Modeling (3)**

In this course, students will learn about fundamental operation principles and mathematical model derivation of various power converters for computer simulation and controller design. This course also provides students with various mathematical tool and system analysis methods for power converters.

· **Advanced Topics on Resonant Converter (3)**

It is inevitable to increase the switching frequency so that the power supply with high density is in our hand. An alternative for the high density is the resonant power conversion technique. In this course, the operating principles and control techniques of resonant converters are covered in depth.

· **Advanced Topics on Printed Circuit Board (3)**

Printed circuit board (PCB) design is the most important factor to secure the system reliability as the clock speed is getting higher. This course will cover the countermeasure against the noise and the signal integrity in the PCB.

· **Advanced Electronics Circuit Analysis (3)**

This course deals with the analysis techniques of the operational amplifier. Students are capable of designing the complex analog circuits through this course.

· **Advanced Topics on Semiconductor Device Physics & Characteristics (3)**

Electrical characteristics of unipolar-type IC devices (JFET, MOSFET, and MESFET), as analog or digital IC components, will be discussed in detail.

· **Advanced Semiconductor Devices (3)**

In this lecture, the current-voltage (I-V) characteristics, capacitance-voltage (C-V) characteristics of semiconductor devices, mainly focusing on the BJTs (bipolar junction transistors) and MOSFETs (metal-oxide-semiconductor field-effect transistors)

will be discussed. Non-ideal and secondary effects including the process-related phenomena in the BJTs and MOSFETs will be also discussed in this lecture.

· **Advanced Digital Image Processing (3)**

Topics include optimum prediction for signal processing based on linear and nonlinear time-frequency models, adaptive signal processing, and speech analysis-synthesis based on spectrogram. Additional topics in multirate signal processing.

· **Advanced Control Engineering (3)**

The course presents advanced analytical and logical control techniques with many practical applications. The objective of this course is (1) the introduction of recently developed control theories and successful application examples, (2) the understanding and survey of advanced implementation issues. Systems with delay, systems with noise, and systems with time-varying parameters are considered.

· **Power Conditioning Systems for Photovoltaic Systems (3)**

This course provides students with knowledge about fundamental characteristics of photovoltaic systems and advanced control schemes for power conditioning systems of photovoltaic systems. In addition, students will learn about advanced maximum power-point tracking schemes and grid integration techniques.

· **Filter Design for Power Supply (3)**

Various filter circuits in the power supply applications is introduced. Circuit topology, computer analysis, and design methods in terms of the optimization technology will be discussed.

· **Multimedia Engineering (3)**

The course deals with digital multimedia and its applications. The basic characteristics of voice, audio, image, and video that consist of the multimedia are examined and the core of audio and video codec are studied. The joint processing of audio and video is also discussed.

· **Wireless Resource Management (3)**

This course deals with the system level control of co-channel interference and other radio transmission characteristics in wireless communication systems, for example cellular networks and wireless networks. This course also involves algorithms for controlling parameters such as transmit power, user allocation, beamforming, data rates, handover criteria, modulation scheme, error coding scheme, etc. The objective of this course is to utilize the limited radio-frequency spectrum resources and radio network infrastructure as efficiently as possible.

· **Advanced Digital Signal Processing (3)**

This course deals with the advanced topics in digital signal processing area. Topics include spectral analysis, multi-rate signal processing, VLSI implementation, and so on.

· **Advanced Microcontroller Applications (3)**

This course covers an architecture of a high performance 16/32bit microcontroller. Programming technique and hardware implementation are provided, and also application examples for mobile device, vehicle electronics and control system are presented.

· **Advanced Computer Programming (3)**

The goal of this course is to learn advanced programming skills. Students develop programs of practical value, using various programming techniques and software tools.

· **Special Topic on Microprocessor (3)**

The goal of this course is to learn recent research problems and results in the microprocessors and application systems.

· **Embedded System Design (3)**

The goal of this course is to understand system implementation issues of embedded systems, and to exercise various practical design techniques for embedded systems.

· **Digital System Architecture (3)**

The goal of this course is to understand the principles and organization of digital systems, and to learn the performance enhancing techniques and quantitative analysis methods used in contemporary digital systems.

❑ **Microwave Communication Engineering Major Courses**

· **Advanced Topics on Multiple Antennas (3)**

This course provides understandings on the basic concept of array antenna, the detection of direction, and the digital beam formation, etc. Also, this course discusses the smart antenna system involving the linear array and circular array antennas.

· **Advanced Theory of Adaptive Signal Processing (3)**

Main topic of this course is the statistical signal processing techniques. This course gives lecture on the various signal processing techniques including the radar signal processing, acoustic signal processing, communication signal processing, bionic

signal processing, etc. based on the adaptive filtering discrete signal and system theories.

· **Internet of Things (3)**

This course introduces the fundamental concepts of the internet of things and its applications and architecture models. This course introduces the technologies and mechanisms for sensing, actuation, processing and cyber-physical data communication. This course discuss radio-frequency identification (RFID), near field communication(NFC), barcodes, QR codes and digital watermarking. This course also deal with conceptual architecture of IoT, network and service architecture of ubiquitous sensor network, and IoT platform and applications.

· **Advanced Optical Communication (3)**

Various linear and non-linear properties of optical signals propagating inside optical fiber are analyzed. Attenuation, Dispersion, SPM, XPM, FWM, SBS, RAMAN are among those properties of optical fiber. Estimation and prevention schemes are also discussed.

· **Advanced Topics in Wireless Broadband Communication (3)**

The course covers the key technologies, such as wireless network, real-time signal processing, mobile communications, radio propagation, and integrated and low-power semiconductor technologies, for next generation broadband wireless communications.

· **Advanced Topics in Mobile Communication Engineering (3)**

The course includes fading phenomenon, fading effects and distribution, multiple access cellular system, channel assignment, cellular system design, channel coding and modulation techniques for mobile communications. It also includes traffic engineering, radio resource management, radio interface protocol, and basic concepts and principles for IMT-2000 and systems beyond.

· **Advanced Electromagnetic Engineering (3)**

In this course, we examine the detail analysis methods for boundary conditions of the electromagnetic field on the basis of fundamental electromagnetic theory.

· **MMIC Design (3)**

In this course, analysis and design methods for monolithic microwave active components such as amplifiers, oscillators, and mixes by using microwave CAD software are studied.

· **RF Circuits Design (3)**

This course provides the design theories for resonant circuits, filters, small-signal RF

amplifiers, frequency mixers, RF power amplifiers, and so on.

· **Ubiquitous Sensor Network (3)**

We introduce ubiquitous sensor network and its applications. Sensor network protocol and sensor node's architecture will be studied. We will cover physical layer, localization, tracking, MAC protocol, network layer including routing protocols, sensor tasking and control, sensor network platform, and mesh network. Convergence with WLAN, cellular network, satellite network, and greedy system will be studied, and the future of sensor network also will be explored.

· **Mobile Computing (3)**

We deal with the overview and architectural model of distributed and mobile computing. Mobile ad-hoc network, peer-to-peer computing, pervasive computing, context-aware computing will be studied. Also, wireless communication including wireless channel and physical layer, MAC, WLAN, geometric routing, mobile agent technology, mobile IP, mobile information system, mobile distributed system, mobile information management and its application will be discussed.

· **Multimedia Communications (3)**

The course deals with video compression, multimedia applications, and multimedia information processing and presentation. It also covers multimedia network and protocols, RTP, RSVP, and DiffServ.

· **Speical Study on Digital Communication System (3)**

Study on communication systems utilizing PAM, PPM and PCM.

· **Energy Scavenging Technology for Wireless Communication (3)**

The goal of this course is to understand the principles of the energy converting to micro electric power, energy management circuitry technologies for this storage, and power management circuitry technologies.

· **Wireless Circuit Design using CAD Tool (3)**

The goal of this course is to learn how to use the versatile CAD tools for the diverse Wireless Circuit and System design with the higher level understanding the principles of Wireless Communications.

· **Digital RF Technology (3)**

The goal of this course is to understand the concept of the reconfigurable software defined RF technology with the latest digital signal processing and the data converting technologies and to learn the reconfigurable RF hardware system technology.

· **Wireless Energy Transmission Technology (3)**

The goal of this course is to understand the basic principles of the wireless energy transmission with the propagating characteristics of various wireless energy medias such as optimal light, RF/Microwave, and Non-radiative near fields, and to learn the system approaches in analysis and design for the purpose of generating these wireless energy medias effectively.

· **Design Theory of Wireless Communication Filters (3)**

The goal of this course is to understand various wireless communication filters, and to learn image parameter methods and filter synthesis methods including the inverter theories.

· **Special Topic in Broadcasting and Telecommunications Networks (3)**

The course deals with recent developments and research issues in broadcasting and telecommunications networks.

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