Dept. of Architecture

Architecture is both a science and an art. Good architecture is the one that is firmly and functionally built, and must give deep aesthetic experience to those who use it at the same time. The education of architecture, therefore, has dual objectives; the learning of technology to make healthy architecture, and a balanced experience of aesthetic appreciation to provide the students intellectual sensibility. In addition, the significance of architecture as a social art emphasized.
The students in Graduate program study and develop the thesis with greater view towards the society and their own field of research. The program also provides the students the opportunity to experience practical projects.

❑ **Architecture Major**

Architecture is a deep process of developing one's design abilities. Students master architectural design, planning, theory. This course studies various principles and concepts of architecture for a fundamental understanding of it.

❑ **Architectural System Major**

Students master concept of building structures concerning a load which act on building and its mechanical movement, and studies force of vector, truss, section, shear moment diagram, stress, strain and application of material.

☐ **Courses**

❑ **Core Courses**

· **Theory of Architectural Style (3)**

The course studies architectural style from European ancient times to modern age.

· **Theory of Spatial Composition (3)**

The course studies composition principle of space. The course analyzes relation of architecture and space through actuality work.

· **Theory of Urban Planning (3)**

The course analyzes urban development according to connection field. Also, the course studies a whole city that led to social development problem from problem of human essence.

· **Research Methodology (3)**

This course studies various principles and concepts of architecture for a fundamental understanding of it. The domain and definition of architecture will be comprehended. The basic knowledge of architecture the process of planning, the basic knowledge of structure, the meaning of architecture and its social role will also be learned.

· **Modern Architectural Theory (3)**

This course studies architecture from the era of Rationalism to the Modern Movement by the various concepts, styles of expression and changes of architectural type and construction. Centering around works and architect, it is learned the arts and crafts movement, the art nouveau, the avant garde, etc. And, studies of history of Korean modern architecture after the nineteenth century are also reviewed.

· **Theory of Contemporary Architecture (3)**

This course studies architecture from the mid 1960s up until now. Various architectural theories including postmodernism and Deconstruction architecture are understood in relation to other arts, literature, philosophy and other cultural factors.

· **Seminar on Korean Architects (3)**

This course studies Korean architect concerned with concept, style, architectural background. In addition, the purpose of this course is to examine the essence of Korean architectural culture.

· **Architecture and Society (3)**

This course studies the interaction between architecture and the physical and social environment based on the interdisciplinary social sciences including sociology, psychology, anthropology, etc. It masters that the way of architectural application for the concepts of a user's need, decision making, social organization and architecture, scientific movement and architectural theory.

· **Research in Architectural Planning (3)**

This course studies design methods and theories of architectural process, analysis and background based on complicacy meaning of architecture and urban.

· **Research in Architectural Planning Seminar (3)**

This course studies various principles and concepts of architecture for a fundamental understanding of it. The domain and definition of architecture will be comprehended. The basic knowledge of architecture the process of planning, the basic knowledge of structure, the meaning of architecture and its social role will also be learned.

· **Theory of Aesthetics (3)**

This course studies logics of architectural theme from ancient to modern aesthetics. Also students practice the architectural critique which uses the concept.

· **History of Oriental Architecture (3)**

History of Oriental Architecture course studies an oriental architecture and regional special formality in a style. Specially, it focuses to make a comparative study how to differentiate Chinese, Japanese and Korean style.

· **Advanced Theory in Computer Aided Design (3)**

This course masters a selection of current hardware and software tools, and provides extensive opportunities to develop practical skills through hands on lab sessions and regular practical exercises. Also students study mechanism, programming, and analysis.

· **Theory of Mechanical Systems for Building (3)**

This course covers principles of construction technology, cost analysis, construction management, and the application to the knowledge to field experience. This study requires full understanding of construction technology and learns how to make a progress schedule. This course also practices the basic of integration and itemized unit cost of progress schedule.

· **Theory of Architectural Acoustics (3)**

This course studies basic architectural acoustics system. Also students master design methods of a theater, studio and concert hall.

· **Structural Systems Analysis (3)**

Students study the structure of response of approximate solution on the statically indeterminate stress of each material, sag analysis, wind load and earthquake load.

· **Theory of Land Use Planning (3)**

The purpose of this course is to study the rational and pertinent use of land. It is researches on the locational conditions of various institutions and the morphological changes of land use. It includes purification method of land use as well.

· **Theory of Site Planning (3)**

This course is the research of intensive technique in order to arrange sorts of structure and building as human environment on the land.

· **Theory of Landscape Architecture (3)**

The purpose of this course is to solve the dilemmatic problem between the development and the preservation of nature with high technology. It is also to find the possible methodology to solve this dilemma.

· **Theory of Urban Environment (3)**

This course is the lecture about the urban environment design to confront with an urban problem. Its factors are searched at both a cultural view and a physical view.

· **Theory of Interior Design (3)**

This course is the overall discussion of environment design to understand interior design as total design. It is constituted with the design methodology and the presentation for background logic. It also provides how to manage a project from a view of interior architecture.

· **Theory of Interior Aesthetics (3)**

This course is the study on the harmonious process of fitness and empathy which is the background logic in interior design. The logic on each subject and the plan of the practical environment are required for its realization.

· **Research in Contemporary Architects (3)**

The purpose of this course is analyzing the international tendency and under-standing each logics through focusing on the architects working since modernism.

· **Critique of Contemporary Architecture (3)**

This course is constituted by study on the tendency of contemporary architecture and theorizing current thoughts on each of them from the general view. The main discussible subjects are focused on the circumstances that progress from modern architecture to post modern architecture. It is based on the analysis of ideas of architects and their works.

❑ **Architecture Major Courses**

· **Advanced Architectural Design Ⅰ (3)**

Advanced Architecture Design I course study theory of background, method of development and analysis that is stood architectural solution on a complex characteristic of architecture and urban fabric.

· **Advanced Architectural DesignⅡ (3)**

Advanced Architectural Design II course study analysis, development and ultimate principle after institute a cooperation theme, as a architectural design process about social contribution of architecture.

· **Advanced Architectural DesignⅢ (3)**

Advanced Architectural Design III course that is started from social cultural analysis about solving a ultimate human environment study a way for embodying to architectural environment with theme creation on the part of freedom subject.

· **Theory of Structural Systems (3)**

Theory of Structural Systems course studies mechanical movement and building system of Core, Shear Wall, Wall Brancing, Tube System, etc. for solution of a horizontal force in buildings.

· **Research and Special Thesis of Architectural Design (3)**

Research and Special Thesis of Architectural Design course study necessity of subject, process of development, collecting and analysis of data, materialization of logic and essay type techniques that is stand established each subject before write a thesis for a degree.

· **Research in Architectural Design (3)**

Research in Architectural Design course studies logical practice and method of analysis that is used by existing architects for an ultimate solution as a process through a study of architectural design.

· **Research in Architectural Design Seminar (3)**

Research in Architecture Design Seminar course study to make a report about a architectural model that include social valuation, economic valuation, and environmental valuation in order to analyze architectural theme and those results with positive.

· **Research in Architectural Form (3)**

Research in Architectural Form course studies an architectural aesthetics theory.

· **Research in Architectural Environment (3)**

Research in Architecture Environment course studies culture, society, psychology, physical the surrounding[social] environment as all things considered background that is formed architecture and research a methodology to be adjusted such a subject.

· **Research in History of Oriental Architecture (3)**

Research in History of Oriental Architecture course studies oriental architecture and regional special formality in a style. Specially, it focuses to make a comparative study how to differentiate Chinese, Japanese and Korean style.

· **Research in History of Western Architecture (3)**

This course covers the substance of western architecture focusing on concept of history. Student will understand sociality, technique and regional differences as an important decision factor of the style.

· **Research in History of Korean Architecture (3)**

This course explores the history of korean architectural design, theory and practice. In collusion with the Far East Architecture, this course studies korean classic building's place in style of architecture. After lessons, detail of each style are explained.

· **Independent Study (3)**

Each student conducts intensive and independent research on a topic chosen in consultation with his or her advisor.

❑ **Architectural System Major Courses**

· **Research in Architectural System Ⅰ (3)**

The focus of this course is the understanding for the organic relations of architectural system that is made by architectural structure, construction/materials, architectural environment/equipment and urban planning.

· **Research in Architectural System Ⅱ (3)**

This lecture provides the recent trend of architectural structure, construction/materials, architectural environment/equipment and urban planning. This course also reviews the developmental direction of architectural system through the consideration of future building or a recent trend of architectural technology.

· **Research in Architectural Structures (3)**

The course introduces various method of structural analysis. Topics includes slope deflection method, the moment distribution, principle of hypothesis work, energy method and influence line method as solving truss, arch and frame.

· **Theory of Steel Structure (3)**

The methodology and consideration of the structure of steel are discussed. Studies of specification and junction planning are reviewed.

· **Theory of Advanced Structure (3)**

This course examines structural analysis on mechanics plan of frame, stress basic principle for frame's motion and the principles and thinking process by which the analysis reaches decisions intended to resolve modification.

· **Special Research Thesis of Architectural Structure (3)**

Study unfolding method, data collection method, own logic organization, synthetic statement techniques on each subject that is established before thesis creation.

· **Research in Matrix Structure Analysis (3)**

This studies structural analysis of Matrix Structure Analysis and Matrix analysis of Digital Computer.

· **Research in Steel Structure (3)**

This studies qualities of the enforced material, explosion, design concept of the steel structure. Also it studies steel structure for earthquake.

· **Research in Reinforced Concrete (3)**

This studies about the beam, pillar, slab, foundation relating strengthen design methodology.

· **Theory of Architectural Environment (3)**

This course focuses on the background of thermal transfer processes in buildings through studies of heat transfer, air flow, thermal comfort, and load calculation algorithms. This lecture also provides the basic knowledge and skills required by architectural engineering students who lack sufficient knowledge of fluid mechanics and CFD.

· **Theory of Indoor Air Quality (3)**

This class explores estimation methods of indoor air quality by investigation of national and international standards. Different types of ventilation systems are examined to study the methodologies used in resolving IAQ problems. CFD analysis and the capability to create new data from the results of CFD are both important. This class is aimed at acquisition of fundamental knowledge and skills through CFD exercises.

· **Simulation for Building Performance (3)**

The focus of this course is the application of simulation techniques in building design. The course uses computers and various other simulation tools for design performance prediction and/or evaluation. These simulation tools are used to promote an understanding of the fundamental principles involved in assessing the built environment and creating new applications for simulation techniques.

· **Finite Element Analysis (3)**

This course studies finite element method for solving structure, two dimensional rigid plate, shell and three dimensional rigid plate in architectural engineering.

· **Dynamics (3)**

This course studies particle using classical mechanics by Sir Isaac newton, geostatics, kinetic mechanics, energy and momentum. And the course introduces the oscillation theory and the equation of motion.

· **Research in Elastic-Plastic Theory (3)**

Study stress, displacement theory, state of elastic equilibrium, distortion of prismatic members, wus, stress concentration, plate and shell.

· **Independent Study (3)**

Each student conducts intensive and independent research on a topic chosen in consultation with his or her advisor.

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Dept. of Materials Science and Engineering

The graduate school of Advanced Materials Engineering Department in Kookmin University was established in November 1974 after the authorization of Ministry of Education. The goal of our graduate course is to educate students who will become pro - active leaders with creative mind in the field of materials related industry by utilizing knowledge of materials engineering. Until now, more than 200 students with master and doctoral degrees have been produced and they play a critical role in the field of industry as well as, academia. 20 faculty members in the graduate school of Advanced Materials Engineering Department are actively doing their research works in the field of metals, ceramics, polymers, semiconductors, displays and energy/environment. Also, the department possesses many up - to - date experimental equipments for various materials - related researches.

Summary Understanding all the topics of materials science and engineering from the synthesis and characterization of metals, electronic materials, ceramics, and polymers to the development of high technology.

□ Courses

· Thermodynamics of Materials (3)

This course is designed for understanding the thermodynamical behavior of solid solutions. Phase equilibria, statistical physics, chemical reactions, structures of interface and imperfection related with thermodynamic principles are discussed.

· Mechanical Behavior of Materials (3)

Advanced theories of dislocation, and strengthening mechanism due to dislocations are discussed. Topics include advanced principles and applications of creep, fatigue and fracture behaviors.

· Advanced Semiconductor Physics and Technology (3)

Behaviors of electrons and holes in semiconductor are discussed and their relevant p-n junction, Schottky junction, MOS capacitors and MOSFET are studied.

· Electronic Materials (3)

This course is designed to achieve knowledge of principles, properties and applications of electronic materials. Topics include conductor, semiconductors, superconductors, dielectrics and ferroelectrics.

· Phase Transformation (3)

Based on diffusion and chemical reaction, principles of phase transformation, solidifications, growth of crystals, precipitation, recrystallization, and Martensite

transformation are intensively and extensively discussed.

· **Engineering English Communications** (3)

-The present new course is developed for graduate students to improve communication skills, reading ability, as well as technical writing skills in English in the field of science and engineering.

· **Electronic Ceramics (3)**

Principles of various electronic ceramics are introduced and semiconducting, insulating, high dielectric, magnetic, superconducting ceramics are discussed. Applications, such as sensors, actuators, solid oxide fuel cells and MEMS are also discussed. Fracture Mechanics of Engineering Materials Based on fracture mechanics, characterization and design applications of fracture, fatigue, creep of metals are studied.

· **Polymer Science & Engineering (3)**

This course introduces the concept of structure, synthesis, physical/chemical properties of polymer materials which is one of most important characteristics for materials applications in industry. Topics include elastic and plastic theory, strengthening mechanism of polymer materials, tensile behavior, and structure.

· **Statistical Thermodynamics (3)**

Topics include ensembles, classical statistical thermodynamics, ideal gases, lattice statistics, chemical equilibrium, and reaction kinetics.

· **Electron Microscopy (3)**

This course is designed to understand and practice principles and techniques of electron microscope for metallurgical phenomena. Topics include electro optics, diffraction phenomena, analysis of diffraction pattern, kinematical theory, dynamical theory, contrast analysis, images on crystalline imperfections, and CBED analysis.

· **Surface Engineering (3)**

Advanced principles and applications of electrodeposition, chemical deposition, colouring, anodizing, spraying, chemical vapor deposition and physical vapor eposition are discussed.

· **Special Surface Modification Engineering (3)**

Study about the principle, the way of treatment, and the development trend of special surface treatment process to give new properties to material's surface.

· **Dislocations in Crystalline Solids (3)**

Topics include generation mechanisms of defects, effects of crystal structure to dislocations, reaction between dislocation and point defect, and phenomena related to defects and their influence to materials characteristics.

· **Creep and Superplasticity (3)**

In this class, the mechanical properties of high temperature structural materials and their deformation mechanisms are studied. Topics include creep deformation, fatigue and fracture, high temperature failure, and superplastic deformation as well as stress/life prediction of materials.

· **Friction and Wear (3)**

In this course, friction and wear of engineering materials are discussed. Special topics include surface interactions, fraction, wear of lubrication, and effects of materials properties as well as development of wear resistant materials and their applications. Relevant techniques of analysis and measurement are also presented.

· **Thin Film Science and processing (3)**

The object of "Thin Film Science and Engineering" class is not only to document what is known about thin films including multilayers, but also to promote the potential of these versatile thin films and to facilitate the adsorption of the technology by others. The field introduced in this class is new. This class will show that thin films including multilayers represent a model platform for promoting modern research and furthermore, the intellectual distance between concept and application is minimal.

· **Process Integration of Integrated Circuits (3)**

This course is to provide the student with an understanding of each process for the fabrication of semiconductor devices and the process integration of Integrated Circuits. In addition, the process for 1㎛, 0.8㎛, and 0.5㎛ CMOS will be introduced, and then discussing its device characteristics. Based on the technology roadmap, the progress for the process development required for the future devices will be predicted and discussed.

· **Plasma Physics and Processing (3)**

The goal of this course if to provide the student with a sound, scientific understanding of plasma physics and plasma chemistry through which he can better use plasma processes for microelectronic fabrication. The introduction of various plasma processes for sputtering, etching, plasma enhanced chemical deposition of thin films helps him to know the main factors affecting each plasma process. In addition, vacuum technology and surface measurement is to be provided to improve his practical ability to control the processes.

· **Solid State Physics (3)**

Basic principles of modern physics and quantum mechanis, such as wave equation, free electrons, crystal lattice and diffraction phenomenon, are presented on the nanometer scale. Applications to solid state and nano structured materials will be emphasized including band structure, bonding, and electronic response in crystal lattice.

· **Powder Processing (3)**

Topics include fabrication, properties, components of powder and fundamentals of sintering. Industrial application examples of powder metallurgy are also examined.

· **Alloy Design (3)**

The objective of this course is understanding of advanced principles and applications of heat treatment on alloys. Impacts of heat treatment on hardenability and correlations of microstructures and mechanical properties are examined. Design and analysis of alloy are practically discussed.

· **Ferrous Materials (3)**

Fundamentals of alloy components and heat treatment effects on mechanical properties of carbon steels and alloys.

· **Non-Ferrous materials (3)**

This course is designed for understanding of fundamental properties of nonferrous metals, such as Cu, Al, Pb, Ti, and noble metals. The mechanical properties of various alloys are discussed from the viewpoint of materials science.

· **Fracture Mechanics of Engineering materials (3)**

Based on fracture mechanics, characterization and design applications of fracture, fatigue, creep of metals are studied.

· **Plastic Deformation in Metals (3)**

Elastic and plastic behaviors of metals under applied force are discussed in this course. Principles and techniques of plastic working are also introduced. Effects of mechanical work on metal involving its microstructure change and its behaviors on the properties are also discussed.

· **Advanced Diffusion in Materials (3)**

In this course, based on statistical mechanics, the atomic level theory is studied on the mass transport and energy and momentum balance to the solution of heat, diffusion and fluid flow problems relevant to materials processing and microstructure. How to describe diffusion in materials at the nano-scale will be discussed as well as the effect of various stress and defect states in the materials.

· **Advanced Metallic Materials (3)**

The manufacturing technologies and application of the recent developed metallic materials, such as shape memory alloys, light metallic materials and ultra fine grained materials are introduced.

· **Manufacturing Process of Metallic Materials (3)**

The application of the principles in metallurgy, such as transformation, deformation and the manufacturing technologies are introduced. Especially, the required principles in the application of deformation process such as rolling, wire drawing, forging is discussed.

· **Advanced Process Design of Metallic Materials (3)**

Recent advanced technology in processing and design of metallic materials is presented and studied along with their applications, such as processing of nano materials, multi phase materials, and shape memory alloys.

· **Manufacturing Process for Materials (3)**

Manufacturing processes to make desired shapes and their effects on the properties of materials are introduced and taught on the basis of the plastic deformation and the metallurgical fundamentals.

· **Purification of Materials (3)**

The concept of chemical potential and the relation of phase rule, phase diagram, and mass transfer are discussed. The topics includes the exercise on the solution thermodynamics, and experimental measurement of thermodynamic quantities, and example for purification of materials.

· **Advanced Computational Materials Science (3)**

This course introduces advanced computer modeling methods in materials science and engineering using discrete particle systems and continuum fields. It covers techniques and software for statistical sampling, simulation, and uses statistical, quantum chemical, molecular dynamics, Monte Carlo, mesoscale and continuum methods to study fundamental physical phenomena encountered in the fields of computational physics, chemistry, mechanics, materials science, biology, and applied mathematics. A term project allows development of individual interests. Students are mentored by members of CMS Lab. in KMU.

· **Surface and Interface Science (3)**

This course surveys the basic concepts of surface and interface free energy, various phase transitions on the surface and interface such as surface roughening, surface reconstruction, etc.. Goals of the course also include the understanding of reaction

rate on the surface and interface, physi or chemi sorption, the role of stress in thin film growth, etc..

· **Nanotechnology (3)**

This course will introduce students to the relevant concepts related to the synthesis, science, characterization, and engineering of nanomaterials. Special applications in nanotechnology will also be reviewed, including bio medical, environmental, energy, defense, and telecommunication areas.

· **Electrochemical Engineering (3)**

Electrochemical Engineering is the course to understand the electrochemical principles and how to apply those theories to the relevant industries such as corrosion, surface finishing, battery and fuel cell and hydrometallurgy. This course covers the fundamental concept of electrochemistry, the equilibrium and the kinetics of electrochemical reactions, the corrosion of materials, the surface treatment, and the energy conversion methods such as battery and fuel cell.

· **Electrochemistry (3)**

This course is designed to understand fundamentals of electrode reactions, thermodynamics of solutions, structures of charged interface, and reaction kinetics. The engineering applications of electrochemistry are emphasized.

· **Corrosion Engineering (3)**

This course is designed for an advanced treatment of corrosion and its control in metals and alloys, stressing fundamentals of electrochemistry and their applications to corrosion system, thermodynamics, and kinetics and their relationship to corrosion reactions. Topics include the Butler Volmer equation, the Wagner Traud analysis, the Pourbaix diagram and Evans diagram, treating electrode reactions, passivity, effects of metallurgical factors on corrosion, anodic and cathodic protection, protective coatings, inhibitors and the proper alloy selections of particular corrosive environments.

· **Mechanics of Materials (3)**

Mechanics of materials deals with the mechanical behaviors of materials when they are loaded. Topics include force and moment, the relationship between stresses and strains, mechanical matters on deformation, compression, torsion, bending, beam deflection, and buckling in a practical manner. This course may provide the fundamentals of elasticity and plasticity as well as the theoretical background of mechanical metallurgy and deformation processing.

· **Advanced Ceramic Materials (3)**

Definition and crystal structures of ceramic materials are fundamental topics and different kinds of bonding and defect structures are advanced subject in this course. In addition it includes effect of crystal structures and defect structures on their physical properties.

· **Materials for Information Technology (3)**

This course will present to students information storage, transmission, and related materials and technology with special emphasis on materials technologies in the areas of optical information processing, memory semiconductors, and large scale information storage.

· **Electronic Display Engineering (3)**

The purpose of this course is to gain an understanding of the principles and techniques of materials and process for flat panel displays (EL, LCD, PDP, FED....) fabrication. Topics also include the characterization and evaluation of display materials and related technologies. Emphasis on materials design in relation to fundamental device characteristics.

· **Nano-material Chemistry & Technology (3)**

In this course, students will learn critical knowledge of chemistry and technology in the areas of advanced metals, polymers, and ceramics. Course modules will cover the fundamental scientific principles of molecular structure, chemical bonding, and structural measurement and analysis of materials at nano scale level as well as related basic theories and mechanisms.

· **Advanced Polymer Materials (3)**

Overview of the problems associated with the selection, design, and function of advanced polymers is presented in this course. Particular emphasis is placed on discussion of the advanced application areas of polymer materials, which may include display, semiconductor, and energy technologies.

· **Materials Recycling Engineering (3)**

Environmental problems are discussed in global scale. Recycling methods for the ferrous and nonferrous scrap and other resources are introduced with their problems. Recent trend in recycling of resources is discussed in related with environmental features.

· **Iron and Steel Processing (3)**

The course is designed for thermodynamic and kinetical treatment of reduction and oxidation reactions, Si Mn reactions, and sulfur reactions for iron and steel making. Topics also include special melt refining.

· **Solidification of Metals (3)**

Topics include properties of melts, solidification of pure metals and alloys, solidifi-cation in a mold, gas at the solidification.

· **Imperfection in Solids (3)**

In this course, fundamental structures of solids, such as arrangement of atoms, direction and plane of lattice are depicted. Topics discussed include point defects, line defects, surface and interactions between dislocation and point defect.

· **Thermodynamics of Phase Equilibria (3)**

The lecture includes the equation of Gibbs free energy, lattice stability, sublattice model of solution and compounds, and the exercise will be made for calculation of phase diagram. Some examples for alloy and semiconductor systems are discussed.

· **Diffraction in Material Science (3)**

In this course, basic principles of techniques used in the characterization of engineering materials by X-ray diffraction are discussed. In addition, fundamental crystallographic study on the engineering materials is also conducted and related to X-ray diffraction phenomena.

· **Crystallography (3)**

This course describes system and symmetry of crystalline and explains material properties made a use of tensor. Mathematical expression on material characteristics including electrical and magnetic as well as mechanical properties.

· **Composite Materials (3)**

In composite materials system of metals, ceramics, carbon fibers and glass fibers, bonding structure, mixing principles, interfacial structure, mechanical properties and causes of fracture are discussed. Design and fabrication of composite materials are studied.

· **Welding Metallurgy (3)**

This course is design to understand effects of heat transfer, phase transformation, grain growth, formation of defects and residual stress due to welding of metals. Topics include evaluation and development of welding process.

· **Electronic Materials Fabrication Processing (3)**

The goal of this course is to provide the student with a fundamental understanding of each process for the fabrication of microelectronic and electronic devices. The processes of oxidation, diffusion, iron implantation, etching, photoli-thography, metallization and packaging will be discussed with an emphasis on the principle of each process and its equipment, and the process related issues.

· **Reaction Kinetics (3)**

Topics include measurement techniques of concentration and reaction rate in chemical reactions, single step and multi step reactions, order of reaction, solid catalyst reactions, gas solid noncatalyst reactions, solid liquid reactions.

· **Mechanical Properties of Thin Films (3)**

This course covers the mechanical properties of the thin films deposited on various substrates with an emphasis on thin film dynamics, process related stresses, and the measurement of thin film stresses. In addition, effects of the microstructure of thin film depending on the process variables such as substrate temperature and pressure, on its plastic deformation and elastic behavior will be discussed.

· **Heat Treatment Engineering (3)**

The effects of heat treatment on properties and microstructures of metallic materials and the rcent trend of new technologies are introduced. Based on the principals of phase transformation and strengthening in metallurgy, the relationship between mechanical properties and microstructures, newly introduced manufacturing process, and the application of heat treating technology to machine parts and structures are discussed.

· **Materials in Energy and Environmental Application (3)**

Energy Storage and Conversion Materials is the course to understand the electrochemical principles related with energy storage and conversion materials and how to apply those principles to the relevant industries such as primary and secondary batteries, fuel cell and hydrogen storage materials. This course covers the fundamental concepts of thermodynamics and the equilibrium and the kinetics of electrochemical reactions associated with energy conversion materials and methods.

· **Special Topics in Structural Materials (3)**

This course covers the special topics and recent case studies in the field of advanced structural materials. Design issues pertaining to materials selection for load bearing applications are also discussed. Specific topics include engineering materials, structure property relationships, materials selection for design, and mechanical behavior of advanced materials through recently published critical papers.

· **Special Topics in Electronic Materials (3)**

This course is an introduction to the physical principles underlying the electric properties of modern solids with emphasis on semiconductors.

· **Speical Topics in Electro-Chemistry (3)**

This course deals with the recent theory on electrochemistry and corrosion. Mechanisms and rates in relation to physiochemical and metallurgical factors are also discussed.

· **Special Topics in Computer Application in Materials (3)**

This course is an introduction to computational materials science. Development of atomic and molecular level simulations for materials science applications will be discussed. Additionally, simple numerical methods are presented for solving differential equations and for studying correlations.

· **Special Topics in Nano-Materials (3)**

In this course, the essential properties of nanomaterials and their relevant concepts governing the synthesis, science, and engineering of nanomaterials are discussed. In addition, new properties at the nanoscale and existing and emerging applications of nanomaterials are presented.

· **Advanced Physical Metallurgy (3)**

Advanced theories, novel techniques, and recent industrial applications related with physical metallurgy.

· **Advanced Chemical Metallurgy (3)**

Advanced theories, novel techniques, and recent industrial applications related with chemical metallurgy.

· **Advanced Theory in Property of Materials (3)**

In this course, a survey of Materials Science and the physical properties of materials at the beginning graduate level is presented. Focus should be on the nature of microstructure and its manipulation and control to determine engineering properties: reviews include bonding, structure and microstructure, the chemical, electromagnetic and mechanical properties of materials.

· **Advanced Process in Manufacturing Materials (3)**

The principles of materials processing with emphasis on the use of processing to establish microstructures with impart desirable engineering properties. Some of the topics in this course should include solidification, thermal and mechanical processing, powder processing, and surface treatments.

· **Seminar in Process Design Engineering (3)**

Principal of process design in advanced materials engineering, recent trend of special technology and problems in advanced materials processing are discussed.

· **Seminar in Materials Engineering (3)**

Principles of materials engineering, recent trend of special technology and problems in advanced materials engineering are discussed.

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

Engineering is the application of scientific/technological knowledge. in order to design, produce/build, and maintain structural and machines/devices systems and it has changed our lives significantly in various ways. This course helps students understand how engineering has changed the world and the students learn how to solve various engineering ethics problems synthetically.

· **Smart Fashion Convergence Research (3)**

Fashion items with functionalities based on module system are investigated in convergence of design, technology and marketing. Constructing platform for wearable electronics is critical issue and various disciplines should cooperate to build it. This course aims the convergence research to figure out the solutions for smart fashion and killer application.

· **Functional soft materials (3)**

Organic and polymeric materials form a variety of hierarchical self-assembled structures based on various intermolecular interactions between the molecules. By the study on the thin film formation, and long range ordering and miniaturization of structures in the material development on the basis of the self-assembly, it is possible to create the most suitable functions and physical properties of the materials in each device.

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Dept. of Mechanical Engineering

We offer graduate programs leading to the degrees of Master of Science (M.S.) and Doctor of Philosophy (Ph.D.) in mechanical engineering. The primary mission of the department is to promote sustainable energy research and education, for the ultimate goal of serving the environment and the global community. Our department is one of the nation's top-ranked engineering departments focusing on energy and environment. Graduate students work closely with faculty members to improve research skills and to build engineering careers. Students can join international research activities through various government- and corporate-funded projects that we offer, which will provide scholarship opportunities. Our research interests are not limited to basic topics in thermal energy and environmental engineering such as refrigeration, air-conditioning, fluid machinery and renewable energy systems, but the funded projects encompass various engineering topics in connection with micro-electro-mechanical systems, information and communication technologies, and bio-systems.

Prospective students are encouraged to contact faculty members in the department to learn about their interests and research areas. Applications and all inquiries regarding the admission should be made to the Office of Admission, which will be able to provide information about requirements, application materials, schedules, finances and other topics.

☐ **Courses**

· **Advanced Applied Mathematics (3)**

The analytic methods to solve ordinary differential equations and partial differential equations with boundary and initial conditions are studied to apply engineering problems encountered in practice.

· **Advanced Numerical Analysis (3)**

Selected topics on numerical methods for engineering applications including interpolation, systems of linear algebraic equations, optimization, numerical differential and integration, ordinary differential equations, and partial differential equations.

· **Advanced Thermodynamics (3)**

Development and application of basic concepts in thermodynamics; system and control volume; ideal gas and real fluid; enthalpy, entropy and exergy; heat engine and heat pump; chemical reaction and equilibrium.

· **Advanced Fluid Mechanics (3)**

Fundamental concepts and methods of fluid mechanics, inviscid flow and Bernoulli theorems, potential flow and its application, Navier-Stokes equations and constitutive theory, exact solutions of Navier-Stokes equations, boundary layer theory, introduction to turbulence.

· **Advanced Heat Transfer (3)**

Basic theories on heat conduction, mathematical solution and simplified method for numerical solution to the 1,2D steady and 1D unsteady heat conduction problems: basic theories on heat convection and related continuity, momentum and energy equations, laminar flow heat convection: radiative heat transfer basics and shape factors.

· **Advanced Topics in Control Engineering (3)**

Study modern control theories for the multi-inputs multi-outputs control system. Include the nonlinear control system theories. Focus on control theories and design method for real systems.

· **Experimental Methods for Engineers (3)**

Experimental planning, variable analysis and identification, data acquisition and recording, statistical data analysis, including regression correlation, and dispersion analysis.

· **Computational Thermodynamics (3)**

Numerical methods applied to the thermodynamic systems: modeling, analysis, simulation and optimal design: development of computer programs.

· **Advanced Thermophysical Properties (3)**

Thermodynamic and physical properties of substances used as a working fluid of various thermo fluid system such as PVT relation, vapor pressures, latent heat, specific heat and Gibbs energy of formation: mathematical expressions and accurate correlations for the prediction of thermo-physical properties.

· **Computational Fluid Dynamics (3)**

This course is primarily aimed at developing a general method of prediction for heat and mass transfer, fluid flow, and related process. It includes mathematical description of physical phenomena, discretization methods, heat conduction, convection and diffusion, calculation of flow field, et al.

· **Turbulent Flow (3)**

Fundamentals of turbulent flows, the basic equations, the origin of turbulence,

turbulent production and dissipation, vorticity dynamics, turbulence scale, correlation functions and spectral dynamics, turbulence modeling.

· **Advanced Turbomachinery (3)**

Fundamentals of energy conversion in fluid machines: principle, application and design procedure for fluid machines such as pumps and turbines: review of past developments, the current status, and future research needs in turbo-machinery fluid dynamics.

· **Computational Heat Transfer (3)**

Numerical schemes and numerical simulation methods are studied to solve mathematical equations, which are derived from the heat transfer phenomena, such as conduction, convection, radiation, evaporation and condensation. Computational practice is carried out in parallel to approach to applied heat transfer problems.

· **Advanced Refrigeration (3)**

Refrigeration cycles, the characteristics of each components, system performance analysis, refrigerants, control methodologies.

· **Thermal Environmental Engineering (3)**

Theoretical and practical topics related to indoor thermal environments such as, IAQ, psychrometrics, heating/cooling loads, air pollutants, thermal comfort, ventilation effectiveness, and airflow simulation.

· **Heat Engine (3)**

Theoretical analysis of heat engines and related combustion processes, design of heat engine components such as boilers and steam turbines, and application in practical problems.

· **Combustion Devices (3)**

Basic theories of thermodynamics, fluid mechanics, chemical equilibrium, and chemical reaction, and their application in systematic analysis and design of combustion devices.

· **Advanced Gas Turbine (3)**

Advanced theories on thermal flow, reaction, structural and dynamic characteristics are studied.

· **Advanced Energy Engineering (3)**

Management for the conservative use of energy reserve and processes of alternative energy resources such as solar, tidal, and wind energy: The social and economic consideration of energy consumption based on the engineering methodology regarding the potential energy problems.

· **Digital Control (3)**

Analyse technical issues associated with computer applications. Study control theories and design methods for digital applications. Include the Z-transform, the analysis of sampled data systems, and the digital filter design.

· **Case Studies in Mechanical Engineering (3)**

Case studies of thermo fluid systems required to identify their characteristics and also to develop the modeling and analysis methods.

· **Special Topics in Mechanical Engineering (3)**

Various technologies, modeling and analysis of specific thermo fluid systems.

· **High Temperature Thermal Engineering (3)**

Thermal behavior of materials at high temperature above 1000℃ is studied. Theories on phenomena at high temperature, such as melting and solidification of mineral materials, radiative and convective heat transfer, pure oxygen combustion etc, are investigated.

· **Biomimetic Engineering (3)**

This course is intended to provide the engineering principles found in nature, which is considered a highly efficient and optimized system. It discusses newly designed man-made systems by mimicking and engineering biological phenomena regulated precisely in a tiny physical space.

· **Biomedical Instrumentation (3)**

This course covers the principles of biomedical devices and related multidisciplinary technologies. Topics include liquid-handling and optical detection systems which are essential parts of various emerging tools for biomedical research and development.

· **Special Topics on Environmental Machines (3)**

Environmental machines applied for waste treatment, waste water treatment, air pollution control are studied. Thermal or cold fluid flow, heat and mass transfer, and reactions for waste incineration system, waste water treatment, various pollution control system is investigated and improve the design ability for actual system by design exercise.

· **Renewable Energy Sources (3)**

This lecture delivers about renewable energy source, its application and management for efficient utilization such as solar, tide and wind etc. Based on the engineering theory and knowledge related with energy and global warming crisis,

the efficient method in the aspect of social and economic utilization of renewable energy is treated.

· **Simulation Software (3)**

Study various commercial simulation softwares for energy systems design and analysis.

· **Building Automation System (3)**

Graduate students will learn principles of automatic control, control systems and applications to building energy systems. They will also acquire knowledge regarding renewable energy sources, energy system, building automation and plant engineering.

· **Industry-University Cooperative Seminar 1 (1)**

This course will provide entry level industry-university joint seminar for graduate students to follow up current research not only conducted from our graduate schools, but also performed from the industries or institutes joined with our programs. Through this seminar, it is expected that students can obtain research senses based on understanding the current technical and research trends and issues.

· **Industry-University Cooperative Seminar 2 (1)**

This course will provide advanced level industry-university joint seminar for graduate students to follow up current research not only conducted from our graduate schools, but also performed from the industries or institutes. Through this seminar, it is expected that students can obtain further research senses based on understanding the current technical and research trends and issues.

· **Industry-University Cooperative Special Lecture (2)**

This course will provide industry-university joint seminar for graduate students to follow up current research not only conducted from our graduate schools, but also performed from the industries or institutes joined with our programs. Through this seminar, it is expected that students can obtain practical research capabilities and skills based on understanding the current technical trends.

· **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.

· **Advanced HVAC System (3)**

Main topics include air conditioning system, zoning, heat pump system and its application, load calculation, system design, and relevant HVAC equipments for a comfort living environment.

· **Measurements in Thermofluidic HVAC Systems (3)**

Study methods of error estimation and analysis, and its propagation occurred during a measurement. Topics also include principles of temperature and flow velocity measurements such as state-of-the-art experimental techniques using thermocouple, RTD, liquid crystal, and laser Doppler velocimetry, hot wire anemometer.

· **Design of Energy Systems (3)**

Modeling and simulation of thermal systems, such as heat exchangers, refrigeration systems, manufacturing processes, power plants etc. Optimization and economic analysis of thermal systems.

· **Energy System Control (3)**

Study the dynamic behaviors of the energy system focused on the control system design of the energy system including the HVAC system.

· **Plant EPC (3)**

Engineering, Procurement and Construction on power plant, incineration lant, renewable energy plant, and environmental plant. Maintenance and economic feasibility analysis are also studied.

· **Advanced Micro Thermofluids (3)**

Control technologies of micro-physical phenomena, heat transfer and fluid flow of thermal fluid systems for their applications in next-generation technologies of BT, NT, or IT are discussed.

· **Intelligent Control (3)**

Study intelligent control technologies for the real time application. Focus on topics related to the expert system, the fuzzy system, the neural network system and the genetic system. Include practical application examples of their algorithms.

· **Selected Topics of Measurements in Heat Transfer and Fluid Flow (3)**

Selected topics on thermo-fluid measurement techniques, using RTD, liquid crystal, hot-wire, LDV, PIV, and other advanced measurement techniques for heat transfer and fluid flow research.

· **Studies on the Thermodynamic Systems (3)**

Modeling and analysis of thermodynamic systems: principles and applications of new thermodynamic cycles and various up-to-date thermofluid systems.

· **Statistical Thermodynamics (3)**

Analysis of behavior of materials in a microscopic point of view, basic probabilities and quantum mechanics, approach of general theories in the classical thermodynamics using statistical method, statistical analysis of chemical equilibrium, ideal gas behavior and real gas behavior, non-equilibrium process and irrevisible processes.

· **Fluid Phase Equilibria (3)**

Theories in chemical equilibrium, phase equilibrium and properties of pure substance and mixture refrigerants, application to the refrigeration cycle analysis.

· **Viscous Fluid Flow (3)**

Advanced topics and methods on analysis of viscous fluid flow.

· **Non-Newtonian Fluid Mechanics (3)**

Fundamentals of viscoelastic fluid: types and behavior of non-Newtonian fluid: governing equations for non-Newtonian fluid flow: Surface Phenomena: dielectric-behavior, pipe flow of non-Newtonian fluid.

· **Advanced Boundary Layer Theory (3)**

Origin of turbulence: fundamentals of turbulent flow: turbulent boundary layers in incompressible and compressible flows: free turbulent flows

· **Advanced Transport Phenomena (3)**

Introduction to the field of transport phenomena emphasizing on understanding basic physical principles: momentum transport (viscous flow): energy transport (heat conduction, convection and radiation): mass transport (diffusion).

· **Compressible Flow (3)**

Fundamentals of compressible flow, governing equations for compressible fluid flow, steady 1D isentropic flow, steady 1D flow with friction and heat transfer, shock and expansion waves, flow with small perturbation, method of characteristics.

· **Applied Computational Fluid Dynamic (3)**

Basic concepts of fluid flow, introduction to numerical methods, finite volume methods, solution of linear equation systems, methods for unsteady problems, solution of Navier-Stokes equations, complex geometries, turbulent flows, compressible flow.

· **Convection and Radiation Heat Transfer (3)**

Natural and turbulent convective heat transfer, The effect of fluid properties on convective heat transfer, high speed turbulent heat transfer, Radiative heat transfer phenomena in an absorptive and transparent media, Analysis of complex heat transfer.

· **Cooling of Electronics (3)**

The state of art on cooling technologies of electronic equipments are studied to pursue the compact systems. Innovative design method on cooling system of electronics is also carried out to solve practical problems.

· **Advanced Mass Transfer (3)**

Transport phenomena due to the concentration difference, property characteristics such as viscosities and diffusion coefficients: turbulent transport: molecular dynamics: heat and mass coupled transport phenomena, special problems.

· **Applied Air Conditioning (3)**

Calculation of air conditioning loads, system design, behavior of components, special problems related to air conditioning.

· **Applied Refrigeration (3)**

Analysis of various refrigeration cycles, design of the whole system and components, special problems related to refrigeration.

· **Ventilation and Air Cleaning (3)**

Theories and practices of ventilation and air cleaning, modeling and measurements of airflow and pollution concentrations, system design of ventilation and air cleaning devices to provide comfortable indoor space.

· **Cryogenic Engineering (3)**

Design and fabrication of cryogenic coolers to obtain the temperature range below -150℃ is studied. Various applications of cryogenic technology to medical, transportations, telecommunications, and industrial process are also dealt with in this course.

· **Thermal Transport in Materials Processing (3)**

Thermal transport encountered in the materials processing, such as casting, continuous casting, extrusion, molding, and heat treatment process, is studied. Design of thermal processing is carried out for the effective operation.

· **Advanced Heat Power (3)**

Advanced topics in performance characterization, analysis, design, and control of

heat power systems and their components.

· **Advanced Combustion (3)**

Advanced topics in combustion engineering including analysis, design, and optimization of various combustion processes based on gaseous, liquid, and solid fuels.

· **Advanced Design of Thermal Equipments (3)**

Modeling of thermal equipments including heat exchangers, turbo machinery, piping and duct systems, simulations and design optimization of thermal systems, economic considerations.

· **Optimal Control (3)**

Study optimal control theories based on linear control theories. Emphasize practical applications of control theories to read systems. Include topics for the dynamic programming, the Pontryagin minimum principle, and optimal control design methods.

· **Application of Advanced Control Engineering (3)**

Study adaptive control theories. Emphasize practical applications of control theories to real systems. Include topics for self-tuning regulators and model? reference adaptive controllers.

· **Process Control (3)**

Study the process control of mechanical systems. Emphasize closed-loop system dynamics and design methods for multi-variable processes. Include topics for the control valve sizing and the control system structure design.

· **Special Studies on Mechanical Engineering (3)**

Methods of modeling and analysis of specific thermofluid systems.

· **Seminar in Mechanical Engineering (3)**

Studies of thermofluid systems to survey the current trend of research and development on them.

· **Multi-phase Flow (3)**

This course covers the current status in estimating the important engineering parameters and physical phenomena in multi-phase flow to cases where more than two phases are present. Adiabatic two-phase flow is not only concerned in this course, but convective boiling and condensation, which is great importance of heat and mass transfer between phases, is also lectured. This course focuses on two-phase flow notation and flow patterns, the basic governing equations of two-phase flow, empirical treatment of two-phase flow, pool and convective boiling, subcooled and saturated boiling heat transfer, critical heat flux, condensation, etc.

· **International Cooperation Seminar (3)**

This course is intended to introduce the importance of international cooperation in education and research activities especially in the field of energy engineering. Students will acquire the understanding on ODA (official development assistance) and the basic ability to participate in international activities. This course is composed of various types of joint seminar, such as online remote lectures from foreign countries and off-line seminar by invited speakers.

· **Smart Convergence Technology (3)**

This subject introduces information technology (IT) for energy engineering including the heating and cooling systems to maximize the efficiency with minimum cost. The subject also introduces new technologies such as biotechnology(BT) and nanotechnology (NT), which are aapplied to core elements of energy systems.

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Dept. of Mechanical Systems Engineering

Mechanical system technology fosters the comprehensive ability to fuse the whole and part into one, providing the core principle of all high-tech development and the development of high-tech industries. Thus, the development of machine system technology is a prerequisite for the development of high-tech and high-tech industries. Automobile production, robot industry, and semiconductor production are all huge mechanical systems and are driven by mechanical system technology. Therefore, this department focuses on the development and design of materials mechanics, computer mechanics, and parts materials in basic mechanical engineering, as well as on the areas of computer-related design and production, as well as on theories and applications related to the fourth industrial technology micro/nano systems, robotics, bio systems, smart factory, information technology, etc.

□ Major Courses

· Continuum Mechanics (3)

This course is intended to provide the entering graduate students with the basic concepts of vector and tensors and the analysis of stresses and deformation at a point in a continuous medium, followed by the derivations and applications of fundamental equations of a continuous medium based on the laws of conservation of mass, linear momentum, moment of momentum, and those of thermodynamics: constitutive relations for fluids and solids. Specialization of the field equations to some boundary value problems in solid and fluid mechanics are also addressed.

· Advanced Numerical Analysis (3)

This course is designed to acquaint entering graduate students with the fundamental theory of numerical analysis that is essential in solving variety of engineering problems of practical interest. In addition to a series of lectures on the solution of systems of linear equations based on direct methods, error analysis, structured matrices, and iterative methods, the students are further introduced to the numerical solution of ordinary and partial differential equations subjected to certain boundary and initial conditions. Stability and convergence of the numerical solutions are also addressed.

· Advanced Finite Element Method (3)

This course deals with the finite element formulations such as direct stiffness method, potential energy method, Galerkin's weighted residual method, and virtual work approach. It also introduces an isoparametric formulation with proper numerical integration rules. This course will offer the students experience in solving the boundary value problems related to solid mechanics with the educational

version of finite element package. Especially, emphasis is placed on the modeling of physical problem and the interpretation of its FE solutions.

· **Bio-Engineering (3)**

This course gives an introduction to the biomechanics and their applications in bio-mechanical engineering. It deals with design concept of biomechanical system based on material science, fluid mechanics, and solid mechanics. Main topics are biofluid mechanics such as lubrication of human synovial joints, cardiac boidynamics and mechanics of heart valves as well as biosolid mechanics such as mechanics of hard tissue, mechanics of joint articulating surface motion and contact mechanics.

· **Advanced Composite Materials (3)**

Composites are widely used in airplanes, and automobiles. This course presents the mechanics and material aspects of deformation, stress analysis, and fracture of man-made composites as well as natural, and biological composites. Topics may include basic modeling, experimental methods, and computational techniques.

· **Advanced Machine Design (3)**

The advanced topics in the field of machine design are studied: fracture theory for ductile and brittle material: design and application of beams: analysis for special springs: tribology: analysis for brake system: design and analysis for gear trains: introduction to robust engineering: and machine balancing design. The participants should research on an application as the final term project and present their results in the end of semester.

· **Topics in Mechanical Design (3)**

This course deals with problems and solutions on deformations and failures of various mechanical and automotive components. The approach emphasizes selection of materials to help with designing mechanical structures. Degradation of materials, fatigue failure by poor design, stress concentration in mechanical design and their solutions are described in this course.

· **Optimal Design (3)**

The optimization theory and practice as it applies to engineering design is studied. Topics include monotonicity analysis, numerical methods in continuous design spaces and techniques for discrete optimization, through the analytical and computer-based assignments and design exercises.

· **Intelligent CAD (3)**

Both the existing and new CAD theories are covered, together with the fundamentals and implementations of the intelligent CAD system so that the latest information technologies such as artificial intelligence, virtual reality applications, and the collaborative design theories are addressed.

· **Fatigue and Fracture (3)**

Composites are widely used in airplanes, and automobiles. This course presents the mechanics and material aspects of deformation, stress analysis, and fracture of man-made composites as well as natural, and biological composites. Topics may include basic modeling, experimental methods, and computational techniques.

· **Plasticity and Forming Process (3)**

This course introduces the stress and strain tensor appropriate for the analysis of large plastic deformation. This course focuses on the physical meaning of yielding, which consists of yield conditions, flow rule, and post yielding behaviour of hardening, together with its mathematical representation or constitutive equations for plastic deformation. The student will complete the term project design of actual forming processes such as rolling, forging or sheet forming.

· **Topics in Manufacturing Technology (3)**

Advanced study on the aspects of manufacturing and production technologies in a competitive environment is performed. Topics include the manufacturing processes, facilities, and systems and operation technology. Seminars involving case studies should be presented by the students.

· **Advanced Engineering Mathematics (3)**

This course covers the methodologies for solving mathematical problems which are encountered in mechanical design processes. The various practical solutions are suggested for engineering applications, i.e., boundary value problems: partial differential equations: complex integration: calculus of variations in the fields of fracture mechanics: elasticity: finite element method: and manufacturing.

· **Advanced Dynamics (3)**

This course covers rigid body kinematics/kinetics, Lagrange equation, Euler equation, Hamilton Jacobi equation, gyroscopic motion, stability analysis of autonomous and non-autonomous system, and nonlinear system analysis.

· **Nano-engineering (3)**

This course describes a guide to nanotechnologies basing on nanometer scale and nano-applications in modern engineering, together with bottom-up and top-down nanofabrication technology being addressed. History and future of nanotechnology, nanoparticles, nanocoatings, micro and nano mechanics, lithography technology for semiconductor device and nanocharacterization are main topics.

· **Advanced Micro-Electro-Mechanical System (3)**

Nano/micro fabrication and equipments for sensor, actuator, energy harvesting device, optical/display device and functional surface applications are introduced. Topics include not only basic semiconductor fabrication process such as optical lithography, deposition, and etching, but also state of art fabrication process such as ink jet, imprint, roll-to-roll, etc.

· **Robotic Mechanism Design (3)**

The lecture 'Robot Mechanism Design' covers two main topics: (1) mathematical theories to derive equations of motion of the robot mechanisms; (2) the modeling methodologies in designing the robot mechanism. The mathematical theories include the POE method, Jacobian and dynamic analysis, which is essential to derive Newtonian and Lagrangian mechanics of the robots. In addition, basic control theories, kinematic modeling of mechanism, and practice of a conventional multibody dynamics program are introduced. The term project about the robot mechanism design will be assigned for the students as a final evaluation.

· **Advanced Production Technology (3)**

The concept and the state of the art of advanced production technology is addressed with emphasis on H/W (CNC machine tools, industrial robot, automated guided vehicle, automatic storage and retrieval system, FMS, CIM) and S/W tools (CAD, CAM, CAPP).

· **Nano Convergence Mechanical Technology (3)**

Related to energy issues such as production, efficiency enhancement, and savement, nano convergence mechanical technology is introduced, which covers design, fabrication, and applications.

· **Dynamic System Design (3)**

This course deals with a design process about dynamic systems which have kinematic chains. The kinematic and dynamic analysis of the mechanism systems are studied on and the function modeling of the mechanism systems is considered with concept of the model-based design. The modeling methodologies about the classical control and digital control are also researched on with the Simulink S/W in this course.

· **Micro-Processor (3)**

In this lecture, students understand a microprocessor and its principle. Using microprocessors, students learn ability to operate and control robotics systems.

· **Linear System (3)**

A linear system is a mathematic model of system based on linear algebra. It is useful for system control and analysis. Through linear system, students learn fundamental knowledge for system analysis.

· **Robot Control (3)**

By increasing the interesting and research for robots, 'Robot Control' deals with advanced control theories and control experiments.

· **Rotordynamics (3)**

Recently, household electric appliances, automobiles, aircraft, factory facilities, and plants are improving the power output and efficiency by applying high-speed rotating equipments. Therefore, in this course, we study the designs of rotating shaft, bearing, seal, and damper supporting the shaft system for the improvement of dynamic stability and reduction of power loss of high power rotating machinery and introduce design and test cases.

· **Machinery Vibration Diagnostics (3)**

Failure to diagnose the health condition of the machine results in major damage to the main part, disruption of operations, and enormous economic losses. Therefore, for vibration-based condition diagnosis of automation machine, plant, and power plant facilities, we learn about signal processing, condition monitoring, fault analysis, facility knowledge, test evaluation method based on vibration theory and introduce diagnosis cases.

· **Structural analysis and Design (3)**

This course covers topics in deformation and stress analysis in terms of structural safety. Discussed in the class are theoretical backgrounds, as well as design software tools.

· **Sensor System Engineering (3)**

Sensor System Engineering (MS and Ph.D course): This course introduces the structure and operation principle of various sensor devices, sensor modules and sensor systems based on physics, chemistry, biotechnology, optics, etc. and application to industrial fields such as automobile, home appliances, biomedical, sports, etc.

· **Applied Finite Element Method (3)**

This course deals with the finite element formulations for the nonlinear, thermo-mechanical problems. Formulations include both explicit and implicit method to satisfy equilibrium of a body. Newton type approaches for nonlinear problem together complicated integration rules are also introduced. This course will offer the students experience in solving the boundary value problems related to nonlinear thermo mechanical stress analysis.

· **Applied Machine Design (3)**

This course covers the theory of the practical machine design applications such as: design for strength and rigidity under both static and dynamic loads: design for the strength under Fatigue: shaft design with joints: lubrication and bearing design: finite element analysis: optimization and statistical consideration in design process. The participants should research on the application as the final term project and present their results at the end of semester.

· **Topics in Applied Mechanical Design (3)**

This course deals with subjects on the progress of advanced engineering techniques in the various fields of design, mechanics, materials, fracture, etc.

· **Applied CAD (3)**

This course introduces the latest technologies related the design process methods and evolutionary methods in actual designing. Reviews are made over the recent researches related to the design and manufacturing systems, by surveying the recent papers. Students will be evaluated by the oral presentation regarding the related fields.

· **Thesis Study 1 (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.

· **Thesis Study 2 (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.

· **Fundamental and Applications of Laser (3)**

The basic knowledge on the principles and properties of laser is acquired, and the application studies the fine processing method using the physical-chemical reaction of laser and material, and the precision measurement method using optical interference, scattering, Moire, etc

· **Design of Precision Machine System (3)**

The design methods of driving equipment, structure, actuator, guide, control, system integration, etc., which are key factors in the development of precision machine system, are studied and based on these, the mechanical systems for actual precision processing or precision measurement are designed and studied.

· **Nontraditional Manufacturing (3)**

The principles, processing characteristics and application cases of material removal processes such as discharge machining, laser processing, composite machining, etc. and material attachment processes such as 3D printing are studied, and the principles and design methods are also studied for recent micro/nano processing and manufacturing methods.

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Dept. of Civil & Environmental Engineering

Civil and Environmental Engineering serves the basic needs of society through construction and maintenance of the public works and infrastructure, and pursues harmony with nature. Civil engineers are involved in planning, designing, researching, constructing, managing, and maintaining infrastructure systems such as bridges, highways, subways, airports, tunnels, seaports, water supply and reclamation networks, power generation and distribution facilities, industrial facilities, transportation, and various environmental and sanitary facilities.

Each project has unique characteristics that challenge civil engineers to apply their knowledge with initiative and creativity to protect society, and meet the construction and operating budgets. These complex goals require not only knowledge of engineering, but also knowledge of the social, economic, and managerial sciences and collaboration with experts in these areas. The field of Civil Engineering has expanded lately into biotechnology for environmental restoration and into materials for construction and other uses. The types of projects in which Civil and Environmental Engineers are involved vary widely, but they are all broadly based on a system of shared knowledge and scientific principles of mechanics, systems analysis, mathematical tools, properties of materials, engineering design principles that ensure safety, reliability, and economy.

Research that seeks to improve projects and systems as well as engineers' capabilities is an important activity in the department of Civil and Environmental Engineering at Kookmin University. Our department is nationally recognized for its leadership in research and education. Our faculty are known nationally for their strong research activities, supported by extensive external funding. Our programs give graduate students a solid foundation to begin careers in professional practice and research.

❑ **Structural Engineering major**

The structural engineering program of the Department of Civil and Environmental Engineering, in Kookmin University, offers excellent opportunities for study and research leading to advanced degrees in the areas of structural analysis and design, mechanics of structures, and materials in structures and construction. The active involvement of our faculty in many research projects and in the solution of challenging real world engineering problems results in an instructional program that is up-to-date and relevant. Graduates from our program have gone on to become leaders in private practice, government service, education, and research.

❑ **Geotechnical Engineering Major**

Geotechnical engineering merges geotechnics, geophysics, geomechanics, and geology and focuses on the behavior of natural materials in engineered systems. The

geotechnical engineering program at Kookmin University encompasses both traditional and emerging topics in the field, including advanced techniques for site and material characterization; constitutive and micromechanical modeling; natural and man-made hazard mitigation; engineered soils; and foundation design, slope stability, and excavation support.

❑ **Hydraulic Engineering Major**

Hydraulic Engineering major deals with water related problems in civil engineering. This field of study can provide hydraulic or hydrologic data for hydraulic structures, such as pier, levee, bank, breakwater, harbor, dam, reservoir, floodplain, etc. Hydraulic structures protect us against water related natural disaster, like flood, drought, tsunami, etc. The courses in hydraulic engineering major are fluid mechanics, hydraulics(I and II), hydrology, coastal engineering, port engineering, water resources engineering, etc.

❑ **Environmental Engineering Major**

Environmental Engineering aims to protect nature and humans from artificial pollutants while preserving the ecosystem. It is a study for ensuring health, safety, and well-being of human life by improving and preserving quality of our surrounding environment. This major will cover water pollution, water environment system solid waste & water pollution treatment, waste resources, advanced water and wastewater treatment, seawater desalination, wastewater reuse, and environmental analysis.

☐ **Courses**

❑ **Core Courses**

· **Advanced Numerical Methods for Engineering (3)**

Introduction to computer programming with the emphasis on numerical techniques as applied to engineering problems. Development of mathematical models and computer programs using a compiled language (FORTRAN). Formulation and solution of initial and boundary value problems with emphasis on structural analysis, fluid flow, and transport of contaminants.

· **Fundamentals of Finite Element Method (3)**

Basic knowledge of finite element method and FEM theories based on energy principles will be studied. Basic development of element model, programming, and examples will be treated.

· **Theory of structural reliability (3)**

Review the probability theories, study analytical and numerical methods for reliability analysis, and apply them for civil engineering problems.

· **Digital signal processing in civil engineering (3)**

The fundamental theories and applications of digital signal processing on civil engineering will be covered. Civil engineering signals and systems. Discrete time and frequency domain operations. Inverse problems. Matrix-based and other solutions. Tomography. Civil engineering examples.

· **CAD in civil engineering (3)**

Learn how to draw 2D and 3D digital plans for design and finite element analysis in civil engineering field, and apply drawing techniques to real in-depth civil projects.

· **Safe construction technology (3)**

The construction techniques to mitigate the natural hazards such as earthquake, typhoon and inundation will be reviewed. The scientific/engineering principles of those techniques will also be covered.

· **Esthetic Aspects of Civil Structures (3)**

Study shape, color, texture, proportion, balance, harmony, characteristics of formation, design concept of civil structures, and investigate on relation between structure shape and mechanical safety.

· **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.

❑ **Structural Engineering Major Courses**

· **Advanced Structural Mechanics (3)**

Structural analysis using energy principles, stiffness method, flexibility method, analysis of special structures, torsional and bending theory for thin-walled members, and fracture theories will be learned.

· **Advanced Construction Materials (3)**

Hydration of cement, concrete mixture design, curing of concrete, construction, special concrete, concrete durability, various experimental methods, mechanical properties of fresh and hardened concrete are studied.

· **Advanced Design of Concrete Structures (3)**

Advanced analysis method including strut-tie method will be studied. Various characteristics of concrete including time dependent behavior, durability, strain-softening, experimental techniques, inelastic and plastic analysis, and fracture mechanics will also be covered.

· **Advanced Steel Structure Design (3)**

General torsion of thin-walled open, closed, and combined open and closed sections: general instability of thin-walled members: consideration of residual stress: fatigue strength.

· **Experimental Stress Analysis (3)**

State of stress, stress-strain relationship, strain measurement, strain gages, strain gage circuits, analysis of strain gage data, basic optics, theory of photoelasticity, and Moire method will be studied.

· **Advanced Bridge Engineering (3)**

Design load for bridges: analysis and design of late girder, box girder bridges, truss bridge, arch bridge: behavior of cable supported bridges: construction method such as FCM, ILM, etc.

· **Theory of Elasticity (3)**

Selected problems of stress and strain in rectangular and polar coordinates. Failure theorem. Torsion and bending of bars.

· **Dynamics of Structures (3)**

Inertia force, damping force and restoring force in structures subjected to dynamic loads are introduced. Single- and multi-degree of freedom systems subjected to dynamic loading will be analyzed.

· **Finite Element Analysis (3)**

Development of finite elements for plate, shell, rigid body motion will be studied. Galerkin method, dynamic analysis using FEM, and nonlinear analysis will be studied.

· **Fracture Mechanics (3)**

Fracture behavior in solids, linear elastic fracture mechanics: stress analysis of cracks: generalization of fracture criteria: fracture toughness testing: fatigue analysis and fracture control plan.

· **Advanced Composite Structures (3)**

Classification and characterization of composite materials. Behavior in the elastic range. Stress strain relations for anisotropic media. Orthotropic laminae. Plane problems. Theory of anisotropic plates. Bending, buckling and vibrations of laminated plates.

· **Advanced Prestressed Concrete Design (3)**

Fundamental principles of prestressed concrete analysis, prestress losses, flexural analysis, flexural design, shear and torsion, composite beams, continuous beams, and various applications of PSC will be studied.

· **Stability of Structures (3)**

Elastic and inelastic buckling of column and thin-walled members: lateral torsional buckling: stability problem of plate and shell including post buckling strength: Approximate and numerical methods of solution.

· **Theory of Plates and Shells (3)**

Plates and slabs loaded transversely in their plane. Buckling and post buckling behavior of elastic and inelastic plates. Membrane and bending analysis of cylindrical, rotational, hyperbolic shells.

· **Special Topics in Structural Mechanics (3)**

Special topics in structural mechanics issues will be studied.

· **Special Topics in Structural Engineering (3)**

Special topics in structural engineering issues will be studied.

· **Cold-Formed Steel Structure Design (3)**

Analysis and design for the composite panels consist of cold formed steel wall studs with wallboard are introduced. Typical failure mode estimation due to global and local bucklings according to specific design manual are also included.

· **Non-destructive analysis (3)**

Ultrasonic methods of inspection, acoustic methods of inspection, visual methods of inspection, vibration methods and modal analysis, application of NDE inspection in Engineering problems will be studied.

· **Seismic Design (3)**

Basic concepts in seismic design are studied and applied for simple structures.

❑ **Geotechnical Engineering Major Courses**

· **Advanced Geotechnical Engineering (3)**

Application of geotechnical theories and principles in construction engineering practice. Introduction to tho following topics in practice: Slope stability, retaining

structures, shallow and deep foundations, soil improvement, and so on

· **Advanced Soil Mechanics (3)**

Identification and evaluation of physical, chemical and mechanical properties affecting the engineering behavior of geomaterials.

· **Advanced Foundation Engineering (3)**

Soil exploration, sampling, and in-situ testing techniques. Bearing capacity, stress distribution, and settlement. Design of shallow and deep foundations.

· **Subsoil Exploration (3)**

Field and laboratory testing and sampling of geomaterials, primarily soils and rocks. Methods of drilling, probing, and in-situ measurements to determine stratigraphy and engineering parameters for analysis.

· **Numerical Mehthods in Geotechnical Engineering (3)**

Numerical methods and techniques to resolve geotechnical engineering problems using computer softwares with emphasis on various geotechnical engineering examples.

· **Seepage through Soil (3)**

Theory of water transportation through soils. Application of seepage theory to practical civil engineering problems. Introduction to embankment and dam engineering.

· **Soil Behavior (3)**

Mechanical response of soils with respect to the various stress states e.g. geostatic loading and stress history issues. Evaluation of stress-strain relationships, undrained drained shear strength, compressibility and hydraulic conductivity of soils using laboratory and field testing methods.

· **Soil Improvement (3)**

Introduction to various soil improvement by using enforced drainage, dynamic compaction, grouting, explosion compaction, etc. Case studies of soil improvement.

· **Soil Dynamics (3)**

Principles of dynamics. Soil behavior under monotonic dynamic loading conditions. Foundation design for vibratory loadings. Introduction to earthquake engineering. Design of embankments and retaining structures under earthquake.

· **Dam Engineering (3)**

Principles of analysis and design for earth and rockfill dam structures. Construction materials, construction methods, internal and external stability, seepage and drainage, performance monitoring, abutment and foundation design.

· **Advanced Retaining Structure Analysis (3)**

Earth pressure theories. Design of rigid, flexible, braced, tied back, slurry, and reinforced walls. Stability of excavation, cut, and natural slopes.

· **Rock Mechanics (3)**

Geological and engineering classifications of intact rock, discontinuities, and rock masses. Laboratory and field evaluation of rock properties. Design of foundations on, and openings in rock masses. Analysis of rock slope stability.

· **Excavation Engineering (3)**

Introduction to excavation methods. Equipments for excavation. Stability and safety analysis of excavated faces. Support systems for excavation.

· **Special Topics in Soil Mechanics (3)**

Special research topics related to soil mechanics are selected by the students with the advice of the faculty members in charge and are pursued either independently or in conjunction with others.

· **Special Topics in Foundation Engineering (3)**

Special research topics related to foundation engineering are selected by the students with the advice of the faculty members in charge and are pursued either independently or in conjunction with others.

· **Soils and Waves (3)**

Characterization of materials with mechanical and electromagnetic waves. Emphasis on particulates with extensions to other materials. Laboratory and field applications.

❑ **Hydraulic Engineering Major Courses**

· **Flow in Open Channel (3)**

Energy and momentum principles in open channel flow: uniform flow: gradually varied flow: rapidly varied flow: unsteady flow: flood routing.

· **Advanced Mechanics of Fluids (3)**

Basic concepts and definitions: pressure distribution in a fluid: governing equations and boundary conditions: integral and differential analysis: dimensional analysis and similarity: experimental analysis: laminar and turbulent internal and external flows: potential flows: engineering applications.

· **Computational Hydraulics (3)**

General review of numerical methods: one dimensional unsteady flow: quasi two

dimensional unsteady flow: unsteady dispersion in rivers: water and sediment routing in rivers: calibration.

· **Advanced Hydrology (3)**

Hydrologic cycle, processes, observations: flood flows, hydrologic design using statistical methods.

· **Hydrodynamics (3)**

Hydraulics of pressure conduits and open channels, dimensional analysis, flow measurements, hydraulic machinery, with laboratory.

· **Coastal Hydrodynamics (3)**

Waves, tides, harbor oscillations: coastal structures, estuary dynamics, salinity intrusion, sediment transportation in estuaries: beach processes and evolution.

· **Water Resources System (3)**

Planning and economics of water resources projects: stochastic basis of design: flood control: river navigation works: hydraulic machinery: hydroelectric power systems: classification, functions of hydraulic structures: hydraulic design of spillways, energy dissipators, gates, outlet works: design of canal, other water conveyance structures: design of municipal and industrial outfall structures.

· **Stochastic Hydrology (3)**

Common probabilistic models used in hydrology, hydraulics, and water resources: derived distributions: multivariate model sand estimation of model parameters: analysis of data and model building: uncertainty analysis.

· **Mechanics of Sediment Transport (3)**

Laws governing fall velocity, applications to particle size analysis: incipient motion, bed forms, bed load, suspended load, natural river processes: theory and practive of movable bed model experiments.

· **Porous Media Hydrodynamics (3)**

Governing equations of groundwater flow through porous media: interaction of surface and groundwater flows: groundwater contaminant transport: numerical methods, parameter estimation applications to groundwater models: hydraulics of wells: seepage analysis, land drainage systems.

· **Hydraulic Analysis of Unsteady flow (3)**

Unsteady flow in closed conduits: method of characteristics: transients caused by centrifugal pumps: transients in power plants: resonance: transient cavitation: surge tanks: transients in open channels.

· **Hydraulic Modeling (3)**

Review of theory: importance of experiments: modeling and scaling laws: experimental environment and facilities: measurements at full scale and on scaled models: use of wind and water tunnels, towing tanks, hydraulic flumes: instruments for measuring pressure, temperature, velocity, turbulence: error analysis: data acquisition and processing: laboratory demonstrations, hands on experiments, project.

· **Mixing in Water (3)**

Review of classical diffusion theories: longitudinal dispersion, transverse and vertical mixing in free surface turbulent shear flow: application to natural channels: selected topics including stream tube models, mixing and dispersion of heated effluents.

· **Special Topics in Coastal Engineering (3)**

Presentation and discussion of selected topics relating to coastal engineering. A wider range of matter and method permissible.

· **Special Topics in Hydraulic Engineering (3)**

Presentation and discussion of selected topics relating to hydraulic engineering. A wider range of matter and method permissible.

❑ **Environmental Engineering Major Courses**

· **Advanced Water Supply Engineering (3)**

This course covers design water treatment processes including conventional and advanced treatment processes through basic principles and experiments.

· **Advanced Wastewater Treatment Engineering (3)**

Process design of wastewater treatment plants, including primary, secondary and advanced treatment through understanding wastewater treatment principles and experiments.

· **Advanced water pollution (3)**

Topics include the cause and damage of water pollution, the control techniques of water quality through theoretical and experimental practice.

· **Water supply network design (3)**

Topics include various tools for the analysis of water supply networks, optimum design and autocad of water supply networks.

· **Sewage system design (3)**

Topics include optimum design and drawing of sewer system using computer

simulation.

· **Industrial Wastewater Treatment (3)**

Topics include fundamentals of chemical, physical, and biological unit processes, and application of the processes for the wastewater treatment.

· **Solid Waste Treatment and Disposal (3)**

Topics include techniques of collection, transport, and treatment of solid waste. It also covers final treatment processes such as incineration, landfill, and resource recovery, and associated groundwater pollution and site remediation.

· **Environmental Impact Assessment (3)**

Topics of legislative requirement, environmental effect, impact prediction and assessment methodologies to be included in project planning and construction.

· **Special Topics in Pollution (3)**

The course discusses the environmental and sanitary issues, especially water and wastewater systems in a seminar format.

· **Special Topics in Environment (3)**

The course discusses the environmental and sanitary issues, especially water, air, and solid waste treatment in a seminar format.

· **Water purification facility design (3)**

Fundamental principles in constructing water purification systems. Major topics include the planning and management of water resources and integrated designs of municipal water treatment plants and sludge discharge facilities including water distribution system, and pumping stations. Practical design exercises are provided.

· **Wastewater treatment facility design (3)**

Design and theoretical understanding of environmental processes in wastewater treatment; mainly physical and chemical processes, and reactor configurations commonly used for effluent quality control; applications to the design of specific wastewater treatment plant operations.

· **Conservation of aquatic environment (3)**

This course will cover the progress of understanding environmental problem in rivers, lakes and reservoirs. The subject matter includes effects on nature and ecosystems from human activities.

· **Industrial Waste Water Treatment plant design (3)**

This course will examine industrial wastewater sources and characteristics, significance of industrial wastewater as environmental pollutants and application. It also cover various unit processes of physical, chemical and biochemical treatment in industrial wastewater treatment plants.

· **Solid waste treatment plant design (3)**

The course will cover theory, planning, and application of sources and characteristics of municipal solid waste, physical/chemical composition, storage, collection, transportation, and treatment and disposal procedure.

· **Special topics in water pollution (3)**

This course will cover the principles of and ecosystem and water system in rivers, lakes and reservoirs. Special topic in water pollution and specific treatment process will be discussed.

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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 27 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 Energy ICT Convergence 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.

❑ **Energy ICT Convergence 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.

· **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 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 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 thedesigend 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.

· **Modern Sensor Technique (3)**

This course aims to provide knowledge of sensor technology. Describe the basic principles, application examples, and the latest trends. Specifically, this course provides an overview of sensor technology, characterization, physical principles, design and detailed description of analytic methods.

❑ **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.

· **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 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.

· **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.

· **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.

· **Optimal design and operation of microgrid (3)**

In this class, students will learn about the control and operation techniques of microgrid that is composed of renewable energy resources and energy storage system, and learn about optimal design techniques considering the characteristics of target systems such as university campus, hospital, intelligent building and so on. This class will also cover the structure and functions of microgrid energy management system (EMS) based on power system stability analysis and economic dispatch techniques.

❑ **Energy ICT Convergence 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.

· **Special 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.

· **Analysis and Optimization of Energy Networks (3)**

The basic theory of queuing and traffic analysis will be taught to theoretically

analyze the energy systems and networks. The main algorithms for convex optimization, dynamic optimization, and optimal control are introduced through examples of power systems and energy networks.

· **Energy Information and Communication Technology (3)**

This course introduces convergence technologies for integrated management and operation of distributed energy for improving energy supply/demand/delivery efficiency and reliability. This course also introduces the technologies of ICT-related SW, platforms, wired/wireless communications, and devices which are gradually advanced in the Internet of Energy (IoE) era.

· **Energy Intelligence Systems (3)**

The energy big data platform consists of energy convergence-based service agent, energy data mining, and energy information retrieval systems. In this course, important concepts of intelligent systems such as knowledge representation, navigation, reasoning, machine learning, planning, neural network, fuzzy theory, and knowledge for building intelligent web-based systems will be implemented using SW.

· **New and Renewable Energy Systems (3)**

This course will cover the operating principle of distributed power source using renewable energy such as sunlight, and wind power. We will model the renewable energy sources and define the output prediction model considering uncertainty such as solar radiation and wind speed. This course will deal with the power grid connection process and equivalent circuit modeling process of new and renewable energy sources as well as we will learn control system accordingly. In addition, we will discuss the latest control techniques and energy management system design.

· **Energy Systems Design (3)**

This course will introduce the modeling and simulation techniques for the design of energy systems including solar power, wind power, heat exchangers, freezers, power systems, and thermal process systems. This course will deal with theories and design of new devices such as energy system optimization, economic analysis, and high-density heat transfer equipment.

· **Energy Business Model (3)**

After analyzing energy technology trends, it will deal with energy business models about energy-based new industries in the electric power market. This course regarding business models introduces Energy of Things (EoT), Energy Storage System (ESS), Micro Grid, Virtual Power Plant (VPP), Zero Energy Building, Vehicle-to-Grid (V2G), and Smart City.

· **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.

· **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.

· **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.

· **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.

· **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.

· **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.

· **ICT Convergence Practice I-1 (1)**

As a Fundmental Practice - I course, ICT convergence knowledge such as information system design and implementation technology, network system analysis and optimization technology, and intelligent management and operation technology are applied to the working environment.

· **ICT Convergence Practice I-2 (2)**

As a Intermediated Practice - I course, the company acquires how to define requirements of ICT convergence industry and the basic theory of field practice, and selects solutions that are necessary for working-level target businesses.

· **ICT Convergence Practice I-3 (3)**

As a Advanced Practice - I course, the entire process of planning, detailed design, development environment construction, development implementation, unit testing, interlock testing, comprehensive testing, interpretation, and evaluation of target solutions is carried out. Practical advanced courses provides opportunities for career exploration and improvement of practical skills.

· **ICT Convergence Practice II-1 (1)**

As a Fundmental Practice - I course, ICT convergence knowledge such as information system design and implementation technology, network system analysis and optimization technology, and intelligent management and operation technology are applied to the working environment.

· **ICT Convergence Practice II-2 (2)**

As a Intermediated Practice - I course, the company acquires how to define requirements of ICT convergence industry and the basic theory of field practice, and selects solutions that are necessary for working-level target businesses.

· **ICT Convergence Practice II-3 (3)**

As a Advanced Practice - I course, the entire process of planning, detailed design, development environment construction, development implementation, unit testing, interlock testing, comprehensive testing, interpretation, and evaluation of target solutions is carried out. Practical advanced courses provides opportunities for career exploration and improvement of practical skills.

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Dept. of Computer Science

Widespread use of computers coupled with fast computer communication technology brought rapidly growing social demand for information processing technology and for its applications. Department of Computer Science provides good quality of education in both computer hardware and software as a means of information processing system.

Department of Computer Science offers core courses that teach fundamental knowledge of computer science. On top of these courses, our department teaches system softwares such as database system, operating system, compilers, and computer network, and also put emphasis on practical training. There are list of courses offered to keep up with real world challenges and dynamically-evolving research trends: Computer Graphics, Multimedia System, Embedded System, Mobile Computing, Wireless Network, and E-Commerce. We also invite professionals from industry, research lab and other universities to our weekly colloquium on variety of research subject, and our colloquium is renowned for its quality contents. The students appreciate it as a good opportunity to balance theory and practice.

The faculty is highly devoted to educating and to advising students to write their thesis in high quality, and as a result, the masters and Ph.D.s trained in our department are internationally competent and recognized.

In these times when the use of computers is universal and the communication technology enhances rapidly, the society demands highly qualified IT personnel's to lead the society. Our mission is to educate students and to provide well-equipped computer professionals to the society in order to meet such need. For that purpose, department of Computer Science trains the students to have a deep understanding of fundamental knowledge in computer science. Based on such knowledge, the students are also trained to have design, development and analysis techniques in broad applications such as computer graphics, parallel and distributed computing, artificial intelligence, image processing, multimedia and computer networks.

Students majoring in computer science acquire fundamental knowledge in computer software and hardware in core courses.

Among those core courses are image processing, artificial intelligence, natural language processing, computer architecture, embedded system, operating systems, computer vision, pattern recognition, wireless network, parallel processing, and object-oriented system.

Ten research laboratories actively perform research and development projects funded by governmental agencies or industry. Knowledge acquired in course materials is exercised in the real-world applications, performing those research projects.

☐ **Courses**

❑ **Core Courses**

· **Advanced Analysis of Algorithms (3)**

An introduction to the design of algorithms. The emphasis is on learning techniques for creating algorithms, analyzing them, and proving their correctness. Topics include models of computation, asymptotic notation for analysis of algorithms, sorting and searching algorithms, design techniques such as divide-and-conquer and dynamic programming, graph algorithms including spanning tree, shortest paths. Additional topics chosen from pattern matching, NP-hard, and NP-complete.

· **Advanced Operating Systems (3)**

Introduction to the design and analysis of operating systems. Topics include processes, mutual exclusion, synchronization, semaphores, monitors, deadlock prevention and detection, memory management, virtual memory, processor scheduling, disk management, file systems, security, protection, distributed systems. Students will present and discuss with hot issued topics.

· **Advanced Database Systems (3)**

Introduction to advanced database systems from a perspective of implementation. Topics include query processing, transaction management, concurrency control techniques, database recovery, database security and authorization, and how these concepts are implemented in real systems.

· **Advanced Artificial Intelligence (3)**

An introduction to basic concepts in artificial intelligence from a computer science perspective. We learn how to find innovative solutions to difficult, independently motivated problems, such as search, logic, knowledge representation, rule-based programming, and reasoning with programming applications.

· **Advanced Computer Architecture (3)**

Advanced topics in the architecture and organization of computer systems. Topics include how information is represented in memory, machine-language instructions and how they can be implemented at the digital logic level and microcode level, assembly language programming, input/output operations, and performance issues.

· **Advanced Computer Network (3)**

In this course, special hot issues in the recent research and development of computer network area are studied extensively. The course contents consist of lectures, paper presentation, demo, and term project.

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

The course will provide mathematical foundations and practical techniques for manipulation of digital images: image acquisition, preprocessing, image transforms, image enhancement, image restoration, image coding, edge detection and segmentation, feature extraction, and image analysis.

· **Advanced Distributed Processing Systems (3)**

An introduction to the principles underlying state-of-the-art distributed computing technology. Topics include distributed system models, networking and internet-working, inter process communication, distributed objects and remote invocation, operating system support, security, distributed file systems, name services, time and global states, coordination and agreement, transactions and concurrency control, distributed transactions, replication, distributed multimedia systems, distributed shared memory, CORBA case study and MACH case study issues.

· **Advanced Embedded Systems (3)**

Introduction to advanced imbedded system. Topics include embedded kernels and various device drivers.

· **Modern Network Analysis (3)**

This course covers the architecture and principles of the modern network (Infrastructure networking, mobile communication, mobile network, social network, etc). It also covers the network structures of wireless lan, ad-hoc network, mesh network, and cellular networks. Furthermore many recent technologies such as medium access protocol, network resource management, mobility and location management, and routing protocols. The students will implement modern network simulation programs by using open source programming, then learn the performance comparison, evaluation, and analysis algorithms.

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

This course will provide the graduate students with the writing skill for the master's thesis as well as the research ethics. It will cover the identification of the research problem, problem solving approaches and results, literature survey, and thesis formats. This course will also provide opportunity to become involved in graduate research, under guidance of a supervisor, on a problem of mutual interest to student and supervisor. Regarding the research ethics, the course emphasizes on plagiarism so that the students can follow the research standards.

· **Research Ethics & Ph.D. Thesis (3)**

The purpose of this course is to enable the student to demonstrate the ability to

conduct research and write a scholarly dissertation reporting, evaluating, interpreting, and synthesizing results, and to orally defend a completed dissertation before faculty and peers. The purpose of the dissertation is to produce new knowledge, new materials, or new methods in the student's field of specialization. Furthermore, the student will learn the research ethics. Especially, the course emphasizes on plagiarism so that the students can follow the research standards.

❑ **Computer Science Major Courses**

· **Advanced Software Engineering (3)**

An introduction to the techniques for building large, reliable, maintainable, and understandable software systems. Topics include programming paradigms for real systems, systems programming tools, structured design, software testing, and documentation.

· **Machine Learning (3)**

Topics in machine learning, including artificial neural networks, genetic algorithms, support vector machines, Bayesian network, Markov chain are taught in this course.

· **Advanced Design of Compilers (3)**

Advanced topics in compilation techniques for high level languages. Topics include lexical analysis, grammars, parsing, symbol-table management, type-checking, run-time storage organization, code generation, and optimization. The course involves a substantial project, to develop a compiler for a significant subset of a high-level programming language.

· **Human Computer Interface (3)**

This course provides an overview and introduction to the field of human-computer interaction. It introduces tools, techniques, and sources of information about HCI and provides a systematic approach to design. The course increases awareness of good and bad design through observation of existing technology, and teaches the basic skills of task analysis, and analytic and empirical evaluation methods.

· **Advanced Pattern Recognition (3)**

This course represents an advanced course in pattern recognition. The following topics are covered: statistical pattern recognition (classifiers, optimal classification schemes, feature extraction, learning, applications): syntactic pattern recognition (grammars, grammar inference, applications), neural networks for recognition: non-standard and combined pattern recognition approaches.

· **Advanced Parallel Processing Systems (3)**

Introduction to primitive parallel computing models and programming skills. This course includes small projects those make use of parallel programming libraries, such as MPI, PVM, Linda, Open MP and BSP.

· **Advanced Object Oriented Systems (3)**

An introduction to the principles underlying state-of-the-art object oriented technology. Topics include object-oriented programming language, object-oriented analysis and design, unified process and design patterns issues.

· **Advanced Real Time Systems (3)**

Introduction to basic concept of real time system and applications. Topics include real time kernel, scheduler, and programming model.

· **Advanced Mobile Computing (3)**

The advanced electronic and communication technology invited wireless communication in any handheld component nowadays. Thus, the computing service can be offered at anywhere and anytime, which is named as mobile computing. In this course, we study basic foundation and its application.

· **Advanced Computer Graphics (3)**

This course provides an introduction of advanced topics in computer graphics. We cover the theoretical background and applications of a selected topic among advanced modeling, real-time rendering and animation, non-photorealistic rendering, and imaging.

· **Advanced Web Information Processing (3)**

This course looks at the methods used to search for and discover information in the Web and Web information systems. Methods that are covered include techniques for searching, browsing and filtering information, classification, clustering, filtering, web mining, the use of classification systems and thesaurus, and Web search systems.

· **Advanced Wireless Internet (3)**

Wireless Internet is one of the key research and development area in computer network. There are several platforms working on wireless phone, based on which we develop wireless application software realizing new concepts in pervasive computing. The course consists of lecture and programming practice.

· **Advanced Information Security (3)**

An introduction to the principles underlying advanced information security technology. Topics include classical encryption techniques, modern encryption techniques, conventional encryption algorithms, confidentiality using conventional encryption, public-key cryptography, message authentication and hash functions,

hash and MAC algorithms, digital signatures and authentication protocols, network security and system security issues.

· **Advanced Media (3)**

An introduction to new digital media and related technologies through their life cycle from creation, delivery and consumption. Topics include audio and video encoding algorithms, metadata description, intellectual properties management and, conditional access system.

· **Advanced Numerical Analysis (3)**

Advanced topics in scientific computation. Topics include differentiation, integration, solution of differential equations, equation solving, minimization/ maximization, linear algebra, interpolation.

· **Artificial Intelligence in Education (3)**

This course addresses the use of artificial intelligence and cognitive psychology to build computer-based intelligent tutoring systems. Students will learn empirical and theoretical methods for creating cognitive models of human problem solving. Such models have been used to create educational software that has been demonstrated to dramatically enhance student learning in domains like mathematics and computer programming. This course will have three components: a literature review of some of the fundamental papers in the field: lectures on the needed cognitive psychology and human-computer interaction (HCI) background: and a significant project component in which students will be practicing the use of methods used to design tutors.

· **Advanced Computer Vision (3)**

The course will cover a number of topics ranging from low level to high level vision, with a focus on both the mathematical formulation of vision tasks, and the development and implementation of algorithms to solve them. Lecture topics will include biological vision and early vision, projective geometry and camera modeling, shape from shading and texture, stereo vision, motion analysis and optical flow, object representation and recognition, high level vision and vision applications.

· **Advanced Formal Languages and Automata Theory (3)**

An introduction to the theory of computation. Topics include finite automata, regular languages and regular grammars, properties of regular languages, context-free languages, simplification of context-free grammars, pushdown automata, properties of context-free languages, turning machines. a hierarchy of formal languages and automata and limits of algorithmic computation.

· **Advanced Topics in Computer Science (3)**

This course is designed to deal with state-of-the-art topics in computer science outside the regular course offerings. For a given semester the course content will be announced prior to registration for that semester.

· **Selected Topics in Computer Science (3)**

This course is designed to study the topics of computer science not covered in regular course offerings, or directed experience in computer science by means of lecture, discussion, seminar, and research. Recent offerings include advanced databases, computer networks, Java programming, and unix system programming. It is good for the first year graduate students who wish to find research topics in various area.

· **Independent Study (3)**

To get a deep study, it is frequently necessary for a student to meet his adviser regularly so as to get the timely and proper guide in the personal meeting. This course exists to meet this kind of needs. It is like a personal tutoring course in the research and development.

· **Case Study in Computer System (3)**

In this course, students survey and study the recent technical trend of computer system architecture ranging from mobile phones and mobile PCs to large computer systems. Selected technical papers are read and presented during the course and each student writes a survey paper for a selected topic on novel computer system architecture.

· **Software Project Management (3)**

In this course, students are trained to follow systematic project management processes in software development. Example software development projects are selected and the whole development processes for the projects are reviewed and revised by course participants.

· **Cyber Infrastructure (3)**

This course is designed to treat the current topics in various issues on Cyber Infrastructure those are including applied Grid computing, e-Science, cluster computing, reliable server management, etc. This course includes seminars and small projects those make use of Globus Toolkit, COG, etc. The contents of seminars will be given in the first lecture.

· **Advanced Computer Network Application (3)**

In this course, special hot issues in the recent research and development of

computer network application, e.g., Web 2.0, sensor network, wireless network, etc., are studied extensively. The course contents consist of lectures, paper presentation, demo, and term project.

· **Intelligent Robot (3)**

This course covers intelligent robot research topics related to building and programming mobile and articulated robots to perform simple tasks. It also covers major paradigms of robot programming and architectures for building perception, control, and learning systems for intelligent robots. These topics will be pursued through independent reading, class discussion, and project implementations. Papers covered will be drawn from robotics, computer vision, animation, machine learning, and neuroscience. Special emphasis will be given to developing autonomous control from human performance.

· **Data Mining (3)**

An introduction to the design of data mining programs. The emphasis is on learning techniques for searching for hidden relationships and patterns in the data, which has been accumulating in many forms, including database systems, spreadsheets, text files, and recently web pages. Topics include machine learning and classification, knowledge representation, decision tree, clustering, visualization, and customer modeling and targeted marketing.

· **Design and Analysis of Algorithms (3)**

An introduction to the design and analysis of algorithms. This course covers a number of ideas and techniques useful for designing and analyzing algorithms. Basic paradigms, e.g., divide and conquer strategies, greedy algorithms, dynamic programming, back-tracking, graph algorithms will be focused. A practical side of algorithm design is also explored with interesting examples of the designing techniques. This course also covers a number of current research topics in this field: problems in communication networks, on-line algorithms, computational geometry, computational biology.

· **Advanced Big Data (3)**

With the advancement in the hardware, distributed computing platforms, and data mining algorithms, BigData analytics provide insights about large-scale dataset that was easily ignored. In the Advanced Big Data course, distributed computing platforms to store and analyze large-scale dataset are covered. By using a real-world open dataset, students are expected to conduct project and have a chance to share the outcome publicly.

· **Advanced Open Source Software (3)**

Open source software has become the most important way of innovating in all industries. In this course, students learn the technical and cultural implications of open source technologies, licensing, and governance. The course covers applications of open source software, community-bases development practices, theory of legal issues in open source licensing, case studies in real industry, and examples of governance building.

· **Advanced Information Computing (3)**

This course will cover traditional material as well as recent advances in information retrieval (IR), the study of the indexing, processing, and querying of textual data. The focus will be on Korean language processing techniques and the newer techniques that try to move beyond keyword search and bring some intelligence to the task of processing and retrieving textual information, including hypertext documents available on the world-wide-web.

· **Smart Internet of Things (3)**

Through this lesson, we will be able to apply IoT / IoS, that is, the distributed environment elements of human, things, and services, to the object space network that forms intelligent relationships such as sensing, networking, and information processing cooperatively without human intervention.

· **Future Internet (3)**

As all the activities of the modern people are connected to the network, the learning of the network infrastructure, the internet architecture and the internet service are carried out in order to overcome the structural limitations of the existing Internet technology and build a more efficient internet environment.

· **Practices in Advanced Big Data (3)**

Students will learn the advanced theory and practices in big data. Students will have industry expert-level skills to program real-world big data software based on open platforms. This course includes a development project and in-depth discussions.

· **Practices in Advanced Machine Learning (3)**

Students will learn the advanced theory and practices in machine learning. Students will have industry expert-level skills to program machine learning software based on open platforms. This course includes a development project and in-depth discussions.

· **Practices in Advanced Mobile Computing (3)**

Students will learn the advanced theory and practices in mobile computing. Students will have industry expert-level skills for mobile programming based on open platforms. This course includes a development project and in-depth

discussions.

· **Cloud Architect by AWS Academy**

This course covers the fundamentals of building IT infrastructure on cloud. It covers how to optimize the use of the cloud services by understanding AWS services and how they fit into cloud-based solutions with few hands-on exercises.

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