

## 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.

- **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.

- **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.

- **Fuel Cell Fundamentals (3)**

Students will learn the basic principles of electrochemical energy conversion while being exposed to relevant topics in materials science, thermodynamics, and fluid mechanics.

- **Advanced Nanomaterials and Nanostructures (3)**

Nanomaterials have been recognized as key for the realization of future advanced

technology. In this lecture, students will learn the diverse aspects of nanomaterials including analysis of the characteristic of nanomaterials, synthesis of nanomaterials with diverse lithography and chemical method, and distinguishing features of 0D, 1D, 2D, and inorganic-organic hybrid materials.

- **Advanced Analysis of Fuel Cell Systems (3)**

Students learn electrochemistry, impedance analysis, and modeling method for understanding the fuel cell systems in depth

- **Bioinspired Functional Surfaces (3)**

This course aims at introducing students to the studies of interacting surfaces in the world of animals and plants and at understanding their functions and working mechanisms based on Tribology. The course also deals with actual cases that resolved various engineering challenges by utilizing the working mechanisms of functional surfaces in nature.

- **Contact Mechanics (3)**

This course deals with various theories of contact stress and strain that occur between contacting surfaces, such as Hertzian contact. The course involves the effects of adhesion and friction on contact.

- **Surface Engineering (3)**

This course introduces surface-related properties such as roughness, surface free energy, and hardness in order for students to understand the mechanical and physical properties of surfaces. This course also aims at introducing various equipment used to measure and analyze surface properties.

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