Descriptions of Courses

▣ Undergraduate Courses

ME106 Human and Machine **3:0:3(3)**

The state-of-the-art technology trends and future outlook of various fields in mechanical engineering are discussed, and how the mechanical engineering contributes to the health, well-being, and convenience of human society is explained. (eg. robot, energy, micro/nano, ocean, healthcare, optics, etc.)

ME200 Basic Mechanical Practice **2:3:3(3)**

Students learn the basic knowledge of product design and manufacturing. Students can practice digital design methodologies including 3D CAD for modeling the geometry and precision of mechanical components, and fundamental machining and 3D printing techniques for realization of real products.

ME203 Mechatronics system design **2:3:3(6)**

Students will learn various elements of mechatronics system via Arduino and Python programming. At the end of the semester, students will build a self-driving car controlled by machine learning-based visual intelligence.

ME207 Applied Electronics **2:3:3(6)**

This course covers the principles of basic electric and electronic circuits and systems, which are essential for undergraduate students in mechanical engineering. Topics include resistance network analysis, AC network analysis, transient analysis, frequency analysis, operational amplifiers, basics of semiconductors, digital logic circuits and systems.

ME211 Thermodynamics **3:0:3(6)**

This course provides a thorough understanding of the 1st and 2nd laws of thermodynamics, which are the most important concepts of classical thermodynamics regarding energy and work. In addition, the necessary skills and systematic approach are taught so that thermodynamic knowledge can be used to solve problems related to actual energy systems.

ME221 Fluid Mechanics **3:0:3(6)**

This course covers the basic principles of fluids, including hydrostatic pressure, buoyancy, control volume analysis, conservations of mass, momentum, and energy for moving fluids, dimensional analysis, and boundary layer flow. Students learn how to apply these concepts to a variety of engineering problems in industry, medicine, and nature, and to develop problem-solving skills for good engineering practice.

ME231 Solid Mechanics **3:1:3(6)**

Solid mechanics is a study about stress and deformation of solid materials under loading. This course teaches basic knowledge of solid mechanics including the concept of stress and strain, torsion, pure bending, shearing stresses in beams and thin-walled members, transformations of stresses and strain, principal stresses, deflection of beams, and finally energy methods.

ME251 Dynamics **3:0:3(6)**

Based on Newton's law, we learn the relationship between force and motion, work and energy, and impulse and momentum. Student will develope quantitative analysis methods through practice problems. To describe motion, various kinematic coordinate systems will be explored.

ME301 Numerical Analysis **3:0:3(6)**

Numerical computations literacy includes computer representation of numbers, and the origin and propagation of computational error. We explore the roots of equations, function approximation, linear algebra and curve fitting of data. Also, we learn the numerical differentiation and integration. Finally, the solution of linear, nonlinear and differential equations are examined.

ME302 Creative Problem Solving **2:3:3(6)**

Creative solving of engineering problems consists of creative problem recognition, problem definition and analysis, and creative synthesis, etc. Each step is treated in the systematic framework then, students would learn important creative ideation techniques. they would be divided into working groups to experience the creative solving procedures through creative discussion sessions.

ME303 Mechanical Engineering Laboratory 2:3:3(6)

In order to learn experimental measurement methods necessary for mechanical engineering, we introduce the usage of various measurement equipments, and train computer-based data collection and processing methods. Design of experimental methods following the identification of objects to be measured is trained. Students will practice how to systematically process and accurately deliver the experimental results through report preparation and oral presentation.

ME305 Electronics Laboratory for Mechanical Engineers 2:3:3(6)

The course "Electronics Laboratory for Mechanical Engineers" provides mechanical engineers with application capabilities utilizing electronics and software technologies. The course is comprised of interdisciplinary topics requiring knowledge from various fields such as mechanics, electronics, software and computer science. The students shall perform a (team based) term project with one of topics related to electronic system design for mechatronics systems, sensor signal conditioning and measurement, digital system design using micro-processor (C-language-based), motor driving for precision control and etc.

Prerequisites are Applied Electronic(ME207) and C-programming language (or equivalent software programming courses). The C-programming language shall be covered by the course unless the students do no have appropriate level of knowledge for the programming skills.

ME311 Heat Transfer 3:0:3(6)

This course serves to introduce the student to the many different processes by which heat may be transferred. These include conduction, convection, and radiartion. Heat transfer deals with two distinguishing features: how larger a heat transfer device is and how fast a heat transfer process takes place, which are not covered in thermodynamics. The student is going to understrand the physical origins of the various transport mechanisms. In addition, the student will be able to perform engineering calculations for problems involving heat transfer.

ME312 Energy and Environment 3:0:3(6)

This course deals with environmental issues related to power generation and energy consumption. Based on the knowledge of thermodynamics and applied thermodynamics, representative energy conversion technologies are introduced. In addition, alternative energy, pollutant emission, and their control are studied. Students will learn about photochemical smog, acid rain, global warming, and environmental policies for sustainable energy are treated.

ME313 Applied Thermodynamics 3:0:3(6)

The goal of this course is to deepen the knowledge of <thermodynamics>, one of the core subjects of mechanical engineering. In addition, students will learn the principles and design concepts of various energy systems and how to apply thermodynamic knowledge. Students will understand the theoretical property equations, exergy, chemical reaction, chemical equilibrium, phase equilibrium, and compressible flow. Using this knowledge, students will learn the design concepts and process of practical energy systems.

ME320 Applied Fluid Mechanics 3:0:3(6)

This course deals with how to apply the fundamentals of fluid mechanics to various advanced problems. The fluid dynamic force acting on an immersed object is analyzed using a potential flow theory, and interesting characteristics of open-channel flow, compressible flow, and low Reynolds-number flow are introduced. Furthermore, simple operation prinicples and performance of turbomachinery are covered.

ME330 Foundation of Stress Analysis 3:0:3(6)

This course is intended for junior or senior students who want to learn more about mechanics of materials or solid mechanics after completing Solid Mechanics (ME231). The following subjects are to be covered: i. Singularity functions, ii. Moment-Area Theorems, iii. Column buckling, iv. Yield conditions and the related material behaviors, v. Vector and tensor calculus, vi. Deformations of a body, vii. Traction vectors and stress tensors, viii. Simple examples of linear theory of elasticity - torsion of prismatic beams - plane problems

ME340 Engineering Design 2:3:3(6)

This course offers a systematic design methodology encompassing all design processes in engineering from the product discovery, conceptual design to the realization of products. Especially, the course empathizes the whole process of product ideation and design starting from the customer/problem finding and definition, creation and synthesis of ideas, evaluation of the ideas, and evaluation of the generated ideas. The course also emphasizes group projects in which students have practical experiences through the actual product finding and design, manufacturing, demonstration and presentation of the results. All this process requires creative ideation and synthesis of all

knowledge and techniques acquired through their undergraduate engineering courses.

ME341 Mechanical Component Design **3:0:3(6)**

The objective of this course is to learn how to design mechanical parts and mechanical systems based on stress calculation of mechanical materials, failure theory, and fatigue failure analysis. This course deals with analysis and design methods for mechanical elements such as screws, shafts, springs, and bearings commonly used in machines through reliability or statistical approaches.

ME342 Mechanism Design **3:0:3(6)**

This course deals with the method of designing and analyzing the motion shape of the mechanical part that makes the motion of the mechanical system. Students will learn designing a mechanical system that meets the requirements by combining and connecting basic mechanical elements such as links, gears, cams, belts, and chains, and analyzing them using kinematics and kinematics methods. Although it mainly deals with planar mechanical systems, it can also be applied to the design of 3D spatial mechanical systems.

ME351 Mechanical Vibrations **3:0:3(6)**

This course aims to build the ability to derive the equation of motion and its solution of a vibration system to understand the vibration phenomena with emphasis on the physical insights for the applications to the various mechanical systems using the basic concepts in the Fundamentals of Dynamics (ME251). For this purpose, this course covers the free and forced vibration analysis of a linear single or multiple degree-of-freedom systems including continuous systems. In the modeling procedure, how the physical parameters such as mass, stiffness and damping influence the vibrational motion is studied, eventually for the application to the design of the vibrational system. As the analytical and numerical approaches, modal analysis, frequency response analysis, Laplace transformation are studied to understand the vibration phenomena in a systematical way providing with practical exercise problems. Vibration problems in automotive, airplane, buildings, robots and musical instruments are given as examples to have tangible experiences in the practical systems. As an outcome of this course, students have ability to model, analysis, measure, and design the mechanical vibration systems with solid understanding and insight of the vibration phenomena.

ME361 Modeling and Control of Engineering Systems **3:0:3**

Most of the mechanical systems in our daily life, such as automobiles, robots, aircraft, and even small sensors, create dynamic movements by themselves or control actuators to create desired movements. This course introduces the essential theory and practical applications for analyzing the dynamic characteristics of a mechanical system and thus for designing a control algorithm based on the model.

ME370 Understanding of Materials and Processing **3:0:3(6)**

Students study the basic knowledge on mechanical properties and surface characteristics of materials, and teaches the principles of fundametal manufacturing technologies including casting, bulk deformation, sheet metal forming, machining, injection molding, thermoforming and additive manufacturing (3D printing). The lecture focuses on understanding the process physics of production techniques based on mechanics theories and explores the engineering solutions to advance the manufacturing processes.

ME371 Advanced Materials Engineering and its Application **3:0:3(6)**

This course aims understanding of basic materials engineering and fabrication/manufacturing process. Basic studies of materials engineering, piezoelectric materials/device, electronic materials/device, polymer materials, and composite materials will be carried out and followed by materials/device fabrication/manufacturing processes study to achieve the course target.

ME400 Capstone Design I **1:6:3(6)**

Students are intended to design and build practical engineering systems using background knowledges learned from mechanical engineering. Being grouped into a number of teams, students will perform mechanical design, prototype building, electronics design, and embedded programming. Students will have an opportunity to present their work in the form of presentation and demonstration to the instructors for evaluation.

ME401 Capstone Design II **1:6:3(6)**

This course is a continuation of Capstone Design I and, based on the designed system, the design is further improved and refined. Also, intelligent algorithms are designed and implemented to successfully achieve target tasks using the system.

ME403 Introduction to Naval Architecture and Ocean Engineering 3:0:3(6)

The general principles of shipbuilding and ocean engineering will be provided to students who did not major in this field in his/her Bachelor degree. Hydrostatics, resistance and propulsion, motion in ocean, structural integrity, rule-based structural design, vibration of ocean systems, offshore structure, drilling principles, under water vehicle will be covered.

ME404 Introduction to Simulation of Medical Procedures 3:1:3(6)

This course introduces the enabling technologies of the medical simulation. The course focuses on visual interface, haptic interface, modeling of organs and tissues, systems integration and control. The course also emphasizes importance of the clinical test and evaluation in the entire life cycle of the medical simulation, ranging from the concept design to the deployment. Example simulations will be used to provide hands-on experience, and to enhance the understanding of the involved theories and practical techniques.

ME405 Design Thinking and Entrepreneurship 2:3:3(6)

For successful launching of new business model, fast implementation of ideation, prototyping, and business model creation is required. This course provides a series of lectures for understanding the concept of open innovation and entrepreneurship. It also provides practical training sessions for students to practice design thinking process, agile development, and new business model creation. The course will provide network to global leaders in design & innovation so that students can have prospective career path understanding.

ME411 Energy System Design and Optimization 3:0:3(3)

The primary objective of this course is to provide an integrated presentation of Thermodynamics, Fluid Mechanics, and Heat & Mass Transfer. The unifying theme is the application of these principles to real-life design processes of energy systems that involve the storage, transfer, and conversion of energy. Components as well as system modeling will be conducted using Python programing with an open-source package, CoolProp (for thermodynamic properties of fluids). In addition, global optimization toolbox in MATLAB will be used for system optimization processes. The computation skills developed for the design of components in energy systems will be applied in the semester-long term project to the detailed design of a complete energy system.

ME413 Engine Technology 3:0:3(6)

To provide principles of engine technology and the systems of automobile power plants. To introduce the operations of gasoline and diesel reciprocating engines and the analysis of performances followed by the discussions on the future aspects of engine technology concerned with environmental impact.

ME414 Applied superconductivity and Thermal Engineering 3:0:3(6)

This course covers basic principle of superconductivity and advanced refrigeration technology with specific refrigeration components such as compressor, refrigerant, expansion device, and recuperative or regenerative heat exchangers. This course is designed for undergraduate seniors so that they can thoroughly investigate actual applied superconducting equipments and their cooling systems by systematically applying acquired thermo-fluid knowledge. The course will emphasize discussion of practical problems and possible improvement for successful commercialization of superconducting technology.

ME416 Vehicle Dynamics 3:0:3(6)

This course will help students in designing new car suspensions and/or improving car dynamics by learning the influence of the mechanical elements(suspension, steering, brake, tire, etc) to the vehicle dynamic behavior.

ME421 Microfluidics 3:0:3(6)

In micro scales, the basic laws governing the macroscale fluid mechanics may not be applicable. The objectives of this course are to identify dominant forces and their effects in micro scale fluid systems; to understand the fundamentals of fluidic phenomena at microscale; to discuss various microfluidic applications; and to explore new possible microfluidic applications in the emerging interdisciplinary fields, with a special emphasis on biomedical engineering.

ME422 Fluids and Environment 3:0:3

This class extends a scope the traditional fluid motionw within a pipe in the fluid mechanis undergraudate class into the open-channel and extenal fluids interfaced with air, which you may find find around you. This class covers various examples of environmental fluids, such as small scale fluids in a coffee cup, fluid motions in a rotating plate, turbulence in van Gough's Starry Night, and vortex shedding in a bridge, hydraulic jump, rip currents, coastal

upwelling along with relevant background physics, applications, and relevant safety remarks.

ME430 Introduction to Reliability in Mechanical Engineering Design 3:0:3(6)

We will discuss Fundamentals of Reliability Engineering in Mechanical Design including failure distribution and basic statistics for reliability, reliability model, reliability testing, Normal and Weibull distribution, reliability estimation and application. The purpose of this lecture is to equip students to save human life by assuring reliability in design, maintenance, and operation of mechanical systems and preventing their failures throughout their engineering career.

ME431 Introduction to Continuum Mechanics 3:0:3(6)

Basic principles of solid mechanics and fluid mechanics are dealt with in a unified view point on undergraduate level. Vector fields and tensor fields are introduced in cartesian coordinate, and deformation, strain and rate of deformation are studied. Forces, stresses, momentum balance and energy balance are dealt with. Constitutive laws in elastic solid and viscous fluid are studied. Some applications of the theory to solids and fluids are also treated.

ME432 Deformation, Fracture and Strength of Materials 3:0:3(6)

The objective of this course is to help the students understand macroscopic behaviors and microscopic characteristics of common engineering materials (metals, ceramics, plastics, and composites). Among many aspects (mechanical, thermal, electrical, optical, and chemical), mechanical properties of materials are specially emphasized in this course. Topics covered include (1) survey of various engineering materials and related engineering properties; (2) structure and deformation of crystalline solids; (3) fracture and strength of materials; (4) fatigue of materials under repeated loading conditions; (5) time-dependent behavior (creep & damping); (6) correlation between microstructural phenomena and macroscale behaviors.

ME433 Introduction to Thin Film Mechanics 3:0:3(6)

Thin films play an important role in many technological applications including semiconductor packaging and micro/nano-scale electronic devices. This course introduces mechanics-related topics involving stress, defect formation, and structural evolution in thin films. The processing, structure, and properties of thin films are discussed emphasizing current areas of scientific and technological interest.

ME440 Engineering Design via FEM 3:1:3(6)

This course introduces the fundamentals of finite element method and how to use commercial finite element analysis software. In particular, the basic principles of the finite element method are explained through easy-to-understand examples, and the fundamental mechanical/mathematical theories are taught. This course presents how to construct the stiffness matrix of a structure composed of simple structural elements such as springs and bars. The governing equations are derived for solid and structural problems, and the finite element formulation is obtained using the principle of virtual work. It also extends to finite element analysis utilizing two-dimensional continuum elements. The properties of finite element solutions are taught. Finite element models are obtained and various solid and structural problems are analyzed using commercial finite element analysis software.

ME450 Fundamentals and Applications of Wave Energy 3:0:3

This course provides the fundamental principles on how pressure perturbation in fluids or dynamic deformation in solids is generated and propagated as wave energy, and introduces recent advances and trends in the field of mechanical wave control.

ME452 Noise Control Engineering 3:0:3(6)

Generation and control of sound/noise will be covered in the course. Fundamental principles that govern sound generation and control are designed to be understood, not by theoretical approach but mainly physical, conceptual means. Class competition and experiment are expected.

ME453 Introduction to Robotics Engineering 3:0:3(6)

This course introduces basic concepts and fundamentals of a robot manipulator system to analyze its kinematics, dynamics, and control. In particular, forward and inverse kinematics, differential kinematics, dynamics, and control of a robot manipulator system will be emphasized along with basic mathematical tools such as rotation matrix, homogeneous transformation, and Jacobian.

ME454 Dynamics System Programming 2:3:3

The theories learned in the dynamics class are applied to multi-body systems to understand the principles of motion of objects in complex dynamical systems such as automobiles and robots. Students learn how to control and

communicate a dynamics system using the Robot Operating System that can be applied in practice, and understand the principle of how the dynamics system interacts with the environment by performing exercises and projects with Gazebo or CoppeliaSim.

ME455 Autonomous Mobile Systems Programming 2:3:3

Students learn algorithms for autonomous driving of mobile systems, such as object recognition, detection, and tracking through deep learning (DL), 3D reconstruciton, simultaneous localization and mapping (SLAM), and path planning and motion control through reinforcement learning (RL). In addition, students learn how various algorithms are used for the automation of mechanical systems by implementing algorithms through programming practice and applying them to mobile systems.

ME458 Programming for signal and image processing 2:3:3

It is essential for students majoring in mechanical engineering to analyze and process experimental data and images to extract useful information. In this course, basic concepts of signal and image processing will be studied. Through relevant exercises and assignments, students will learn MATLAB and OpenCV programming and algorithms related to signal and image processing to apply real-world applications.V programming and algorithms related to signal and image processing to apply real-world applications.

ME459 Introduction to Visual Intelligence 3:0:3

Visual intelligence is the ability to understand the contextual information contained in images and to perform tasks that interact with the surrounding environments and objects. In this course, students will learn the classification of visual intelligence and how to achieve visual intelligence through computers and mechanical systems, and also implement visual intelligence algorithms and systems through assignments and term projects.

ME460 Automatic Control 2:3:3

Actuation is used not only in large systems such as automobiles, airplanes, and robots, but also in most devices that can be easily seen in the vicinity. It has become essential to understand and apply control theory in order to control the operation of many of these devices as desired by humans. In this lecture, students can increase the basic understanding of control theory and experience practical skills through experiments and application cases.

ME461 Introduction to Fuel Cell System 3:0:3(6)

This course aims to understand the basic principles of fuel cells and the hydrogen energy system using fuel cells. Through thermodynamics and electrochemical approaches, students can understand the overall fuel cell structure, basic principles, operating conditions, and energy conversion efficiency. In addition, it is possible to understand the characteristics of the material constructing the fuel cell and to comprehensively learn the major balance of plants such as fuel processors, power conditioning systems, and gas systems for the fuel cell system.

ME475 Mechanical Engineering and Applied Mathematics 3:0:3(6)

This course serves to introduce students to various mathematical methods for solving differential equations. A list of the specific topics is provided in the attached Schedule. In covering those contents, there should be three overriding objectives: (a) The student will be able to obtain an intelligent working knowledge of a substantial number of useful mathematical methods. (b) The student will be able to connect the mathematical knowledge to physical problems encountered in mechanical engineering. This will lead to an improved understanding of the physical phenomena. (c) A final, yet equally important objective is to develop a positive attitude towards the subject of mathematics. It is incumbent upon the instructor to reveal the vital role that such skills play in students' professional careers and to thereby transmit a sense of excitement for the subject.

ME480 Introduction to Biomedical Optics 3:0:3(6)

The intention of the course is to introduce basic principles of optics and optical components and to develop a broad skill set for research in biomedical optics including technologies such as lasers, fiber optics, and microscopic optical imaging systems. The lecture series will also introduce current clinical and basic biology challenges that may be addressed by optical solutions.

ME481 Introduction to Electromagnetism & Optics 3:1:3(6)

This lecture is an introductory course of basic optics mainly intended for undergraduate students and also graduates having no significant prior knowledge on modern optics. The first half of the course deals with fundamentals of physical optics with emphasis on electromagnetic behaviors based on Maxwell equations. Then most of the remainder

of the course is devoted to the quantum nature of light along with rapidly growing applications of lasers in modern science and technology.

ME484 Structure & Function of Human Body 3:0:3(6)
This course covers the basics of human anatomy and physiology, so that engineering students become familiar with the body functions. Topics include mechanisms of the cells as well as systems, and some of the ways in which bioengineering, genetic engineering and cell biology are being used to address problems of health and disease based on the principles of physiology.

ME487 Introduction to Cell Mechanics 3:0:3(6)
This course is designed for mechanical engineering students who are interested in biological motility and its application to engineering and medicine. We will go over the basics of essential cell biology, examples of various cellular movements, and methodology to understand their mechanism. We intend to explore cellular movements and their physical properties, especially for those cells closely related to diseases.

ME488 Introduction to biomedical machine technology 3:0:3(6)
Basic principles and applications of biomedical machines are introduced for students majoring in mechanical engineering. Qualitative bio-modeling techniques based on biomechanical modeling and basic concepts of bio-signal processing are taught. Based on this, EMG-based intention recognition, surgical robots, artificial organs, haptics, robot recognition, rehabilitation devices, and cell manipulation technology will be introduced. As a final project, students find application of mechanical engineering technology in biomedical technology, and investigate and present the principle and development direction of the technologies.

ME489 Special Topics in Mechanical Engineering Practice Ⅰ 2:3:3

This course is for a special topic that has not been dealt with so far in other subjects (areas). The lecture topic could be diverse and specialized depending on the purpose. ME489 and ME491 have difference in L:L:C

ME490 Thesis Study 0:6:3
Research project is undertaken during the final part of undergraduate study under the supervision of a faculty member. the topic of the project is chosen by the supervisor and the student

ME491 Special Topics in Mechanical Engineering 3:0:3(6)
This course is for a special topic that has not been dealt with so far in other subjects (areas). The lecture topic could be diverse and specialized depending on the purpose.

ME492 Special Topics in Mechanical Engineering Practice 1:6:3
This coures is desinged to introduce special topics in the filed of Mechanical Engineering that are difficult to deal with in other courses.

ME493 Special Topics in Mechanical Engineering Ⅰ 1:0:1
this course deal with selected special subjects that it is hard to deal the other course.

ME494 Special Topics in Mechanical Engineering Ⅱ 2:0:2
this course deal with selected special subjects that it is hard to deal the other course.

ME495 Individual Study 0:6:1
Students choose project topics and are supervised by a faculty member.

ME496 Seminar 1:0:1
Recent advances and related topics in mechanical engineering are presented by invited lecturers.

▣ Graduate Courses

ME500 Mathematical Methods in Mechanical Engineering **3:0:3(6)**

Basic mathematical knowledge such as matrices, linear equations, linear spaces, eigenvalue problems, quadratic forms and variational calculus will be covered to study mechanical engineering. Those mathematical knowledge acquired in this course can be used for analysis of various linear systems, derivation of approximate solutions (or optimal solutions), and application to machine learning.

ME502 Introduction to Finite Element Method **3:0:3(6)**

Finite element method to solve a differential equation.

ME505 Measurement Instrumentation **3:0:3(6)**

Fundamentals of various physical, chemical, and biological sensors (displacement, time, velocity, acceleration, angular velocity, density, force, pressure, velocity, electromagnetic, chemical/biological, etc.) from macroscale to nanoscale are introduced. Students are expected to learn about the principles of sensor fabrication as well as their uses in engineering systems. In addition, students are expected to learn how to monitor sensor signals and how to process them, as well as about smart sensors and Internet of Things (IoT) sensor networks, which are currently being explored.

ME510 Advanced Fluid Mechanics **3:0:3(6)**

This course is intended for graduate-level students to understand fluid mechanics more in-depth. First, the governing equations of fluid mechanics are rigorously derived and their special forms are also treated. Further graduate-level fluid mechanics will be studied in terms of ideal-fluid flows, viscous flows of incompressible fluids, compressible flow of inviscid flows and methods of mathematical analysis. The course will demonstrate various research applications of the course contents to help students apply them to their research.

ME511 Advanced Thermodynamics **3:0:3(6)**

This course is for graduate students who want to understand and apply classical thermodynamics fundamentals physically. We will review basic thermodynamic concepts and acquire additional knowledge for energy system optimization. These include equilibrium conditions, Maxwell's functions, reversible processes, maximum work theory, Gibbs, Helmholtz, enthalpy functions, stability of thermodynamic systems, phase changes, chemical thermodynamics, critical phenomena, and irreversible thermodynamics.

ME512 Advanced Heat Transfer **3:0:3(6)**

This course introduces the students to the fundamental mechanisms, practical applications, and several advanced research topics of conduction, convection and radiation heat transfer, including kinetic theory, thermal physics, transient heat conduction, condensation & evaporation, heat exchangers, blackbody radiation & radiative transfer equation, solar radiation, and dimensional analysis.

ME513 Advanced Combustion **3:0:3(6)**

Combustion is defined as reactive fluid motion. In this course, methodologies and fundamental theories for understanding combustion are introduced in detail. Various combustion phenomena and combustion systems are introduced as well. Students will learn various phenomena caused by the interaction of the flame structure and flow, such as the governing equations of multicomponent systems, and combustion reaction kinetics. They will be essential for the design and performance improvement of combustion systems.

ME514 Phase Chang Heat Transfer **3:0:3(6)**

This course deals with various liquid-vapor phase change phenomena, including nucleation, evaporation, boiling, and condensation. Part I of the course discusses non-equilibrium thermodynamics, wetting, and transport process at interfaces. Part II covers nucleation, boiling, and condensation processes on the external surfaces of a body. Part III deals with internal flow boiling and condensation. The background physics, basic equations, analytical models and experimental results will be discussed in the class. The recent advances and new opportunities in the phase change heat transfer area will also be introduced.

ME515 Cryogenic Engineering **3:0:3(6)**

This course reviews the overall cryogenics fundamentals along with an introduction of the low temperature applications. It will familiarize students with the behavior of materials at low temperature as well as the

low-temperature refrigeration system. The entropy transfer concept is introduced and used with the second law in the same way that heat transfer and work transfer are used with the first law. The cryogenic systems of gas separation and gas liquefaction, various types of cryocoolers, cryogenic heat transfer, vacuum technology, and application of superconductivity are main topics.

ME516 Experimental Thermo-Fluid Engineering 2:3:3

This lecture is designed to educate and train students how to use measurement techniques and visualization techniques to study Fluid Mechanics and Heat Transfer problems. This course provides backgrounds of various experimental techniques. In every class, the principle of measurement technique will be delivered, and based on the theoretical backgrounds the participated students will perform and experience actual experiments. Beyond the experiences, students will also analyze the data. This course is highly recommended for a student who performs experimental research.

ME517 Interfacial Flow 3:0:3

In Mechanical engineering, multiphase flow problems are important in a wide range of industrial printing and coating applications. In this lecture, we study (i) whether a fluid-fluid interface is stable and (ii) how the interfacial flows can be controlled. To explore these problems, we need to understand the physical phenomena and internal flows near the liquid-liquid interface. This course provides various backgrounds about the capillarity and wetting phenomena.

ME518 Mechanical Engineering Principles in Biological Systems 3:0:3(6)

This course provides broad exposure to mechanical engineering principles in biological systems. Topics include diffusion-reaction, fluid flow, convection and electrical fields in physiological systems in addition to interactions in the integrative system. This course discusses experimental methods and case studies of membrane transport, flows in hydrated porous tissues, and microfluidics.

ME521 Viscous Fluid Flow 3:0:3(6)

This course deals with the effects of viscosity on flows in diverse scales. Based on fundamental equations and boundary conditions, the theoretical backgrounds of vortex dynamics, which include the creation and transport of vorticity, are provided. The next topic discusses how the relative magnitude of viscosity determines flow characteristics in the boundary-layer flow and low Reynolds-number flow broadly applied in fluid systems. Furthermore, various flow patterns induced by flow instability are introduced.

ME526 Introduction to Nanotech Processing 3:0:3(6)

The fundamental principles of nanotechnology are discussed with a special focus on the fabrication process of nanostructures and nanodevices. Specific topics include (1) basics of physics, chemistry, and materials science for the nanotechnology, (2) top-down nanofabrication, (3) bottom-up nanofabrication, (4) hybrid nanofabrication, (5) manipulation and integration of nanomaterials/structures, and (6) applications of nanotechnology.

ME530 Advanced Mechanics of Solids 3:0:3(6)

This course provides the core of solid mechanics for graduate students. Vectors and tensors are treated and applied to introduce traction vectors and stress tensors in addition to deformations and strain measures. To treat the constitutive equations, the objectivity is explained and followed by discussion of various constitutive equations such as elasticity, viscoelasticity, elastic-plastic behavior and viscoplasticity. Plane problems - plane strain, plane stress and generalized plane stress - are covered and illustrated. Further discussed is St. Venant beam problems to illustrate the semi-inverse approach. Some general principles including reciprocal theorem, the principle of virtual work, the principle of complementary virtual work, the principle of minimum potential energy and the principle of stationary potential energy are introduced and their applications are illustrated.

ME533 Fracture Mechanics 3:0:3(6)

Today, fracture mechanics is broadly used for reliable design of structural components in mechanical/aerospace engineering applications and micro/nano-scale electronic devices. In this course, fundamentals of linear elastic fracture mechanics are introduced, emphasizing singular nature of stress field at the tip. Energy release rate and J integral are studied together with fracture criteria applied to elastic-plastic fracture. Topics such as fracture toughness measurement methods, crack bridging, and mixed-mode fracture are also discussed.

ME534 Fatigue, Fracture and Strength 3:0:3(6)

This course is designed to give senior or graduate students in engineering the ability to handle fatigue phenomena,

methods of life prediction and life enhancement of engineering structures including electronic packaging MEMS and bio system. Topics include macro/micro/nano aspects of fatigue of metals, constant amplitude fatigue tests and data, notches and notch strain analysis, multiaxial stresses and strains, fatigue from real load Histories, fatigue crack propagation, environmental effects and fatigue behavior of electronics packaging and MEMS structures

ME536 Mechanics of Plastic Deformation 3:0:3(6)

The course deals with the fundamental theory of plasticity including yielding, anisotropy, associated and non-associated flows, tensile and compressive instabilities, crystal plasticity, and constitutive relations in plastic deformation and the methods of analysis for the deformation behavior. The solution of nonlinear problems in plastic deformation will be discussed. The method of numerical analysis and FE-based material modeling will be also introduced.

ME537 Optimal design of Composite Structures 3:0:3(6)

Introduction of anisotropic solid mechanics based on the classical laminate plate theory (CLPT). This course gives an insight on the properties of composite materials and helps to prepare computer programs for the stress and strain analyses. A brief experiment using autoclave vacuum bag molding method is offered to manufacture a sand composite structure.

ME543 Optimal Design 3:1:3(6)

The course aims at exploring methodologies of design optimization and its applications to design of engineering systems. The course is intended for undergraduate seniors and graduate students who are interested in design optimization in engineering analysis and design. Participants in this course will learn how to formulate and model engineering systems, and how to find the best design. This course covers fundamental optimization theories, modern optimization theories, and additional topics on design optimization.

ME545 Theory of Hydrodynamic Lubrication 3:0:3(6)

Basic theory of fluid film lubrication and its application in machine design with special emphasis on boundary conditions. Topics include generalized Reynolds equation, THL, EHL, hydrostatic lubrication thrust and journal bearings, turbulent lubrication, oil whirl and oil-whip in journal bearings.

ME547 Knowledge-Based Design System 3:1:3(6)

Computers are replacing more of human work which require low level of intelligence. This class covers KBDS which can be used for engineering design such as expert system, TRIZ, KMS, ontology, configuration design. By applying basic principles, commercial systems are used for the term project.

ME549 Reliability in Microsystems Packaging 3:1:3(6)

The importance of reliability in microsystems packaging are treated. Fatigue and creep of solder joints of advanced packaging, fracture mechanics approach for the reliability assessment in microsystem packaging are covered. Fundamental principles of reliability evaluation procedure including Micro-Moire Interferometry are provided. Student will also learn the reliability in microsystems packaging through selected experiments and projects.

ME550 Advanced Dynamics 3:0:3(6)

Starting from definition of angular velocity of a body in a 3-dimensional space, formulations of equations of motion for a dynamic system are covered. Vector dynamics by Newton-Euler and analytical dynamics by D'Alembert, virtual power, Lagrange, Hamilton, and Kane are taught. Both holonomic and nonholonomic systems are treated.

ME551 Linear Vibration 3:0:3(6)

Vibrations in Linear Systems(ME551) deals with topics of the undergraduate vibration course in far more depth and width. For lumped-parameter dynamic systems which behave nonlinearly mostly in practice, how to derive governing equations of motion, find out equilibriums, and then linearize those about the equilibrium points to obtain 2nd order linear differential equations in matrix form are taught. It is learned that coefficients matrices can be non-symmetric. In such cases, how to do eigen or modal analysis and understand physical meaning of the results given often in complex numbers are taught, together with several numerical techniques. Regarding continuous systems, 1-dimensional systems such as string and beam are revisited before going to 2-dimensional systems such as membrane and plate. How to approximate the continuous systems by finite degree of freedom lumped parameter systems is introduced together with characteristic limits of such approximations.

ME552 Introduction to Acoustics **3:0:3(6)**

Theoretical descriptions that have to do with basic acoustic phenomena; propagation, reflection, transmission, radiation, diffraction, and scattering are to be studied, emphasizing their physical meanings and practical implications. The basic physical quantities in acoustics, such as pressure, impedance, intensity, power, and energy are studied. Human perception on sound also to be introduced, Various scales, including dB and Octave scale, will be introduce and appropriately exercised.

ME553 Robot Dynamics **3:0:3(6)**

The goal of this course is to teach modern robot kinematics and dynamics algorithms. We focus on various recursive algorithms such as Composite Rigid Body Algorithm, Recursive Newton Euler Algorithm and Articulated Body Algorithm. Through multiple coding exercises, the students will be ready to write full robot simulation code.

ME554 Future energy-utilization engineering **3:0:3(6)**

This course covers several different topics related to future energy utilization at 21st century. From solar energy that is human's ultimate energy resource, various recent energy utilization issues will be reviewed including hydrogen energy, Stirling cycle, transcritical cycle, thermoelectrics, and superconductivity. Micro thermal energy conversion system such as micro gas turbine, micro engine, and micro refrigerator will be also discussed for their impact to traditional energy systems. This course will familiarize students with new emerging energy field topics that are driven by environmental protection issues and less dependence of fossil fuels. Advanced thermodynamic cycles and exotic materials will be considered through new energy utilization strategies.

ME561 Linear System Control **3:0:3(6)**

Designed to enable graduate students to make analysis of a given linear system in terms of stability, controllability and observability, and to design a linear controller by using eigenstructure assignment

ME562 Digital System Control **3:0:3(6)**

When control theory is applied to a real-world system, a computer or microprocessor should be utilized. A computer, however, cannot perform continuous calculations, and no matter how fast the calculation cycle is made, it has a different characteristic from the continuous time domain students have learned so far. In this lecture, digital control theory and application cases are introduced so that students can understand and design computer-assisted control systems.

ME564 Artificial Neural network : Theory and Applications **3:0:3(6)**

This course treats a variety of artificial neural network techniques being currently applied to many difficult-to-solve engineering problems.

ME567 Introduction to Statistical Thermodynamics **3:0:3(6)**

The main purpose of this course is to provide students with enough statistical mechanics background to the molecular simulations, transport, and nanomechanics. The topics include the fundamental concepts such as ensemble, entropy, and free energy, etc. The main theme of this course is how the laws at the macroscale (thermodynamics) can be obtained by analyzing the spontaneous fluctuations at the microscale (dynamics of molecules).

ME570 Advanced Manufacturing Systems **3:0:3(6)**

This course includes the design and automation of the manufacturing system, Rapid Product and micro fabrication technologies.

ME572 Design and Implementation of Nano Actuation System **2:3:3(6)**

Several kinds of positioning systems with the accuracy of nano meter are needed in the field of nano/ bio researches such as semiconductor industry, flat panel display manufacturing, bio manipulation, etc. Lectures for learning principles and design methods of nano precision actuation systems are given during the first half of the semester. During the second half of the semester, nano precision actuation systems using VCM and PZT actuztors, nano precision position feedback sensors and precision motion guide mechanisms are designed and implemented by students in the form of term project.

ME573 Adhesion and Adhesive Technology **3:0:3**

The objective of this course is to learn theoretical approaches and experimental methods for the design of adhesive joints between polymer composite and dissimilar materials. Further, this course covers basic sciences such as physics and chemistry and basic knowledge learned in solid mechanics, thermodynamics, and fluid mechanics, which makes it

an optimal joint with excellent durability.

ME574 Joining Engineering **3:1:3(6)**

This course teaches the principle and application of the joining/welding processes as well as the advanced joining technologies for semiconductor and display industries. Especially various adhesion measurement methods and brief fundamentals of fracture mechanics for the understanding of beam-bending tests are introduced. Moreover, students will experience a lab experiment for the thin film adhesion measurement by the double cantilever beam (DCB) test.

ME576 Vehicle Dynamics and Control **3:1:3(6)**

The purpose of the course is to understand the basics of power transmission mechanism and steering, braking and suspension systems as well as mechanics between tire and various road surfaces. Two commercial softwares, Carsim and Simulink, will be taught to enhance the understanding of the dynamics of vehicle with and without various active chassis controls. Also, vehicle dynamics control algorithms are studied to enhance vehicle longitudinal, lateral, vertical, yaw and roll dynamics.

ME582 Introduction to Microfabrication Technology **3:0:3(6)**

Based on the fundamental IC process technology, basic MEMS (Micro Electro Mecahnical System) technologies such as bulk-micromachining, surface micromachining, and HAR-MEMS process are introduced which are applied for microsensors, microactuators, and micro systems. It also covers recent interdisciplinary subjects such as microfluidics, piezo-MEMS, optical-MEMS, and Bio-MEMS.

ME583 MEMS Design and Experimental Microfabrication **2:3:3(6)**

Based on the fundamental MEMS (Micro electro Mechanical System) technology, various microfabrication processes are introduced and processed in the clean room. It covers mask design, photolithography, thin film deposition/etching, bulk microfabrication, and X-ray mask fabrication, which provide the base for independent MEMS research. It also covers recent interdisciplinary subjects such as microfluidics, piezo-MEMS, optical-MEMS, and Bio-MEMS.

ME585 Mechanics and Control of Human Movement **3:0:3(6)**

This course covers methods for modeling and analyzing human movement as biomechanical systems. Topics to be covered include dynamics of body segments, kinematic analysis, forward dynamics simulations, inverse dynamics, control analysis, and muscle mechanics. The course also includes the topics on central nervous system as well as sensory organs.

ME587 Optomechatronics **3:0:3(6)**

This course will treat a new engineering field termed "optomechatronics" and focus on an integrated approach to effectively combine multi-disciplinary fields (optical/mechatonic). Based on the review of fundamentals optics/mechatronics, the lecture will introduce an in-dept analysis on how such multi-disciplinary fields can be combined to generate fundamental functions generated by the fused technology.

ME589 Applied Optics **3:1:3(6)**

This lecture covers the fundamentals of geometrical optics, wave optics and electromagnetic optics for their applications in 'Mechanical Engineering'. Each section will start with the the governing equations, which can provide the in-depth understanding of the photon generation, propagation, delivery, focusing, and control. This will direct the students to be able to understand the very strengths, weaknesses and limitations of the optics as well as their ultimate uses in 'Mechanical Engineering'.

ME591 Random Data: Analysis and Processing **3:1:3(6)**

This course treats both fundamentals and applications of signal processing techniques primarily based on the engineering knowledge of probability, correlation and spectral analysis. It starts with introduction of some basic topics such as probability distribution, ensemble averages, stochastic process, normal distribution, correlation and spectral density function, frequency response function, band-limited white noise for students with not enough background on statistical analysis. Then, digital signal processing techniques such as data acquisition, pre-processing, data qualification, discrete Fourier transform, digital filter, decimation, zoom transform, windowing, overlapping and averaging are treated. Then, random vibration analysis with multi-input/multi-output systems is extensively studied and applied to system identification, energy source identification, nonlinear system analysis and so on. Finally, some of the advanced techniques such as time-frequency analysis, wavelet, cepstrum analysis and Hilbert transform are briefly discussed mainly focusing on the field applications.

ME592 Laser: Principles and Applications **3:0:3(6)**

This course is designed to introduce basic principles on lasers and their applications to mechanical engineering graduate students whose research involves lasers and laser-based technologies. Laser theory topics include quantum nature of light and matter, interaction of radiation with atoms and ions, optical resonators, pumping processes, laser amplifiers, CW lasers, Q-switching, and mode-locking. Laser engineering covers gas and dye lasers, solid-state lasers, fiber lasers, semiconductor lasers, and free-electron lasers. Finally, broad overview of laser applications in manufacturing, metrology, biomedicine, sensing and telecommunications will be provided.

ME600 Mechanical System Design Project 1 **0:9:3(6)**

The course aims to provide the students who have declared to take the Renaissance program and have already taken the core course "Collaborative System Design and Engineering" and the departmental system design course with the opportunity to take practice in their own design project(s) based on the collaborative creativity and teamwork by forming relevant team(s) of the similar topical category through practices and discussions. The implementation of the cycle operation in knowledge creation would be made in common effort for two cycles.

ME601 Mechanical System Design Project 2 **0:9:3(6)**

The course aims to bring advancement and improvement of the works from the preceding semester of the same teams to attain the advanced level by continuing the knowledge creation process with renewed two cycles through practices and discussions and by operating the project in common effort.

ME604 Metrology **2:3:3(6)**

This course deals with the subject of precision dimensional metrology which plays important roles in various fields of modern science and engineering mainly for distance and surface measurements. Principles, fundamentals of optics especially for electromagnet wave interference are explained with emphasis on monochromatic interferometry, white light scanning interferometry, holography, and speckle and moire interferometry.

ME606 Creative Knowledge Creation Process and Application **3:0:3(6)**

The course is designed to learn creative learning methods, computer-aided group ideation and methods for creative knowledge creation toward technology innovation. The course covers the creative learning theories, creative idea generation techniques with related computer-aided creativity methods, knowledge creation model for technology innovation and computer-aided knowledge creation process. Then the learned techniques are applied to practical examples by student groups.

ME607 Computational Linear Algebra **3:1:3(6)**

Numerical techniques for applying linear algebra to mechanical engineering systems are introduced as well as underlying fundamentals for practical applications. Simultaneous linear equations, eigen analysis, iterative methods, and sparse matrix solution method are covered. Through programming practice, computational capability can be enhanced.

ME611 Convective Heat Transfer **3:0:3(6)**

This course deals with various fundamental aspects of convective heat transfer, which can be applied to cooling technology of electronic equipment, turbine blades, steel plates, laser weapons, to name a few. Basic mechanisms of convective heat transfer and the methods of analysis are going to be discussed in depth. Major topics to be covered in this course are the laminar/turbulent heat transfer in internal/external flows under the conditions of forced or natural convection. Also, some important aspects of phase-change heat transfer and the convection in porous media will be discussed.

ME612 Transport Phenomena **3:0:3(6)**

The objective of this course is to build a consistent knowledge of transport phenomena for momentum, energy, and mass. Instead of covering the topics of transport phenomena one by one and then trying to apply them to the real world, we will take the opposite approach; in this course we will identify what kind of technical challenges we have in the real world and then try to learn the topics of transport phenomena to tackle the challenges.

ME613 Computational Fluid Mechanics and Heat Transfer **3:0:3(6)**

The class introduces numerical methods that are widely utilized in commercial or in-house computational fluid dynamics (CFD) source codes. The methods include finite difference methods, finite volume methods, finite element methods, methods of solving systems of linear equations, time integration schemes, methods of solving Navier-Stokes equations, grid generation, parallel computing, compressible flows, turbulent flows, and so on.

ME615 Nanoscale Heat Transfer **3:0:3(6)**

This course will cover microscopic concepts and methodology in thermal energy transport at micro/nanoscale, including equilibrium statistics, kinetic theory, Boltzmann transport equation, and radiative properties of nanostructures, and surface plasmon resonance and metamaterials. Lectures will cover fundamental theories and applications in contemporary technologies, while this course will emphasize a term project to incubate the independent research abilities of students. All students are expected to write a thorough review paper on any topic of his/her interests. Project topics can be freely chosen as long as they are related to micro/nanoscale heat transfer.

ME616 Automobile Technology and Environment **3:0:3(6)**

Principles of vehicle powerplant, performance analysis, and design & combustion technologies for high performance/efficiency and low emission will be discussed. Environmental & energy issues involving Emission characteristics and other mobility technologies will be discussed, as well as the future prospects of vehicle market. Especially, low-carbon technologies and carbon-neutral fuels for net-zero emission will be provided.

ME617 Advanced Vehicle Control Design **3:0:3(6)**

This course covers the subjects of dealing with the real world problems associated with applying control theories to general mechanical systems that have the unique design limitations in cost and robustness as well as actuator performance. This course introduces signal processing methods and diverse control methods which can be applied to general mechanical control systems. The course is concluded with the case studies of applying the introduced methods to automotive controls.

ME621 Turbulence **3:0:3(6)**

This course covers the subjects of introduction to graduate-level turbulence. The governing equations of turbulent flow are derived. The statistical descriptions of turbulence are explored. The kinematics and dynamics of homogeneous turbulence are examined. The spectral dynamics of turbulence is studied. Next, the subjects of real turbulent flows are dealt with: boundary-free shear flows and wall-bounded shear flows. Finally, new trends in turbulence are introduced.

ME623 Rotating flow **3:0:3(6)**

Flow of fluid in a rotating container is discussed. Models of both inviscid and viscous fluids are dealt with.

ME632 Theory of Viscoelasticity **3:0:3(6)**

Theory of linear viscoelasticity is treated. The extensive discussion on the constitutive behavior of practical viscoelastic materials is followed by the discussion on the various solution techniques for the viscoelastic boundary value problems. Brief treatment on the thermo-viscoelasticity and variational theorems will also be done towards the end of the class.

ME633 Mechanical Behavior of Polymeric and Composite Materials **3:0:3(6)**

In this course various characteristics of the mechanical properties of polymer and composites materials such as deformation, fracture and strength of materials are introduced for the application to engineering design. The evaluation method of mechanical properties are also explained.

ME635 Plastic Analysis and Design of Structures **3:0:3(6)**

Plastic analysis is introduced emphasizing its difference form elastic analysis for strength and design of machines and structures. Plastic behavior of materials is studied based on yield criteria, and limit analysis formulation is derived with variational methods. Beams, Plates, shells and frames are analysed by plastic analysis for design purpose. Complicated structure are also considered for plastic analysis and optimum design.

ME636 Probabilistic Engineering Design **3:0:3(6)**

The course aims at exploring methodologies of engineering design under uncertainty. The course is intended for graduate students who are interested in statistical and probabilistic methods and design optimization in engineering, and thus is recommended to graduate students who already took "Optimal Design" course. It covers fundamental statistics/probability theories, reliability analysis, analytical robustness assessment, and reliability-based design optimization.

ME638 Axiomatic Design of Composite Structures **3:0:3(6)**

This course is a continuation of MAE 537. It deals throughly the joining process of composite structures, manufacturing and transport issues in composite materials and impact and fatigue properties of composite structures. After getting acquainted with the axiomatic design theory, the design and fabrication of composite robot structures,

machine tools, bearings, rehabilitation of infrastructures and automotive structures which are all the actual research results of the instructor are throughly treated.

ME639 Introduction to Elasticity and Micromechanics 3:0:3(6)

This course provides an introduction to the elastic theory and its application to microstructure. We will discuss two major methods for solving elasticity equations: the stress function method for 2D problems and the Green's function approach for 3D problems. Also, we solve the elasticity problems of the microscopic defects in solids, such as inclusions, inhomogeneities, cracks and dislocations, which would naturally lead to the discussion on the effective properties of particulate-reinforced composites. We will then discuss the extension of the theory to multiphysics problems and non-linear problems. Matlab programming is used to aid analytic derivation and numerical solutions.

ME642 Medical Biomechanics 3:0:3(6)

This course deals with the process of understanding the structure, function, and behavior of the skeletal-muscular system of the human body, understanding the biomechanical problems of the skeletal-muscular system based on mechanical knowledge of engineering, and seeking mechanical engineering solutions.

ME643 Rehabilitation Engineering for Analysis and Treatment of Movement Disorders 3:0:3

This course deals with comprehensive contents in human movement including human brain function, nervous system, and musculoskeletal biomechanics. After understanding neural mechanism of human movement and neurological movement disorders, various types of engineering methods along with the history of neural engineering will be introduced. Students will finally produce their own research ideas in the field of neuro-rehabilitation engineering.

ME644 Tribology 3:0:3(6)

An introduction to tribology which is defined as the science and technology of interacting surfaces in relative motion and of related subjects and practices. Topics include the physics and basic mechanism of friction, wear and lubrication and its application to machine systems.

ME647 STEP for Electronic Commerce 3:1:3(6)

e-Business is integrated with manufacturing to create new concepts such as B2B, SCM, CRM, CPC, PLM. In this course these new technologies are introduced for the e-business in manufacturing. STEP is an ISO standard which is one of the core technology in this development. Hands-on experience with STEP software tools is provided.

ME653 Mechanical Signatures and System Analysis 3:1:3(6)

This course is intended to give a profound perspective on the meanings and utilities of mechanical signatures that can be observed in vibro-acoustic areas. The extraction of useful information from measured typical signal patterns related to the excitation, transmission, reception, and vibration (or radiated sound) will be dealt with, and, more importantly, the consolidation of ideas based on the basic understanding of signatures and underlying dynamics will be emphasized for the practical applications. By using the analyzed signatures, changes in transmission path, mechanism itself, and operating parameters can be revealed. The final object of this course is to provide students with an understanding of close conceptual relationships between the diagnostics of machine operating condition by using the signature analysis, and the system design of quiet machines.

ME654 Noise Control 3:0:3(6)

Environmental pollutions are being seriously concerned very much along with the fast development of industry and enhancement of the living standard. Among various pollution topics that are generated from various mechanical systems, 'noise', in particular, becomes a big concern to generals and manufacturers because the machinery noise is usually directly related with our ordinary life. The quietness of machines becomes one of the most-concerned evaluation points of a machine and the customers in the viewpoint of quality and market value. Also, regulations demand a lot of noise-related functions to the machine manufacturers and social system constructors. In this course, for the high-value design of machines, the quietness of everyday life and environment, and the comfort for the tasks, speech communication, and various auditory experiences, fundamental knowledges for the noise control will be studied intensively.

ME655 Robotics Engineering 3:1:3(6)

Designed to enable graduate students to understand the most updated topics in kinematics and dynamics of robotics and to apply recently introduced control techniques.

ME656 Vehicle NVH **3:1:3(6)**

This course aims at providing fundamental knowledge on vehicle noise, vibration, and harshness (NVH), which is regarded as one of very important factors in the automotive design and development. Basic characteristics of automotive noise and vibration and analysis techniques for modeling paths and receiver systems will be covered: characteristics of sources, human response, identification of sources and paths, analysis of vibro-acoustics fields. Principles and design method of passive measures such as mountings and bushings, damping materials, sound-proofing materials, and silencers for scavenging systems will be studied with the discussion on their concurrent issues. Problem nature and remedial plans of NVH problems in recent eco-friendly cars will be also covered.

ME662 Design of Precision Actuation System **3:0:3(6)**

This course is designed for graduate students. In the beginning, Design principles are introduced. Next, several structure design techniques such as kinematic design, flexture mechanism design, guide mechanism design, etc. are studied. Then error analysis/compensation and uncertainty analysis are dealt with. In this course, every student proposes a term project and the result of the project is estimated by presentation at the end of the semester.

ME674 Optical Imaging System Design **3:0:3(6)**

The contents of this course include introduction of various optical imaging systems, design method of the optical imaging systems, and practical implementation of the optical instruments. Students will learn the basic principles, theory, design processes, and implementation of the optical imaging systems, such as digital microscopy, confocal laser scanning microscopy, and optical coherence tomography. In particular, we will cover practical aspects of optical imaging system design through examples and exercises. By participating in the design process of the imaging systems, students will learn how to build optical imaging systems through hands-on experiences and process the data to form two- and three-dimensional images. Prerequisite courses, such as optics and biomedical optics, are useful but not necessary.

ME675 Ultrafast Optic Technology **3:0:3**

Principles in ultrashort pulse generation, propagation, characterization and its applications will be covered. Important topics include (a) linear and nonlinear pulse shaping processes, (b) pulse generation (active and passive mode- locking; solitons), (c) pulse characterization, (d) optical frequency combs, (e) ultrafast amplifiers, and (f) applications (pump-probe techniques, imaging, precision metrology, materials processing, communications and signal processing).

ME683 Human Robot Interaction: Haptics **3:0:3(6)**

As the human-robot interaction is becoming the important issue for the upcoming human-robot symbiosis era, this year's lecture is extending the haptic interaction study in human-robot to multimodal interaction. Telerobotics and haptic interaction is the robotics research area that is related with transmission of force or tactile information about remote place or virtual model. The lecture will address fundamental topics about telerobotics and haptic interaction; bilateral control architecture, haptic devices, human haptic perception, haptic modeling, performance evaluation and related applications. Also, various topics in human-robot interaction will be lectured jointly with guest lecturers and Prof. Kwon.

ME684 Soft Robotics: Bioinspired Systems **3:0:3**

This class provides fundamental knowledge of sensors/actuators, and their applications to soft robots in both biological and bio-inspired human-made designs for graduate students studying robotics, mirco/nano systems, human-machine interaction, and etc.

ME692 Wave Propagation **3:0:3(6)**

Waves in a string, bar, plate and shell are theoretically, but emphasizing their physical and practical meaning to be conveyed. Surface waves and waves in solid are also to be discussed.

ME711 Radiation Heat Transfer **3:0:3(6)**

This course introduces you to the fundamental mechanisms, practical applications, and several advanced research topics of thermal radiative heat transfer, including physics foundation and applications of radiative heat transfer, blackbody radiation, radiative properties of surfaces, radiative transfer between surfaces, materials properties, radiative transfer equation (RTE) and solution methods for participating media, interference phenomena of electromagnetic wave in thin films, absorption and scattering by particles, multi-mode heat transfer (radiation dominant and combined with conduction and/or convection), special topics in thermal radiation measurement techniques, and near-field thermal radiation.

ME722 Computational Turbulence Modeling **3:0:3(6)**

Introduction and hands-on experience on the selected experimental methods commonly used in the high temperature thermal engineering. Basic electronics and computer interfacing, photography, lens and mirrors, Schieren, interferometry, image processing, high speed image, radiation detectors, monochromators, lame emission spectroscopy, flame scanning, flame extinction, flame probe measurements.

ME731 Nonlinear Computational Mechanics of Solid **3:0:3(6)**

Treated are nonlinear finite element analysis of materials and structures undergoing large deformations, including numerical schemes to solve nonlinear equations . Emphasis is placed upon numerical implementation of finite-strain plasticity to cover large deformations.

ME732 Reliability in Strength Design **3:0:3(6)**

Reliability is one of the most important issues in strength design of machines and mechanical structures. Statistical characteristics of various material strengths and statistical properties of service loads are studied, and design concepts related to reliability in automobiles, railways and aircraft are introduced in this course.

ME752 Structure-borne Sound **3:0:3(6)**

Sound is radiated from the vibration of structures or transmitted through the structures that enclose the whole machine. In this course, generation conditions and characteristics of sound from vibrating structures are studied. The following topics are studied in a successive manner: propagation and damping characteristics of waves in solids, how the structure receives the external excitation, how the structural waves propagate within a complex structure and to a connected structures, how the sound is radiated from structures that received an amount of excitation power, and how the sound is transmitted through an enclosing structure of a machine and a partition.

ME761 Nonlinear System Control **3:0:3(6)**

This course deals with the contents about the nonlinear system and nonlinear controller widely. Those contents involve the analysis, stability, controller design for the nonlinear system and design, analysis for the nonlinear controllers.

ME771 Analysis and Design of Metal Forming Processes **3:1:3(6)**

The basic analysis techniques required for design of the manufacturing processes such as extrusion, rolling, forming, deep drawing, etc. will be introduced. the fundamentals of such design procedures will be handled by case studies and experiments.

ME781 Molecular Dynamics and Nanomechanics **3:0:3(6)**

This course provides an in-depth coverage of the molecular dynamics simulation, and various examples are treated in conjunction with its applications for nanomechanics, which deals with the mechanics of nanoscale systems. The lecture will start with a brief introduction to statistical mechanics at a level appropriate for mechanical engineering students, and a short coverage will be given to the straightforward treatment of the microcanonical ensembles. Then non-Hamiltonian dynamics is discussed to treat the use of thermostats or barostats in MD simulation, and various ensembles will be covered. We emphasize that MD simulation leads to the characterization of various mechanical systems at the atomistic level and its usefulness for calculating mechanical properties of materials and systems.
Other topics may include free energy calculation, non-equilibrium molecular dynamics, Ab Initio Molecular dynamics, coarse graining and time scale problems, and rare events etc. Lastly various examples of nanomechanics will be explored from the application aspect of molecular dynamics and the related techniques.

ME800 Special topics in Mechanical Engineering **3:0:3(6)**

This lecture is designed to deal with the selected theory and application in mechanical engineering part. The specific topics will be announced before the semester begins.

ME801 Special topics in Mechanical Engineering Ⅰ **1:0:1**

This course deal with selected special subjects that it is hard to deal the other course.

ME802 Special topics in Mechanical EngineeringⅡ **2:0:2**

This course deal with selected special subjects that it is hard to deal the other course.

ME810 Special topics in Thermal & Fluid Engineering **3:0:3(6)**

This lecture is designed to deal with the selected theory and application in thermal and fluid engineering part. The specific topics will be announced before the semester begins.

ME830 Special topics in Design Engineering **3:0:3(6)**

This lecture is designed to deal with the selected theory and application in design engineering part. The specific topics will be announced before the semester begins.

ME850 Special topics in Dynamics and Control **3:0:3(6)**

This lecture is designed to deal with the selected theory and application in dynamics and control part. The specific topics will be announced before the semester begins.

ME870 Special Topics in Production Engineering **3:0:3(6)**

This lecture is designed to deal with the selected theory and application in production engineering part. The specific topics will be announced before the semester begins.

ME960 M.S. Thesis

ME964 Individual Research M.S. **0:3:1**

When an individual work is required for the topics which are not covered by the current M.S. curriculum in the field of mechanical engineering, an individual research will be carried out and the research results should be summarized by the students and be submitted to the supervisor for its evaluation.

ME966 Seminar M.S. Program **1:0:1**

The recent advances and related topics in mechanical engineering are presented by invited lectures. Also, special projects and thesis study given to students are presented and discussed. This course proceeds with group that is composed of several students guided by advisor professor.

ME967 Individual Research M.S. **0:6:2**

When an individual work is required for the topics which are not covered by the current M.S. curriculum in the field of mechanical engineering, an individual research will be carried out and the research results should be summarized by the students and be submitted to the supervisor for its evaluation.

ME980 Ph. D. Thesis

ME985 Individual Research Ph.D. **0:3:1**

When an individual work is required for the topics which are not covered by the current Ph.D. curriculum in the field of mechanical engineering, an individual research will be carried out and the research results should be summarized by the students and be submitted to the supervisor for its evaluation.

ME986 Seminar (Ph.D.) **1:0:1**

The recent advances and related topics in mechanical engineering are presented by invited lectures. Also, special projects and thesis study given to students are presented and discussed. This course proceeds with group that is composed of several students guided by advisor professor.