

## Descriptions of Courses

### □ Undergraduate Courses

#### MAE106 Human and Machine

This course is designed to provide freshmen-level students with perspectives, directions and methods necessary to help them pursue successful careers, not only as students at KAIST, but ultimately as responsible and competent professionals. To this end, this course covers: goal-setting method for life planning, strategies for a successful career, and time-management skills; and systematic methodologies for analysis and design. This course deals with the various attributes of mechanical civilization to identify the advanced civilization in which the scientists and engineers drive the main stream. Cultural attitude and technical methodologies are studied to secure the leadership of engineers.

#### MAE200 Basic Mechanical Practice: Modelling & Realization

This course concentrates on the basis in modelling and realization of mechanical components. This can be divided into the tasks of CAD and manufacturing. We will cover the former by pursuing a sequence of design examples and the latter by manufacturing the design example.

#### MAE205 Mechanical Engineering Laboratory

Various equipments will be applied to explain the essential experiments in mechanical engineering. Measurement and processing of data will be carried out using PC and LabView. A systematic way to select measurement parameters, to collect and process the data, and to report and present experimental results will be taught.

#### MAE206 Machine System Automation

The object of this course is to provide the undergraduate students with good understanding and to generate interest about the machine system. In the first half of the course, Lectures about the pneumatic elements / systems and PLC system / programming are given and in the second half, actual automated machine systems are designed, built, and actuated by the students.

#### MAE208 Experiences in New Mechanical Engineering Fields

The course provides fundamental principle and basic experiment experience of new areas of mechanical engineering such as rapid prototyping, MEMS (Micro Electro Mechanical System), and fuel cell. It also gives the new academic experience of experiments for a basis for applications to other mechanical fields.

#### MAE211 Thermodynamics

Fundamental concepts and definitions of material and its properties. Basic understanding of energy conversion problems. Formulation of 1st and 2nd laws of Thermodynamics, and application to engineering systems. Definition of material properties including energy and entropy, and concepts and calculation procedure of heat and work as applied to the thermodynamic systems. Application systems include the gas and vapor power cycles and refrigeration cycles. Some general introduction to the issues of energy and environment.

#### MAE221 Fluid Mechanics

This course introduces fundamental concepts of fluid mechanics, fluid statics, basic equations in integral form, basic equations in differential form, Bernoulli equation, dimensional analysis and internal viscous duct and boundary layer flow.

#### MAE231 Mechanics of Materials

Basic structural mechanics modeling will be covered for students to learn various materials behavior systematically. Through its application the formation of various structural components and parts will be

analyzed and understood.

#### MAE251 Dynamics

This course introduces dynamic systems for motivation enhancement and kinematics of rigid bodies including velocity and acceleration calculated in various reference systems. Topics include: kinetics of rigid body including Newton's law, work-energy methods, impulse-momentum methods, measurement of important properties for dynamic analysis. Commercial computer software for dynamic analysis is also introduced.

#### MAE301 Numerical Analysis

This course covers numerical modeling, computers and error analysis, roots of equations, linear algebraic equations, curve fitting, numerical differentiation and integration, ordinary differential equations, and partial differential equations.

#### MAE302 Creative Problem Solving

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

#### MAE305 Mechanical Engineering Lab II

Various equipments will be applied to explain the essential experiments in mechanical engineering. Measurement and processing of data will be carried out using a PC. Topics include systematic ways to select the measurement parameter, to collect and process the data, and to report and present the experimental results.

#### MAE307 Applied Electronics

Applied Electronics covers the fundamental principles of the electrical engineering and electronics, and provides design and experimental experience for the students to develop the capability of applying principles to engineering practices. The course includes passive and active circuit elements, analog and digital systems, and electronic instrumentation.

#### MAE311 Heat Transfer

This course deals with transport phenomena associated with steady and transient heat conductions, forced and free convections, and thermal radiation. Basic heat transfer mechanisms, modeling and formulation of the phenomena, solution procedures, and empirical correlations will be discussed. Also some practical applications will be introduced.

#### MAE312 Energy and Environment

This course deals with the topics of energy and environment problems. It includes application of thermodynamics like chemical reactions, combustion, phase and chemical equilibrium, thermodynamics of mixture, air conditioning. Also, aerosol fundamentals, particle transport properties, origin and sources of air pollution, emission control technology and air pollutant and global climate, etc. are studied.

#### MAE320 Applied Fluid Mechanics

This course offers a brief review of Fluid Mechanics (MAE220); laminar and turbulent internal and external flows; engineering applications; introduction to compressible flows.

#### MAE330 Foundation of Stress Analysis

This class is designed to train students to handle the deformation of solids under various field loads

analytically and physically. The class will focus on the basic ideas of stress, deformation, energy methods and establishing the governing equations for stress analysis of unsymmetric beam, curved beam, torsion of beam with complex cross section and plates.

#### MAE340 Engineering Design

This course offers a systematic design methodology encompassing all the design processes from the conceptual design to the embodiment of products. The whole process of product design starting from the problem definition, creation and synthesis of ideas, evaluation of the ideas, and combination of the generated ideas are included. The course is highlighted by the group project in which students can have practical experiences through the actual product design, manufacturing, operation, and presentation of the results, which requires the synthesis of all the knowledge and techniques acquired through their undergraduate courses.

#### MAE341 Mechanical Component Design

This course deals first the design methodology and failure criteria based on the deterministic and stochastic analyses. Then the design of mechanical components such as gears, bolts, nuts, shafts, spring, bearings are taught by both the classical safety factor approach method and the reliability or statistical method.

#### MAE342 Mechanism Design

This serves as an introduction to planar linkage kinematics and mechanism design with special emphasis on kinematic synthesis. Topics include displacement and velocity analysis, acceleration analysis, dynamics of mechanisms, cam design, gear trains and kinematic synthesis.

#### MAE351 Mechanical Vibrations

This course is designed to give students ability of vibration analysis for dynamic system.

Prerequisites: Dynamics (MAE250).

#### MAE360 Modeling and Control of Engineering Systems

This course deals with modeling and control of engineering systems including mechanical systems and electrical systems. In this course, differently from conventional approach, some practical systems are introduced first for control experience, and then the basic principles are presented for mathematical modeling and feedback control.

#### MAE361 Introduction to System Dynamics

This course deals with linear and nonlinear system modeling methods by studying integral process and common concepts of mechanical device, electronic device, fluid and thermodynamics device.

#### MAE370 Understanding of Materials and Processing

This course covers the basic principle of engineering materials and fabrication processes as well as the micro-fabrication processes for the semi-conductor and MEMS processing.

#### MAE371 Advanced Materials Engineering and its Application

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.

#### MAE400 Capstone Design I

This course helps to provide the students who already have taken engineering design course the ability to apply the design knowledge to practical industrial problems and the creative problem solving ability based on

the design methodology and techniques. The design team starts to solve the problem by defining the problem and further tries to think of new creative designs followed by detailed designs. The design team then makes a design prototype and evaluates the result. During this entire process, the advisorial group of professors and researchers, related with the chosen topic, gives assistance to achieve the design objective.

#### MAE401 Capstone Design II

This course is a continuation of Capstone Design I and based on the designed item the design is further refined to meet the industrial requirements of the industry. The opinions from the industrial side is fed back to design for completion of the design objective. The evaluation is performed in the public presentation.

#### MAE403 Application of Computer Graphics

Computer graphics on the Internet will be introduced with hands on experience. It covers VRML (virtual reality modeling language), X3D (Extensible 3D, XML for 3D), Java3D, MPEG-4, and also commercial systems Cortona, EON Studio, Cult3D. Term project will be a group project where you should build a cyber world on the Web.

#### MAE411 Design of Thermal Fluid Systems

The objective of this course is to study optimum design methods for thermal fluid systems that consist of various components such as pump, compressor, heat exchanger, burner, expansion valve, reactor and distillation tower, etc. First, methods to make mathematical equations to simulate operational performance of each component are presented and solution methods for systems of simulation equations for large system are explained. A number of popular optimization methods are explained in detail and they are used to find the optimum configuration for each component that make up the total thermal fluid system.

#### MAE413 Engine Technology

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.

#### MAE414 Applied superconductivity and Thermal Engineering

This course covers basic principle of superconductivity and advanced refrigeration technology with specific refrigeration components such as compressors, refrigerants, expansion devices, 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 the possible improvement for successful commercialization of superconducting technology.

#### MAE430 Introduction to Reliability in Mechanical Engineering Design

This course treats statistical distributions and methods for evaluation of reliability in mechanical engineering design. The students also learn briefly and efficiently about general fundamental statistics. Projects to evaluate reliability are assigned to students.

#### MAE431 Introduction to Continuum Mechanics

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.

#### MAE432 Deformation, Fracture and Strength of Materials

This course will treat the subjects of deformation, fracture and strength of materials which are essential considerations in mechanical design. The dislocation theory and fracture mechanics will also briefly treated.

#### MAE440 Engineering Design via FEM

This course provides an introduction of FEM, and its application for mechanical engineering design and analysis at the undergraduate level. Basic principles and background of FEM are discussed with the aid of various mechanics examples illustrating the fundamentals of FEM, with the minimum usage of advanced math skills. Typical examples include the coverage of simple elements such as a spring, a truss and a beam via the principle of virtual work, and the extension of this concept to the continuum level. Students will be exposed to intensive use of commercial codes during the lab hours to acquire various techniques for applications of commercial packages for design and analysis.

#### MAE441 CAE Systems and Applications

Through introduction of various software systems in use in industry and research sectors, the state of the art in practical engineering analysis and design are reviewed. Also introduced are basic principles and limitations of the software tools in the areas of solid mechanics, thermal fluid and dynamical systems. Methods included are finite difference, finite element, mesh free, algebraic differential equation, optimization and other simulation techniques. A literature survey of CAE application cases must be presented. A CAE project of student's interest area must be performed and presented.

#### MAE452 Noise Control Engineering

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 competitions and experiments may be included.

#### MAE453 Introduction to Robotics Engineering

In the robot motion, one will analyze the static and spatial restriction factors and deal with basic robot design and applications.

#### MAE460 Automatic Control

The subject of the course is to study methods to improve the performance of the mechanical control systems by analyzing their characteristics by transfer function between input and output or by state space approach. contents include analogy between mechanical system and electrical system, modeling of mechanical systems, characteristics of closed loop control system.

#### MAE461 Introduction to Fuel Cell System

This course aims overall understanding of fuel cell systems by studying mechanism, thermodynamics, electrochemical energy conversion and loss, major balance-of-plants such as fuel processors, power conditioning systems, gas moving systems for fuel cells. The course also includes lectures on constructing materials of fuel cells in detail.

#### MAE471 Precision Engineering

Students learn about the principles in design and manufacturing of precision machines and precision components. This course includes lectures and experimental practices on precision machine design and realization of a real products using precision machine tools, measuring machines, and corresponding software.

#### MAE474 CAD / CAM (Computer Aided Design and Manufacturing)

This course concentrates on learning about definitions, history, development directions, principles and

applications of CAD / CAM and improving applicability by pursuing a sequence of exercises and a term project.

#### MAE481 Introduction to Electromagnetism & Optics

This course deals with fundamentals of electromagnetism and optics that are of significant importance in modern mechanical engineering. Emphasis is given to understanding of basic principles and applications of electromagnetic forces, motors, and electromagnetic wave propagation. Optics is also treated with the aims of gaining deep comprehension of elementary and system technologies needed to design opto-electro-mechanical systems.

#### MAE483 Introduction to Statistical Thermodynamics

This introductory course deals with principles of theory and application of statistical thermodynamics for students with mechanical engineering major. The course includes principles of kinetic theory and transport phenomena, relation between classical and statistical thermodynamics, and fundamentals of quantum statistical mechanics. Furthermore, applications of statistical thermodynamics to the gas, liquid and solid systems are introduced.

#### MAE484 Structure & Function of Human Body

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.

#### MAE490 Thesis Study

A research project is undertaken during the final part of undergraduate study under the supervision of a faculty member. The project topic is agreed on by both the supervisor and the student.

#### MAE491 Special Topics in Mechanical Engineering

This course deals with selected special subjects in mechanical engineering that are important but were challenging to be included in other courses.

#### MAE495 Individual Study

Students choose project topics and are supervised by a faculty member.

#### MAE496 Seminar

Recent advances and related topics in mechanical engineering are presented by invited lecturers.

### **□ Graduate Course**

#### MAE500 Mathematical Methods in Mechanical Engineering

Basic mathematical skills, matrices, linear equations, and linear space will be covered for application to mechanical engineering.

#### MAE502 Introduction to Finite Element Method

In this course finite element method is introduced to solve differential equations.

#### MAE505 Measurement Instrumentation

Basic principles, concepts, and methods of measurement instrumentation of physical quantities dealt with significance in mechanical engineering are introduced. Emphasis is given to the measurements of lengths, forces, and temperature with mechanical, electromagnet, and optical instrumentation technologies.

#### MAE510 Advanced Fluid Mechanics

Fundamental knowledge on fluid flows is discussed. Derivation of the basic equations and several relevant approximate flow models are introduced. Both inviscid and viscous fluid models are treated.

#### MAE511 Advanced Thermodynamics

This course deals with advanced classical thermodynamics for the graduate student. It covers basic concepts and postulates, entropy generation and exergy destruction, condition of equilibrium, thermodynamic functions, reversible process and maximum work theorem, Maxwell relations, stability of thermodynamic system, phase transitions and critical phenomena. It also includes chemical thermodynamics and irreversible thermodynamics.

#### MAE512 Advanced Heat Transfer

The aims of this course are to give the students more concrete understanding of basic ideas of heat transfer and to enable them to design actually applicable devices. Brief introduction to recent research topics will be added at the end. There will be a few homework assignments.

#### MAE513 Advanced Combustion

This course deals with the calculation of thermochemical equilibrium, chemical kinetics, governing equations for reacting flow, premixed flame, diffusion flame and heterogeneous combustion.

#### MAE514 Multiphase Flow I

This course deals with various aspects of flow and heat transfer phenomena in multiphase systems, mostly focused on the gas-liquid flow. Basic flow patterns and their background physics, conservation equations, analytical models and experimental results are introduced. In addition, details on the boiling and condensation heat transfer phenomena are discussed. To take this course, basic knowledge on fluid mechanics, thermodynamics, and heat transfer are required.

#### MAE515 Cryogenic Engineering

This course reviews the overall cryogenics fundamentals along with an introduction to 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.

#### MAE521 Viscous Fluid Flow

This course discusses equations of viscous flow; classical analytical and numerical solutions; flow regimes and approximations; laminar boundary layers - solution methods, and applications; introduction to stability theory; turbulent boundary layers - mean-flow and Reynolds stress equations, modeling, solution procedures, and applications.

#### MAE525 Turbomachinery

The objective of this course is to first study the basic principle of analysing the performance of axial, centrifugal and regenerative type turbomachines and to carry out optimum design of such turbomachines. In order to establish sound theoretical background, fluid mechanics and thermodynamics are re-examined in depth. The analysis and design methods presented in this course can be directly applied to practical industrial fields.

#### MAE530 Advanced Mechanics of Solids

Fundamentals of solids mechanics are treated from the continuum mechanics view, and the content of the undergraduate solid mechanics is extended and generalized to the graduate level.

#### MAE531 Numerical Stress Analysis

This course offers theoretical bases of the finite element method for linear elastic problems. Various elements are introduced and their merits, defects, and remedies are discussed. Techniques for error analysis, dynamic analysis, and nonlinear analysis are covered. Effective modeling techniques are practiced through engineering problems.

#### MAE533 Fracture Mechanics

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 elasto-plastic fracture. Other fracture related topics such as fatigue, creep fracture, corrosion fracture are briefly introduced.

#### MAE534 Fatigue, Fracture and Strength

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.

#### MAE535 Experimental Stress Analysis

In this course the experimental methods and associated techniques, through which mechanical properties of engineering materials such as stress, strain, strength and fracture toughness can be evaluated, are introduced and explained through experimental examples.

#### MAE536 Mechanics of Plastic Deformation

The course deals with the fundamental theory of plasticity including the constitutive relations in plastic deformation and the methods of analysis for grasping the deformation behavior. The analytic solution of nonlinear problems in plastic deformation will be discussed and partially, the method of numerical analysis will be introduced.

#### MAE537 Optimal design of Composite Structures

This course introduces anisotropic solid mechanics based on the classical plate theory (CLT). 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.

#### MAE543 Optimal Design

This course introduces optimization methods and theories. Capability of selecting and applying various algorithms is emphasized. Techniques for formulation and optimization of real problems are covered including discrete optimization, multi-criteria optimization, evolutionary programming, and probabilistic optimization.

#### MAE545 Theory of Hydrodynamic Lubrication

This covers 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.

#### MAE546 Vehicle Dynamics

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.

#### MAE547 Knowledge-Based Design System

Computers are replacing more human work requiring low-level 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.

#### MAE548 Feature-Based Modeling

The geometric kernel is the engine of a CAD / CAM system. The basic concepts of a geometric modeler, parametric design, and feature modeling will be introduced. The group term project allows you to develop a geometric modeler. The history-based parametrics is also introduced.

#### MAE549 Reliability in Microsystems Packaging

The importance of reliability in microsystems packaging are treated. The topics of 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.

#### MAE550 Advanced Dynamics

Kinematics of two and three-dimensional motions of rigid bodies are started with as well as particle motions. An efficient and systematic method for derivation of equations of motion of such a system is studied based on Kane's approach. The most fundamental law, *i.e.*, Newton's 2nd law and other advanced dynamic (Hamilton and Lagrange) equations are covered as well for comparison purpose.

#### MAE551 Linear Vibration

Beginning with linear system theory, principles in advanced dynamics are introduced. Then, single and multiple degree-of-freedom(DOF) systems are covered. Relevance of eigen-value problems to multiple DOF system analysis is introduced together with some numerical techniques. How to deal with distributed systems such as string, rod, beam, membrane and plate is covered for simple geometries. Numerical approximation techniques for the distributed systems are studied finally.

#### MAE552 Introduction to Acoustics

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 the octave scale, are introduced and effective exercises are performed.

#### MAE553 Robot Dynamics

To develop an understanding and facility with basic analytical tools for the analysis and design of multi-body dynamic systems through robotic manipulators.

#### MA554 Future energy-utilization engineering

This course covers several different topics related to future energy utilization in the 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, trans-critical 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.

#### MAE561 Linear System Control

This course is 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 eigen-structure assignment

#### MAE562 Digital System Control

This course introduces the basic concept of discrete time control in the time domain and the state space. the major results of control theory such as stability, observability, controllability, optimality, etc. will be reviewed for the discrete time case. some other contents included in this course are sampling theory, discrete modeling of the systems, discretization of continuous system, microprocessor applications, etc.

#### MAE563 Microprocessor Application

This course is designed to give graduate students the ability to understand basic principles of microprocessors and their applications in modern product designs. Prerequisites by topics: basic electrical circuits, computer languages.

#### MAE564 Artificial Neural network : Theory and Applications

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

#### MAE570 Advanced Manufacturing Systems

This course includes the design and automation of the manufacturing system, rapid product and micro fabrication technologies.

#### MAE571 NC Machining & CAM

In this course, students learn about basic principles in Numerical Control System and machining mechanism. This course includes lectures and practice for precision machine design and realization of real products using CAM with Intelligent Machine, Measurement and Verification.

#### MAE574 Joining Engineering

This course involves the principle and application of the joining / welding technologies as well as the electronic and MEMS bonding technologies.

#### MAE582 Introduction to Microfabrication Technology

Based on the fundamental IC process technology, basic MEMS (Micro Electro Mechanical System) technologies such as bulk micro-machining, surface micro-machining, 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.

#### MAE583 MEMS Design and Experimental Microfabrication

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 a base for independent MEMS research. It also covers recent interdisciplinary subjects such as microfluidics, piezo-MEMS, optical - MEMS, and Bio-MEMS.

#### MAE585 Mechanics and Control of Human Movement

This course covers methods for modeling and analyzing human movement as bio-mechanical 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.

#### MAE586 Biomechanical modeling and simulation of tissue behavior

The course provides an overview of musculo-skeletal anatomy, the mechanical properties, behavior of biological tissues. Topics include structure and function relationships in tissues and organs; application of stress and strain analysis to biological tissues; introduction to modeling viscoelastic tissues; digital human anatomy modeling; real time simulation of a tissue behavior.

#### MAE587 Optomechanics

This course will treat a new engineering field termed "optomechanics" and focus on an integrated approach to effectively combine multi-disciplinary fields (optical / mechatronic). Based on the review of fundamental 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 this fused technology.

#### MAE588 Fuel Cell System Design and Numerical Analysis

This course aims understanding and acquirement about numerical analysis and optimization technique of thermal and fluid system to design fuel cell system. The course also includes system analysis and design technique including balance-of-plant to obtain efficient fuel cell system.

#### MAE591 Random Data: Analysis and Processing

The course introduces fundamental concepts associated with probability, correlation and spectrum which are required for analysis of random data in the ensemble, time and frequency domain analyses, respectively. Random input and output relationships in linear systems are then described in terms of the correlation and spectral density functions. In particular, techniques using coherence and spectral density functions are demonstrated with various application examples. Data acquisition, processing and qualification issues are also discussed for digital data processing.

#### MAE592 Laser: Principles and Applications

This course deals with the principles and applications of various lasers. The principles of laser generation and modification will be introduced. The applications of lasers in different measurement systems and materials processing including electronic fabrication will be treated. Finally laser application in information handling and communication will be explained.

#### MAE603 Advanced Mathematical Methods in Mechanical Engineering I

Properties and solution methods of partial differential equations in mechanical engineering are treated in this

course. Additionally, initial and boundary value problems, of diffusion, equation, wave equation and Poisson equation, Green's function, method of characteristics, weak solution, and perturbational methods are included.

#### MAE604 Metrology

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 electromagnetic wave interference are explained with emphasis on monochromatic interferometry, white light scanning interferometry, holography, and speckle and moire interferometry.

#### MAE605 Boundary Element Method

Mathematical background of boundary integral equations is introduced with basic tools. Boundary element discretization is explained using 2-D potential problems. Various manipulations for boundary conditions, body forces, initial strain, etc. are studied with programming techniques. Various application areas such as acoustics, transient problems, and shape design sensitivity analysis will be discussed. Students are required to submit term project reports and present one of them.

#### MAE606 Creative Knowledge Creation Process and Application

The course is designed to teach creative learning methods, computer-aided group ideation and methods for generating creative knowledge toward technological innovation. The course covers creative learning theories, creative idea generation techniques using related computer-aided creativity methods, knowledge creation model for technology innovation and computer-aided knowledge creation process. These newly learned techniques are then applied to practical examples in student groups.

#### MAE607 Computational Linear Algebra

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.

#### MAE611 Convective Heat Transfer

This course deals with various fundamental aspects of convective heat transfer. The mechanism of convective heat transfer and the approach involving analytical methods are going to be discussed in depth. The major topics included in this course are the laminar / turbulent heat transfer in internal / external flows and the forced / natural convections. The students are assumed to have taken the introductory courses on fluid mechanics and heat transfer.

#### MAE612 Transport Phenomena

Discussions are given for a fundamental understanding of mechanism of transport phenomena. A thorough review is conducted for the basic equations in arbitrary continuum and transport processes by molecular motions.

#### MAE613 Computational Fluid Mechanics and Heat Transfer

The purpose of this course is to familiarize the students with numerical methods of treating differential equations in fluid and thermal engineering fields. In this course, participants develop abilities for predicting and analyzing diverse physical phenomena by using a program. Through homework assignments on the various contents as well as term projects, students can analyze physical models numerically.

#### MAE616 Automobile Technology and Environment

Principles of engine technology and performance analysis for the environmentally-friendly design and

operation are discussed. The key technologies to reduce and treat hazardous exhaust emissions from the automobile systems (especially engines) are focused on. Advanced engine concepts are introduced to emphasize new power-plant aiming for fuel economy and low emissions to solve both environmental problem and energy resources crisis.

#### MAE621 Turbulence

An introduction to turbulence and the topics of governing equation and turbulent flows, statistical description of turbulence, kinematics and dynamics of homogeneous turbulence, spectral dynamics of turbulence, boundary-free shear flows, wall-bounded shear flows and recent trends in turbulence research are covered.

#### MAE623 Rotating flow

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

#### MAE631 Analytical Solid Mechanics

Advanced theories on solid mechanics, including mathematical formulations of large deformations and some constitutive theories, are covered in this course.

#### MAE632 Theory of Viscoelasticity

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 final weeks of the course.

#### MAE633 Mechanical Behavior of Polymeric and Composite Materials

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.

#### MAE634 Intelligent Structures and Components

In this course smart structure or intelligent system, which can respond properly to the given environments such as applied load and dynamic forces, will be introduced. The basic theory and design method will be explained with associated components of smart structures such as sensors, actuators and controllers.

#### MAE635 Plastic Analysis and Design of Structures

Plastic analysis is introduced emphasizing its difference from 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 structures are also considered for plastic analysis and optimum design.

#### MAE638 Axiomatic Design of Composite Structures

This course is a continuation of MAE 537. It deals thoroughly with the joining process of composite structures, manufacturing and transport issues in composite materials, and impact and fatigue properties of composite structures. After students become 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 thoroughly treated.

#### MAE641 Computational Machine Dynamics

Theoretical background of the numerical method of analyzing multi-body dynamics will be dealt with along

with application. A commercial package is used for practice of applying the method for real problems.

#### MAE642 Medical Biomechanics

Study the structure, function and its behavior of human musculo-skeletal system, identify the physical problem of musculo-skeletal system to find contribution in solving those problems applying mechanical principles.

#### MAE643 Theory of Mechanisms

The kinematical behavior of mechanical system is dealt with in depth including 3-dimensional space and systematic computer aided design methodology will be introduced based on graph theory for type and dimensional synthesis.

#### MAE644 Tribology

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.

#### MAE647 STEP for Electronic Commerce

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.

#### MAE651 Rotor Dynamics

The course introduces simple rotor systems and gradually progresses to the complex systems such as gyroscopic and speed-dependent parameter systems, with a description of all analytical solutions for discrete and continuous rotor systems. It then introduces the concept of lambda matrices, which allows a unified approach to the rotor vibration problems. Some practical issues such as balancing and directional spectral analysis techniques are also treated.

#### MAE652 Computational Vibration Analysis

This course covers various computational methods for structural vibration analysis. The topics include discrete and continuous modeling, qualitative behavior of Eigenvalue Problems, efficient algorithms for eigen properties calculation, forced response analysis, finite element analysis for vibration, etc. Also, the new emerging techniques such as component mode synthesis, eigen-property sensitivities, structural dynamics modifications will be studied. At the end the course, all the students will have the experience to do a term project related to computational vibration analysis.

#### MAE653 Mechanical Signatures and System Analysis

This course is intended to give a profound perspective on the meaning and utility of mechanical signatures that can be observed in sound and vibration 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. 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 design of quiet machines.

#### MAE654 Noise Control

Various environmental pollutions are being concerned very much along with the fast development of industry and living standard. Among various pollution topics, 'noise,' in particular from various mechanical systems,

becomes a big concerning item to generals and manufacturers because the machine noise is usually directly related with the ordinary life of human beings. The quietness of machines becomes one of quality and market value evaluation points of a machine and the customers and regulations demand a lot of noise-related functions to the machine manufacturers. In this course, for the high value design of machines and the quietness of everyday life and environment, source characteristics, human perception characteristics, identification of noise sources and transfer paths, product sound quality, and countermeasure plans are studied, which should be in mind for a noise and vibration engineer.

#### MAE655 Robotics Engineering

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

#### MAE661 Optimal control

The course will introduce linear quadratic design concepts with LQR and LQG ideas, and provides the bridges to LQG/LTR and introductory H<sub>∞</sub> synthesis. Numerical solving with Matlab software is encouraged to illustrate the design methodologies. Once the LQR concept is established, the tracking and disturbance rejection problem is dealt with in a linear quadratic sense. For the output feedback system, the measured signal corrupted with noise will be handled with the optimal estimation, and the stochastic regulator problem will be studied as a LQG design with fixed-order compensation. Then the robust-system design issues are discussed. A term project that applies the optimal control method will be pursued and completed.

#### MAE662 Design of Precision Actuation System

This course is designed for graduate students. In the beginning, design principles are introduced. Next, several structure design techniques such as kinematic design, flexure mechanism design, guide mechanism design, etc. are studied. Then, error analysis/compensation and uncertainty analysis are covered. 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.

#### MAE683 Human Robot Interaction: Haptics

As the human-robot interaction is becoming an important issue for the upcoming human-robot symbiosis era, this year's lecture course 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 on by joint guest lecturers and with Prof. Kwon.

#### MAE692 Wave Propagation

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

#### MAE694 Discrete Event Systems and Applications

This course introduces the discrete event systems theories for modeling, design, analysis, evaluation, and control of systems. The course focuses on Petri-nets-based supervisory control theories with sound mathematical foundation.

#### MAE711 Radiation Heat Transfer

Starting with fundamental concepts, the most advanced topics are treated in depth. It is aimed that the students will be able to understand and analyze the fundamentals of boilers, industrial furnaces, space heat

transfer, super-insulators and etc.

#### MAE712 Experimental Methods in High Temperature Thermal Engineering

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, laser emission spectroscopy, flame scanning, flame extinction, flame probe measurements.

#### MAE714 Multiphase Flow II

This course deals with various advanced topics on multiphase flow such as the interfacial behavior, two-phase flow instabilities, critical flows, phase separation at branches, microchannel flows and some other current topics of interest. Basic knowledge of two-phase flow phenomena is required before taking this course. The students taking this course are strongly encouraged to actively participate in class discussions on each topic.

#### MAE722 Computational Turbulence Modeling

The purpose of this course is to study logical methods to develop computational turbulence models at various closure levels. Modeling philosophy is exemplified in detail for the mixing length model and the two-equation model. The model behavior is investigated with a number of ideal benchmark flows and the effects of model constants are discussed. Recent methods of LES and DNS are also presented.

#### MAE723 Theory of Hydrodynamic Stability

This course introduces the basic concept and mathematical method for the hydrodynamic stability, Bernard problem, stability of Couette flow and stability of parallel flow. Also, it deals with the introduction of nonlinear stability and recent research or technology.

#### MAE724 Stratified flow

Physical descriptions of stratified flow are dealt with. Flow models of inviscid and viscous fluids are also discussed.

#### MAE731 Nonlinear Computational Mechanics of Solid

Material and geometric nonlinear mechanics of solids is covered from the viewpoint of computational methodology, with the main focus being given to finite elements and the related computational methods.

#### MAE732 Reliability in Strength Design

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.

#### MAE734 Analytical Fracture Mechanics

Various conservation integrals in regard to fracture mechanics are studied beginning from Nöther's theorem and Eshelby's energy momentum tensor. Their application to recent fracture mechanics is studied, emphasizing recent developments in interfacial fracture mechanics (isotropic and anisotropic bimetals, etc).

#### MAE738 Design of Light Sandwich Structures

The weight reduction of mechanical, aerospace structures and infra-structures not only reducing material usage, but also reduce energy consumption during their operations. This course introduces methods for the design of composite faces and cores of sandwich structures. Also the adhesive bonding between the faces and cores of sandwich structures are thoroughly treated. Then the design, characterization and manufacturing method of composite structures are treated in detail.



#### MAE741 Advanced Optimal Design

This course introduces theories and methods dealing with distributed parameter optimization, shape design sensitivity analysis for mechanical and structural systems. Formulations of recent topics are then introduced together with typical algorithms, implementations, and applications: reliability-based design optimization, robust design, Pareto optimality, and topology optimal design.

#### MAE752 Structure-borne Sound

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 sound is radiated from structures that received an amount of excitation power, and how sound is transmitted through an enclosing structure of a machine and a partition separating two connected cavities.

#### MAE761 Nonlinear System Control

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

#### MAE762 Adaptive Control System

This course deals with the adaptive control method such as model based adaptive control (MRAC), STR, LMFAC and the various constant measurement methods based on the least square method. Theoretical analysis involves the adoption theory of Lyapunov, Popov, robustness analysis, stochastic adaptive control and variable measurements by Kalmana filter.

#### MAE771 Analysis and Design of Metal Forming Processes

The basic analysis techniques required for design of the manufacturing processes such as extrusion, rolling, forming, deep drawing, etc. are introduced in this course. The fundamentals of such design procedures will be instilled through case studies and experiments.

#### MAE800 Special topics in Mechanical Engineering

This lecture is designed to deal with selected theory and application in mechanical engineering. Specific topics for this course will be made available before the semester begins.

#### MAE810 Special topics in Thermal & Fluid Engineering

This lecture is designed to deal with selected theory and application in thermal and fluid engineering. Specific topics for this course will be made available before the semester begins.

#### MAE830 Special topics in Design Engineering

This lecture is designed to deal with selected theory and application in design engineering. Specific topics for this course will be made available before the semester begins.

#### MAE850 Special topics in Dynamics and Control

This lecture is designed to deal with selected theory and application in dynamics and control. Specific topics for this course will be made available before the semester begins.

#### MAE870 Special Topics in Production Engineering

This course is designed to deal with selected theory and application in production engineering part. Specific topics for this course will be made available before the semester begins.

MAE960 M.S. Thesis

MAE966 Seminar (M.S. Program)

Recent advances and related topics in mechanical engineering are presented by invited lecturers. Also, special projects and thesis study given to students are presented and discussed. The students of this course are guided by an advising professor.

MAE980 Ph. D. Thesis

MAE986 Seminar (Ph. D. Program)

Recent advances and related topics in mechanical engineering are presented by invited lecturers. Also, special projects and thesis study assigned to students are presented and discussed. The students of this course are guided by an advising professor.