Course Descriptions

❒ Undergraduate Program

MAE200 Basic Mechanical Practice

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.

MAE210 Thermodynamics

This lecture covers definition and concepts related to thermodynamic laws. 1st and 2nd laws of thermodynamics are explained. Properties of pure substances including ideal gases and real gases are covered in processes of energy conversion systems such as heat engines and heat pumps. Chemical equilibrium condition is derived from the fundamental law of the nature.

MAE220 Fluid Mechanics

This course covers the basic fundamental subjects of the fluid mechanics. The detailed materials covered are introduction to fluid mechanics, fundamental concepts, fluid statics, integral form of basic equations, differential form of basic equations, dimensional analysis and similitude, and incompressible inviscid flow. Brief introduction to compressible flow and viscous flow is also provided.

MAE230 Solid Mechanics

This course introduces the mechanics for the elementary structural members such as bars, torsion bars, and beams. The concepts for stress and strain, stress-strain relationship, deformation, statically determinate and indeterminate structures, and bucking are covered.

MAE250 Dynamics

Basic principles of dynamics are introduced in this course. Rotating and inertial coordinate frames are used to describe dynamic motion of a number of example problems. Absolute and relative motion descriptions are introduced depending upon the types of problems. Principles of work-energy and conservation of angular and linear momentum are presented with example systems. Systems of particles are also discussed with definition of the center of mass. Both particle dynamics and rigid body dynamics including rotational degree-of-freedom are covered extensively. We also cover definition of angular momentum with respect to different base points. Various aerospace vehicle examples are used to help understanding basic concepts.

MAE260 Elementary Mathematics for Aerospace Mechanics

This course deals with fundamental mathematical theories and skills often used in major subjects in Aerospace Engineering. Topics to be covered include calculus, linear algebra, (linear) differential equations, and approximation methods. Mathematical details are given together with clear indication on how they are applied in the engineering problems in Aerospace Engineering.

MAE285 Software Application in Aerospace Engineering I

This course is intended to cover several key software languages such as MATLAB, C++, Visual C++, and FORTRAN, which are applicable to various aerospace engineering applications. Introductory lectures about each subject including technical content as well as intensive lab practice are provided. Basic tutorial introduction to real-time operating systems is also planned. After taking this course, students at moderate

level will be able to develop application software tailored to applications.

MAE291 Introductory Space Projects
This course introduces the fundamental operational principles for the space systems. Lectures and labs on various issues on design and operation of launch vehicles / spacecraft and related disciplines (fluid, structure, propulsion, dynamics / control and communication) will be provided.

MAE292 Introductory Aeronautical Projects
This course introduces aeronautical engineering to young undergraduate students by performing basic design project. From the brief history of flight, various fundamental aspects of aeronautical systems will be covered including mechanics and system design. Students will design and manufacture remote controlled model airplane or airship based on the defined design mission, and finally perform flight testing.

MAE301 Numerical Methods
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.

MAE307 Applied Electronics
This course covers the fundamental principles of the electrical engineering and electronics, and provides design and experimental experience for the students to develop the capability to apply the principles to engineering practices. The course includes passive and active circuit elements, analog and digital systems, and electronic instrumentation.

MAE308 Aerospace Engineering Laboratory I
This is the first course of a two semester sequence dealing with basic concepts of experimentation, analog and digital signal processing, measuring system characteristics, and their application in engineering testing and experimentation. Topics include measurements of material properties, pressure and velocity, thermal behavior, and vibration characteristics of structures.

MAE 309 Aerospace Engineering Laboratory II
This course is the second of a two-semester sequence dealing with experimental planning, probability and statistics, uncertainty analysis, and their application in engineering testing and experimentation. Topics include measurements of structural buckling, vibration, lift and drag, flame characteristics, shock tube testing, noise analysis, and attitude control of aerospace vehicles.

MAE311 Heat transfer
Fundamental concepts of basic heat transfer modes in various type of coordinates are introduced. Conduction, convection and radiation heat transfers in diverse configuration and flow conditions are covered. Also see course description of the same course in Department of Mechanical Engineering.

MAE315 Aerospace Propulsion System
A propulsion system refers to a device that transforms energy stored in a chemical compound into propulsive power in a flight vehicle. The majority of propulsion systems are built upon heat engines in order to release the chemical energy into heat that is eventually converted to mechanical power. In this course, students learn how basic knowledge of thermodynamics, fluid mechanics, and gas dynamics is applied to the design and performance evaluation of aerospace propulsion systems.

MAE325 Aerodynamics
Aerodynamics is a branch of fluid mechanics, and deals with the forces and moment of solid bodies in

relative motion with the fluid. In the present course, particular interest is given to the air as an inviscid incompressible medium. The property of air, its characteristic changes around immersed bodies, mathematical description of air flow, conservation of mass principle, conservation of momentum principle, derivation of the Bernoulli's equation, mathematical modeling of the ideal flow, the method of images, the concept of circulation, the Kutta-Joukowsky theorem, and the generation of lift and moment will be covered. Also covered are the two-dimensional thin airfoil theory and the three-dimensional lifting-line theory.

MAE326 Compressible Aerodynamics

State of a compressible flow is changed by arrival of various waves of finite speed. Study of waves in the compressible flow is therefore of foremost importance. Thermodynamics and conservation Laws are first presented. Isentropic flow, quasi one-dimensional nozzle flow, normal shock wave, oblique shock wave, Prandtl-Meyer expansion waves are discussed. Gas flow affected by the wall friction (Fanno flow) and heat transfer (Rayleigh flow) is formulated. Unsteady shock waves and shock tube problems are discussed. Computer program for the general one-dimensional gas dynamic flow is tested.

MAE335 Aerospace Structures

Basic structural elements including wing and fuselage, aerospace materials, basic elasticity, torsional problems for closed single-cell and multi thin-walled sections, bending and flexural shear, flexural shear flow in thin-walled sections, failure criteria for isotropic materials, elastic buckling and composite laminates will be discussed in this subject.

MAE351 Mechanical Vibration

Based on the dynamics (MAE250), the governing equations for the vibration of mechanical systems are derived. The analysis methods for the free and forced vibrations of the linearized 1-DoF, 2-DoF and M-DoF systems are studied. The mode analysis, matrix methods and frequency response analysis are studied with the practice examples. Vibration measurement, analysis and design methods are studied with the real applications.

MAE365 Flight Mechanics

This course covers the study of lift, drag, thrust and power for maximum range and endurance of propeller and jet aircraft. Topics Include: Discussion of climb flight, take off and landing, turning flight and accelerated climb flight, Study of longitudinal and lateral static stability and control, Discussion of wing installation position and geometric angles of wing effects on stability, Introduction of dynamic stability & control, Effect of propulsion on stability, and Discussion of vertical & high speed flight performances.

MAE405 Aerospace System Design I

A standardized aircraft design procedure is described including aspects of aircraft aerodynamics, performance, stability and control, structures, and propulsion in a single-system approach to create configuration of an aircraft to perform a specific mission. Determination of take-off weight, choice of aerodynamic configuration, selection of powerplant and their integration are covered. Students practice performing conceptual design using the design principles learned in this class.

MAE406 Aerospace System Design II

This course provides an opportunity to apply the design method covered by Aerospace System Design I as well as engineering principles taught in other lower level undergraduate courses in the process of design of an aerospace system or subsystems, procurement of parts, fabrication, system integration, and performance evaluation, including final report with recommendations for improved design. Students experience entire stages of engineering activities from scratch to functioning engineering artifacts.

MAE415 Combustion Engineering

Combustion is an essential phenomenon to extract heat from fuels. An understanding of combustion is necessary for design of efficient power and propulsion systems. This lecture covers thermodynamics and fluid mechanics of multi-species gas system. Thermodynamic principles that governs chemical equilibrium are reviewed and evaluation of adiabatic flame temperature is deduced. Issues of laminar and turbulent flames, diffusion and premixed flames are discussed.

MAE425 Viscous Aerodynamics

This course is an introduction to viscous flow theory and the Navier-Stokes equations. Boundary layer theory and the Blasius solution. Topics Include: Compressible flow boundary layer, Skin friction and convective heat transfer, Introduction to transition and turbulence, and Turbulent boundary layer.

MAE435 Computational Methods in Aerospace Structural Analysis

Matrix Algebra, One Dimensional Structures, Trusses, Two Dimensional Structures, Axisymmetric Solids, Beams and Frames, and Three Dimensional Structures will be discussed in this subject. Also, Static and Dynamic Analyses, Eigenvalue Analyses, and Stress and Deformation Analyses will be studied by using the Finite Element Method. The experience with commercial software will be helpful to the student in the future for work at a research institute or in industry.

MAE463 Global Positioning System

This course will provide an in-depth understanding of GPS architecture, signals, measurements and performance. It is by nature an interdisplinary course, covering subject material in orbit prediction, satellite systems, signal processing, error modeling, and computer programming. It will include detailed consideration of differential GPS since this innovation greatly increases the power and utility of the system.

MAE464 Fundamentals of Control Theory and Practice

Knowledges on system modeling and classical control are very important for understanding flight mechanics and aircraft control. The class will be presented with systematic modeling techniques and various analysis methods such as transfer function, Nyquist plot, Bode plot, and root locus. We also learn the basic control system design using PID and other approaches. The basic theories on moden control in state-space are also introduced.

MAE465 Flight Dynamics and Control

In the beginning, students are introduced to equations of motion of aircraft, and to the linearized and decoupled equations. Various stability/control augmentation systems such as pitch attitude control, normal acceleration control, turn coordination, yaw damper are then treated. Guidance problems such as instrument landing and path tracking are also discussed with longitudinal and lateral autopilot.

MAE466 Satellite Systems

The primary objective of this course is to introduce fundamentals of spacecraft systems. With this goal in mind, topics such as basics of orbital mechanics, orbit transfer, rendezvous, station keeping and geostationary spacecraft mission are covered. In addition, attitude dynamics of rigid spacecraft are introduced in conjunction with basic principles of spacecraft attitude control. An introduction to spacecraft sub-systems for small-scale satellites is provided on a frequent basis.

MAE467 Aerospace Sensors and Actuators

The primary objective of this course is to understand and gain practical experience through experiment with various sensors and actuators in aerospace engineering. Sensors and actuators such as GPS, PZT, FOS, angular rate sensor, accelerometer, and altimeter are subjects of study. Operational principles and application area are studied by experimental work. Moreover, sensor data is measured for quantitative

analysis.

MAE485 Software Application in Aerospace Engineering II
This course covers the basic understanding and how-to-use several commercial software packages for structural analysis like PATRAN and ABAQUS, aerodynamic analysis and design like FLUENT, and high-level technical computing and interactive environment for numerical computation like MATLAB, in aerospace engineering fields.

MAE490 Thesis Study
A student registers for this course during the preparation of his thesis based on his analytical and experimental studies.

MAE492 Special Lectures in Aerospace Engineering
This course is designed to extend the student's understanding of current topics and issues in aerospace engineering. The specific topics will be announced before the semester begins.

MAE495 Individual Study
This course is directed individual research for undergraduate students dealing with a specific area of interest.

MAE496 Seminar
Recent advances and related topics in mechanical engineering are presented by invited lecturers.

❒ Graduate Program

MAE500 Mathematical Methods in Mechanical Engineering
This course covers the following topics: Fundamental mathematical techniques applicable to study of mechanical engineering, Matrices and linear equations, Vector space, Eigenvalue problem, Quadratic form, Calculus of variations, Introduction to tensor analysis, Introduction to theory of functions of a complex variable. Conformal mapping, Integral transforms, and Asymptotic expansions.

MAE518 Rocket System Engineering
Elementary principles of the rocket propulsion system are taught in this lecture. This course is offered for senior level undergraduate and 1st year master program students majoring aerospace engineering and mechanical engineering. Students will practice design calculation to apply basic principles of fluid mechanics and heat transfer to this calculation. The lecture will cover issues of maximum velocity, acceleration, total impulse and derivation of performance parameters from thrust chamber data.

MAE522 Advanced Aerodynamics
This course covers the following topics: Conservation principles of mass, momentum, and energy, Inviscid flow and Euler equations, Potential flow theory, Fundamental solutions of potential flow, Lifting line and lifting surface theory, Effect of viscosity, and Effect of compressibility.

MAE 523 Helicopter Aeromechanics
The course deals with helicopter rotor aerodynamic performance theories such as simple momentum theory and combined annular momentum / blade element theory in axial flights, blade motion and control in forward flight, simplified performance analysis and trim in forward flight, and estimation of ground effects.

MAE524 Computational Fluid Dynamics

This course deals with classification and characteristics of partial differential equations, numerical accuracy, stability and convergence problems, error analysis, grid generation technique, numerical techniques for various types of PDEs. Lastly, inviscid flows and incompressible viscous flows are considered using these techniques.

MAE527 Experimental Methods in Aerodynamics

This course covers the following topics: Experimental Uncertainty, Issues in experimental design, Flow Measurement using LabView software, Fundamentals of signal processing, Hot-wire Anemometry, and Intro duction to PIV.

MAE528 Aeroacoustics

This course covers the following topics: Acoustic equations for a stationary homogeneous fluid; multipole expansions of sound field; Kirchhoff integral representation; scattering and diffraction; duct propagation; Lighthill's formulation on the generation of fluid induced sound, Ffowcs-Williams and Hawking for turbulence and surface in motion; vortex sound; jet, propeller and ducted fan noise, and boundary layer noise; sonic boom, effect of uniform flow, friction and heat flow; sound propagation in a homogeneous medium.

MAE538 Flight Vehicle Structures

Design considerations are covered in this course for airframes including subsonic transport and military fighter, and some thermal structures like launch vehicles and artificial satellite structures. With the understanding of space environment, effects upon space structures, thermo-elasticity and the stress analysis of thermal structures are further discussed.

MAE540 Structural Dynamics

This course covers the following topics: Vibrations of simple and complex structures, bars, strings, rods, beams, and plates; analysis of continuous and multimass systems; finite elements, Galerkin, integral equation; numerical collection; Hamilton's principle and Lagrange's equations; response of structures by modal superposition; vibration of composite materials.

MAE542 Mechanics of Composite Materials

This course covers the following topics: Classification and characteristics of composite materials; strain-stress relations of anisotropic materials; classical laminate theory; analysis of symmetric and unsymmetric laminate; interlaminar stress; failure criteria of composite; mechanical testing methods and applications.

MAE566 Spacecraft Trajectory Guidance and Control

In this course, spacecraft orbit guidance and control problems are discussed. Detailed analysis on guidance and control techniques necessary for mission operations from the launch phase is covered. In particular, lectures are given in the areas such as spacecraft rendezvous and docking, formation flying, inter-planetary mission analysis, optimal orbital maneuver, and guidance and control of reentry vehicles. Simulation study is also paralleled with lectures to provide practical experience.

MAE584 Smart Composite Lab

This course introduces various functional materials, which are the key ingredients for the smart structure implementation, and several laboratory exercises are provided to solidify understanding of the material behaviors. After the lecture on the analysis and design methods for smart structures, students will design and implement structural control system and health monitoring system for term projects.

MAE593 Aerothermochemistry and Combustion

This course covers the following topics: Thermodynamics of gas mixture; conservation equations for multicomponent reacting gas mixtures; diffusion controlled flames; premixed flames; droplet and spray combustion; flame propagation; ignition; reactive boundary layers; turbulent reacting flows

MAE594 Radiation and Combustion Phenomena

This course covers the following topics: Effects of radiative heat transfer on combustion phenomena; surface radiation; radiation in absorbing and non-absorbing media; radiation properties; solution methods for radiation; solution methods for reacting flows with radiation.

MAE595 Introduction to Optimal Control

In this course, classical optimal control theory is introduced. Then, various practical optimization algorithms are introduced and applied to trajectory optimization and flight control design. Students are supposed to develop the code by themselves. Emphasis will be given to formulation of optimization problems and numerical efficiency of algorithms such as convergence characteristics.

MAE596 Advanced Flight Stability and Control

Introduction of eigen-structure assignments, linear quadratic controller, H-infinity control synthesis, nonlinear dynamic inversion, adaptive control using neural networks, and variable structure control will be given first. Application procedure of these techniques to flight control will then be discussed. The students will conduct flight control design by themselves to learn the advantages and the drawbacks of each method.

MAE597 Spacecraft Attitude Dynamics and Control

Advanced spacecraft attitude dynamics and control subjects are covered in this course. Classical dynamics approach are introduced to establish a variety of spacecraft attitude dynamics problems. Different attitude kinematics are also discussed to provide thorough understanding on the description of attitude dynamics and kinematics modelling. Attitude control problems using on-off thrusters are explained with simulation results. Recent developments in thruster modulation techniques are addressed. Flexible spacecraft modelling and control law design are presented to provide basic knowledge on recent advances in large spacecraft modeling and control technologies.

MAE618 Kinetic Theory of Gases

This course covers the following topics: Introductory kinetic theory; transport phenomena; velocity distribution function; Maxwellian distribution; chemical equilibrium and the law of mass action; mixture of perfect gases; equilibrium gas properties; non-equilibrium kinetic theory; Chapman-Enskog solution; direct simulation Monte-Carlo methods.

MAE622 Compressible Shear Flows

Topics in High Speed Compressible Viscous Flow are studied. Topics include: Compressible laminar and turbulent boundary layers, Favre averaging, Theory of compressible turbulence and turbulence models, and Variable density flows.

MAE624 Advanced Computational Fluid Dynamics

This course covers the following topics: Properties of hyperbolic partial differential equations and Euler equations, Riemann problems, Concept of upwind methods, Godunov method for the nonlinear equation system, Random choice methods, flux vector splitting methods, approximate-state Riemann solvers, HLL and HLLC methods, Roe's method, Osher's method, AUSM series method, High-order TVD methods, Source term treatment, dimensional splitting methods. Comprehensive computer programming is requested for test problems based on the compressible nonlinear equation systems.

MAE625 Advanced Gasdynamics

The present course deals with compressible isentropic flows, method of characteristics of two-dimensional potential and rotational flows, method of characteristics of axisymmetric potential flows, numerical solution of TSD equation, FPE, and unsteady transonic small perturbation flows, and introduction to inverse airfoil design technique.

MAE626 Hypersonics Aerodynamics

This course covers the following topics: Hypersonics similarity laws; aerodynamic force coefficients; approximate closed-form solution for two-dimensional airfoils; three-dimensional hypersonic flow; angle-of attack effect; minimum-drag bodies; hypersonic small-perturbation theory and application; slender body theory; Newtonian flow theory; stability derivatives and re-entry problem; real gas effect; magneto-aerodynamics; aerodynamic heating and skin friction.

MAE627 Nonlinear Wave Theory

This course covers the following topics: Propagation, dispersion, radiation, and energy dissipation of sound waves; surface water waves, ripples, attenuation, and group velocity; Fourier analysis of dispersive waves; effect of obstacles and ship waves; internal waves in ocean and atmosphere; shock waves in a nonuniform duct; propagation of shock waves through stratified layers; diffraction of plane shock waves; stability of shocks; traffic flow; flood waves and other waves.

MAE628 Unsteady Fluid Flows

This course covers the following topics: Unsteady motion of airfoils, wings and bodies in incompressible potential flows; boundary layers and Navier-Stokes flows, transonic and supersonic flows; impulsive starting of motion; oscillatory motions; unsteady turbulent flow and unsteady separation; time-dependent fluid flow and the resulting motion and forces.

MAE629 Biomedical Fluid Dynamics

This course gives an introduction to the study of blood circulation in the heart, arteries, capillaries and veins. It covers the systemic, pulmonary and cerebral circulations. The physiological as well as pathological aspects of the heart, vessels, and blood are discussed. Mechanical modeling of circulation is introduced. Tissue engineering for the vascular grafts and cardiac prostheses are explained. Overall, this lecture offers a good starting point for students interested in the study of fluid dynamic aspects of the human body or in biomedical engineering.

MAE636 Theory of Plates and Shells

This course covers the following topics: Bending of plates; stress analysis; rectangular and circular plates; general theory of thin shell; analysis of isotropic and orthotropic circular cylindrical shell; pressurized tank; plate bending by numerical methods.

MAE637 Aeroelasticity

This course covers the following topics: Concepts of aeroelasticity; static aeroelasticity and divergence problems; dynamic aeroelasticty and flutter problems; typical section models; one dimensional structures; two dimensional structures; unsteady aerodynamics (subsonic, supersonic and transonic); strip theory; lifting surface theory; supersonic and panel flutter; dynamic response of unrestrained vehicles.

MAE663 Experiment in Flight Control

The primary goal of this course is to provide students with practical hand-on experience in aerospace flight control system design and analysis. Specific tasks will be assigned to students at the beginning of the semester. Depending on the size of the tasks, it could be individual basis or group projects. Students perform their own tasks during the semester during a laboratory hour. The tasks are very much relevant

to flight control system design. Some examples are spacecraft attitude determination experiment, predictive estimation experiment, UAV communication system analysis, flexible launch vehicle control, autonomous docking experiment, INS/GPS, vibration control, rotary wing UAV auto-pilot design, navigation by image data, etc.

MAE664 Navigation and Guidance
In this class, fundamentals of inertial navigation and GPS are introduced, and detail algorithms of strapdown inertial navigation are also discussed. For integrated navigation, Kalman filtering is studied in depth. Guidance laws for aircraft en-route flight and missile systems are also reviewed. Students are expected to conduct extensive computer simulations of GPS / INS navigation systems.

MAE665 Advanced Navigation Systems and Applications
This course introduces navigation system design with an emphasis on aviation and unmanned system applications. The lectures will cover navigation performance requirements, navigation system error models, risk classification, fault-tree analysis, navigation system hazard mitigation, and safety assesment.

MAE726 Equilibrium Hypersonic Aerothermodynamics
This course deals with the basic concepts of thermochemical phenomena occurring in hypersonic flight. Learns the basic principles of atoms, molecules, quantum mechanics, statistical mechanics, radiation, and spectroscopy related to the equilibrium state in hypersonic flows, and computational methods.

MAE727 Nonequilibrium Hypersonic Aerothermodynamics
This course deals with the nonequilibrium thermochemical phenomena occurring in hypersonic flight. Learns the transitions between internal states of atoms and molecules, chemical reaction rates, conservation equations of gas flows accounting for these phenomena, gaseous radiation, and aerodynamic effects on hypersonic flight vehicles.

MAE728 Reentry Aerothermodynamics
This course deals with the heat transfer phenomena, ablation phenomena of the thermal protection systems, and methods of testing thermal protection systems. Beginning with the theory of boundary layers in hypersonic flight, one learns the phenomena occurring at the surface of the thermal protection system, the phenomena occurring inside the thermal protection system, shock tubes, arc-heated wind tunnels, and ballistic ranges.

MAE820 Special Topics in Aerodynamics
Theories which are not covered in regular class in the field of aerodynamics are presented here in this course. This course also introduces current research activities and relevant references.

MAE840 Special topics in Flight Vehicle Structures
Theories which are not covered in regular class in the field of flight vehicle structure are taught in this course. This course also introduces current research activities and references.

MAE860 Special Topics in Propulsion and Combustion
Advanced and contemporary theories and their applications in the field of propulsion and combustion that are not adequate to be included in a regular class are covered in this lecture.

MAE880 Special Topics in Flight Mechanics and Control
Theories which are not covered in regular class in the field of flight dynamics and control are taught in this course. This course also introduces current research activities and references.

MAE890 Special Topics in Aerospace Engineering
Theories which are not covered in regular class in the field of aerospace engineering are taught in this course. This course also introduces current research activities and references.

MAE960 Thesis (M.S. Program)

MAE966 Seminar (M.S. Program)

MAE980 Thesis (Ph.D Program)