# Course Descriptions

**SPE510 Space Mission and Orbit Analysis**
This course covers space mission design and orbit analysis. Target spacecraft include earth observation satellites, geostationary and solar system exploration satellites. For such a goal, basic analysis on mission requirements and procedures to meet the requirements will be discussed with fundamental orbit analysis.

**SPE520 Introduction to Spacecraft Engineering**
This course covers basics on spacecraft engineering. Basic mission analysis, and introduction to sub-systems are discussed. In addition, launch trajectory analysis, docking systems and reentry dynamics are introduced. Different sensors onboard the spacecraft will be studied also.

**CS530 Operating System**
The main focus of this course is to understand the concurrency features of modern operating systems. Concurrent programming is dealt with in detail to simulate various parts of an OS. Other topics that are required to understand the process-oriented OS structure are also discussed.

**EE421 Wireless Communication Systems**
This course emphasizes practical implementation aspects of digital communication systems. A physical-layer software implementation project will be assigned for a selected commercially-deployed communication system. Topics covered in this digital communication course include : (1) Digital modulation and demodulation, Optimum receivers, (2) Adaptive equalization and Synchronization, (3) Channel capacity, Error control codes.
(Prerequisite: EE321)

**EE432 Digital Signal Processing**
This course studies the representation, analysis, and design of discrete-time signals and systems. Topics include a review of the z-transform and the discrete Fourier transform, the fast Fourier transform, digital filter structures, digital filter design techniques, analog-to-digital and digital-to-analog data conversion, rate conversion, sampling and aliasing issues.
(Prerequisite: EE202)

**EE528 Engineering Random Processes**
In this course, based on the fundamental concepts and knowledge addressed in EE210, we discuss advanced topics in probability and random processes for applications in engineering. Topics includes algebra of sets, limit events, random vectors, convergence, correlation functions, independent increment processes, and compound processes. (Prerequisite: {EE210} or {Approval of the Instructor})

**EE535 Digital Image Processing**
This course deals with the fundamental concept of digital image processing, analysis, and understanding. Topics include sampling, linear and nonlinear operations of images, image compression, enhancement and restoration, reconstruction from projections, feature extraction, and image understanding.

**EE542 Microwave Engineering**
This course is designed to provide in-depth understanding and knowledge on the theory and applications of microwave circuits, components, and systems used in Microwave and RF wireless communication systems.
(Prerequisite: EE204)

**EE567 Photovoltaic Power Generation**
In this course, various photovoltaic devices and systems are introduced. This course deals with basic theory of solar cells, the structures and characteristics of various solar cells, and the recent R&D trend and future prospects of photovoltaic technologies.
(Prerequisites: EE302)

**EE571 Advanced Electronic Circuits**

This course introduces new analysis methods for analog-circuits implemented by using bipolar and MOS transistors. Since the design of analog circuit requires both approximation and creativity, this course explains how to approximate and design complicated circuits.
(Prerequisites: EE206, EE301)

**EE581 Linear Systems**

Topics include system representation (input-output description, state variable description), solutions of linear dynamical equations, controllability and observability, irreducible realization, stability (BIBO stability, Lyapunov stability) for rigorous treatment of linear systems. In addition, feedback linearization is to be covered.

**EE594 Power Electronics Systems**

This course covers the design and analysis of the topology about the DC / DC converter, PFC (Power Factor Correction) circuit and control methode in that topology. Also the topology such as inverter, resonant converter, and active power filter is introduced, and the control algorithm of that topology is studied in this course. Finally the state of the art in power conversion system is discussed, and every student carries out a term project about design and modeling of power supply. On completion of this course students will have built confidence on their ability to design and analyse the power conversion system.
(Prerequisite: EE391)

**EE681 Nonlinear Control**

This course is intended to present the fundamental result of analysis and design of nonlinear control systems. Especially, this course is concerned with the analysis tools for nonlinear dynamical systems and the design techniques for nonlinear control systems.
(Prerequisite: EE581)

**EE827 Special Topics in Communication**

This course covers topics of interest in communication engineering at the graduate level. Course content is specifically designed by the instructor.

**IE 532 Simulation and System Modeling**

An advanced course on complex system modeling and simulation. Major topics include: system modeling formalism, world views, network system modeling, next-event simulation methodology, random number generation, input modeling, output analysis and variance reduction techniques, etc. Application case studies will be conducted using commercial simulation languages.

**IE 539 Convex Optimization**

We consider the convex optimization problem which is a special case of nonlinear optimization. We study the theoretical backgrounds, duality, interior point methods, conic programming, semidefinite programming. Applications in engineering, communications, financial engineering, data mining, and other areas will be examined.

**IE 632 Stochastic Modeling I**

The course deals with stochastic modeling and performance analysis methods for system design and operation of complex engineering systems such as production / manufacturing systems, computer / communication systems, and service systems. The course covers more advanced mathematical modeling and analysis than OR-II. Topics include basic concepts, modeling and analysis, and applications for fundamental stochastic models, including Poisson processes, renewal processes, Markov chains, stationary processes, Brownian and diffusion processes, stochastic Petri nets, basic queueing models and queueing networks, and Markov decision processes. Advanced topics like Markov renewal processes, Martingales, large deviation theories, and advanced traffic models can be introduced depending on the class.

**AE405 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.

**AE455 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.

**AE501 Multidisciplinary Design Optimization for Aerospace Systems**
This course presents the tools and methodologies for design optimization of complex systems. Topics such as system modeling, gradient-based optimization, heuristic methods, multi-objective optimization, techniques for decomposition of the multidisciplinary design, post-optimality analysis will be covered during in-class lectures with design case study for aerospace vehicle design and practiced through assignments and the course project. Special focus on the multi-disciplinary nature of complex engineering systems and its implication to system design will be maintained throughout the course.

**AE505 Appraisal of Engineering Projects under Uncertainty**
This course aims at providing a systematic framework to assess the value of a complex engineering project such as aerospace systems development under uncertainty. Risk analysis, decision theory, cost-benetif analysis, and project appraisal framework using these concepts will be introduced/discussed by lectures and case studies

**AE516 Rocket System Engineering**
Elementary principles of the rocket propulsion system are taught in this lecture. This course is offered for senior level undergraduate and graduate students majoring aerospace engineering. Brief history of rocket science and space development will be introduced. 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.

**AE532 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.

**AE550 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.

**AE551 Introduction to Optimal Control**
This course addresses optimal control theory and associated numerical methods in the context of flight trajectory optimization. Students learn theoretical concepts on optimality condition in static & dynamic optimization problems, such as Karush-Kuhn-Tucker condition, Hamilton-Jacobi-Bellman equation, Euler-Lagrange equation, and Pontryagin's minimum principle; and then numerical methods such as nonlinear programming, dynamic programming, and pseudo-spectral method for practical applications.

**AE555 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.

**AE621 Hypersonic 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.

**AE650 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.

**AE810 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.

**AE890 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.

**ME481 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 aims of gaining deep comprehension of elementary and system technologies needed to design opto-electro-mechanical systems.

**ME500 Mathematical Methods in Mechanical Engineering**

Basic mathematical skill, matrix, linear equation, linear space will be covered to study mechanical engineering.

**ME502 Introduction to Finite Element Method**

Finite element method to solve a differential equation.

**ME505 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.

**ME512 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.

**ME550 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.

**ME551 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 eigenvalue 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.

**ME553 Robot Dynamics**
To develop an understanding and facility with the basic analytical tools for the analysis and design of multi-body dynamic systems through robotic manipulators.

**ME561 Linear System Control**

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.

**ME761 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 the nonlinear system and design, analysis for the nonlinear controllers.

**ME800 Special topics in Mechanical Engineering**
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.

**MAS504 Applied Matrix Computation**
This course covers the graduate-level matrix computation and related numerical methods that are frequently used in science and engineering.

**NQE599 Special Topics in Nuclear and Quantum Engineering Ⅱ**
Course covers the special field of nuclear and quantum engineering which is not covered by the given courses. The content can be variable and will be chosen by the instructor.

**PH402 Laser Optics**
This course is designed to give junior and senior physics majors the basic understanding of modern optics, providing them with an ability to study advanced subjects in optics and optoelectronics. Topics include: Interference, Diffraction, Fourier optics, Coherence theory, Quantum nature of light, Contemporary optics (Lasers, Holography, and Nonlinear Optics).

Topical Prerequisites: Electromagnetism (College Level Physics), Fourier Transformations, Special Functions.

**PH441 Introduction to Plasma Physics**
This course is designed to help students build their ability to understand basic plasma concepts. Topics include discharge processes and application of plasmas, motion of charged particles in electric and magnetic fields, plasmas as fluids (magnetohydrodynamics), diffusion in weakly and fully ionized plasmas, waves in fluid plasmas, and kinetic theory and nonlinear effects.
(Prerequisites: Electromagnetism)

**PH481 Astrophysics**
This course is designed to help students understand the astronomical phenomena in terms of basic physical principles. Topics include the physical properties of interstellar medium, stellar structure and evolution, structure and dynamical evolution of galaxies, and theories of cosmological evolution.
(Prerequisites: PH232, PH312)

**PH503 Quantum Mechanics I**
This course introduces the mathematical foundation of quantum mechanics to the first year physics graduate students. Topics include: Hilbert space, Measurement theory, Theory of rotation and Angular momentum, Group theory and application to quantum mechanics, Wigner Eckart theorem, Clebsch Gordon coefficients, Stationary perturbation, Time dependent perturbation, Applications to atoms, molecules and solids.
Topical Prerequisites: One year of undergraduate Quantum Mechanics, Mathematical Physics, Mechanics, Electromagnetism.

**PH507 Advanced Electrodynamics I**

This course provides graduate students in physics with an understanding of electricity and magnetism. Topics include: Electrostatics, Magnetostatics, Maxwell's equations, Wave propagation, Wave guides, Radiating systems.

**PH601 Applied Physics Laboratory I**

The main objective of the course is to give students laboratory experiences in condensed matter and plasma physics that form a broad background. Each group of two or three students chooses five experimental themes for a semester. After completion of three-week experimental work on each theme, students are required to submit a report for assessment. The course offers a variety of themes on experimental techniques such as vacuum coating, dielectric and magnetic measurements, NMR spectroscopy, X-ray diffraction, low temperature measurements, photoemission and modulation spectroscopy, nonlinear dynamics measurements, ECR plasma generation and Tokamak operation.

**PH622 Geometrical Optics**

This course is designed to teach general concepts on Gaussian optics, Seidel first order aberration theory, and optical design method. Methods of optical testing are also reviewed.
(Recommended Prerequisites: Introductory of optics, Introductory on wave optics.)

**PH624 Quantum Optics**

Laser resonator, Laser rate equations, Q-switching, Mode-locking, and Laser amplifiers are covered. Various electro-optic modulators, Laser optic components, Laser applications are also discussed. Introductory quantum optics is treated.
Recommended Topical Prerequisites: Electromagnetic theory, Optics, and Quantum mechanics.

**PH641 Advanced Plasma Physics**

Basic knowledge of plasma kinetic theory, electron and ion fluid equations, and MHD equations will be covered. The Fokker-Planck equation will be derived and the properties of the Vlasov equation and Coulomb collision operator will be studied. Fluid and MHD equations will be derived from the Fokker-Planck equation (and the Maxwell's equations). The MHD property, drift-kinetic equation, gyrokinetic equation, and the quasi-linear RF heating operator will be introduced.