GRADUATE PROGRAM COURSES

ME 501 Numerical Methods in Mechanical Engineering (3-0-3)

Concepts of consistency, stability, and convergence of numerical schemes. Initial and boundary value problems for ordinary differential equations. Various finite difference and finite element methods and their applications to fundamental partial differential equations in engineering and applied sciences. Case studies.

Prerequisite: SE 301 or Equivalent (not to be taken for credit with MATH 574)

ME 530 Advanced Compressible Fluid Flow (3-0-3)

Oblique shock waves. Expansion waves. General features of multidimensional compressible flow. Introduction to small perturbation theory. The method of characteristics with applications to steady and unsteady flows.

Prerequisite: ME 425/AE 325 or Equivalent

ME 531 Advanced Thermodynamics I (3-0-3)

Axiomatic presentation of fundamentals of classical thermodynamics. First law, equilibrium, Euler and Gibbs-Duhem relations. Entropy production, thermodynamic cycles. Legendre transformations and extremum principle. Maxwell relations and thermodynamic derivatives. Stability. Phase transitions. Nernst postulate. Chemical equilibrium. Applications.

Prerequisite: ME 204 or Equivalent

ME 532 Advanced Fluid Mechanics I (3-0-3)

Conservation equations for viscous fluids. Boundary layer concept. Navier-Stokes equations and some exact solutions. Stokesian flow. Laminar boundary layer equations and methods of solution. von Karman momentum integral equation. Theory of stability of laminar flows. Introduction to turbulent flow.

Prerequisite: ME 311 or Equivalent

ME 533 Ideal Fluid Flow (3-0-3)

Kinematics and dynamics of inviscid fluids in steady and unsteady motion. Two-dimensional and axisymmetric potential flows. Singularities. Complex potential and various transformation techniques. Free-stream line flow. Airfoils and wings.

Prerequisite: ME 311 or Equivalent

ME 534 Conduction Heat Transfer (3-0-3)

Thermal conductivity and law of thermodynamic equilibrium. General heat conduction equation. Boundary conditions involving specified temperature and heat flux, convection and grey body thermal radiation. Thermal circuit concept. Steady one-dimensional conduction: composite walls, heat source systems, extended surfaces. Steady multi-dimensional conduction applications. Unsteady one – and multi-dimensional heat conduction applications. Phase change with moving boundaries. Numerical and classical analytical solution methods.

Prerequisite: MATH 301 & ME 315 or Equivalent

ME 535 Radiation Heat Transfer (3-0-3)

Radiation from a black body. Definitions and estimation of radiative properties of non-black surfaces. Radiative properties of real materials. Radiation exchange between black and gray surfaces. Thermal radiation between non-diffusion gray surfaces. Radiation exchange between gases and enclosures. Combined convection and radiation heat transfer. Radiative behavior of windows, coatings, and solids. Applications and numerical solution methods.

Prerequisite: ME 315 or Equivalent

ME 536 Convection Heat Transfer (3-0-3)

Convection systems. Derivation of conservation equations and solutions for laminar and turbulent boundary layer flows. Forced convection, internal and external flows. Natural convection. Special topics and applications.

Prerequisite: ME 532

ME 537 Combustion and Emission (3-0-3)

Fundamentals of emission formation in combustion systems. Wall quenching and imperfect combustion. Unburned hydrocarbons, carbon monoxide, aldehydes, nitrogen oxides, species stratification in the combustion chamber, particulates. Effect of design parameters and engine operating variables on emission formation. Emission controls and instrumentation.

Prerequisite: ME 204 or Equivalent

ME 539 Solar Energy Utilization (3-0-3)

Design consideration of various concentrating collectors for thermal and photovoltaic applications. Solar thermal/electric power conservation. Solar thermal energy storage. Solar thermal design methods: f-chart utilizability. Solar space conditioning design and computer simulation models such as TRNSYS. Economic considerations. Solar desalination and other applications. Design projects in selected areas.

Prerequisite: ME 439 or Equivalent

ME 543 Nonlinear Finite Element Analysis (3-0-3)

Introduction, Finite Element Formulation. Small-Deformation Elastic-Plastic Analysis. Finite –Strain Formulation. Implementation of the Finite-Strain Formulation. Practical applications in metal forming processes and structural component design.

Prerequisite: ME 489 or CE 517 or consent of the instructor.

ME 546 Industrial Aerodynamics (3-0-3)

Planetary boundary layer and atmospheric characteristics. Bluff body aerodynamics; separation, vortex shedding, wakes, static and dynamic wind forces. Response of structures to dynamic loading. Applications to buildings, structures, vehicles, etc.

Prerequisite: ME 311 or Equivalent

ME 547 Thermal Environment and Energy Analysis (3-0-3)

Requirement of thermal environment and its effects. Solar radiation measuring techniques and estimation methodology. Heat transmission in buildings. HVAC load and system analyses; computerized techniques. Effects of building configuration, orientation, and systems operation on energy consumption.

Prerequisite: ME 315 or Equivalent

ME 548 Combustion Phenomena (3-0-3)

Flame propagation theories, structure of premixed hydrocarbon flames, mathematical formulations for flame propagation. Diffusion flames, droplet combustion. Detonation and deflagration wave theory.

Prerequisite: ME 204 or Equivalent

ME 549 Thermal Design of Heat Exchangers (3-0-3)

Classification of a variety of heat exchangers, various methods for the exchanger analysis and performance evaluation, pressure drop analysis including header design and flow maldistribution, fouling and its impact on the exchanger performance and life-cycle analysis. Special design considerations for regenerators, plate-fin, tube-and-frame, shell-and-tube, reboilers, condensers, evaporators, and direct-contact heat exchangers.

Prerequisite: ME 315 or Equivalent

ME 550 Fundamentals of Astronautics (3-0-3)

Introduction to the solar system, launching, fundamental laws of astrodynamics (space mechanics), orbit maneuvering and determination, important applications in missile trajectories, optimal trajectories, communication satellite and spacecraft attitude, re-entry and hypersonic considerations.

Prerequisite: Graduate Standing

ME 551 Continuum Mechanics (3-0-3)

Tensors, indicial notation, transformation of coordinates. Stresses, principal stresses. Mohr's circles. Deformation and strain. Velocity fields and compatibility conditions. Constitutive equations. Isotropy. Mechanical properties of solids and fluids. Field equations: applications to elasticity, viscoelasticity, plasticity, and fluid mechanics.

Prerequisite: Graduate Standing (also offered under CE 518)

ME 552 Advanced Dynamics (3-0-3)

Fundamentals of Newtonian dynamics. Hamilton's Principle and Lagrange's equations. Relativistic dynamics. Central force motion, stability of circular orbits. Rigid body dynamics. Euler equations of motion, Euler angles, gyroscopic motion, spinning projectile, Hamilton's equations and phase space. Hamilton-Jacobi equation.

Prerequisite: Graduate Standing

ME 553 Advanced Vibrations (3-0-3)

Review of single degree of freedom oscillator: formulation using generalized stiffness, inertia and damping. Damping mechanisms: viscous, friction, and complex. Response to transient and general excitations. Multiple degrees of freedom systems: formulation and methods of solution. Direct stiffness, influence coefficients and variational approaches. Eigenvalue analysis. Vibration of continuous systems. Approximation methods of continuous systems. Modal reduction technique.

Prerequisite: Graduate Standing

ME 554 Elasticity (3-0-3)

Plane stress, plane strain, biharmonic solutions. Problem formulation in cartesian and polar coordinates; polynomail, Fourier series and complex variable solutions. Energy theorems and variational techniques. Three-dimensional elasticity. Saint-Venant torsion and bending theory. Navier equation and Galerkin vector.

Prerequisite: ME 551

ME 555 Plasticity (3-0-3)

The physics of plasticity: Plastic deformation, Stress-Strain relations, temperature and rate dependenc crystal plasticity. Constitutive theory: Viscoplasticity, rate-independent plasticity, yield criteria, flow rule and hardening rules, uniqueness theorems, limit analysis. problems in contained plastic deformatio torsion of prismatic bars, thick walled cylinder, bending of beams. Problems in plastic flow and collaps Large deformation plasticity. Numerical methods in plasticity.

Prerequisite: ME 551

ME 557 Modern Control of Linear Systems (3-0-3)

Overview of state space modeling of linear systems. Stability of time-invariant linear system Controllability and observability conditions. Formulation of tracking and regulator problems. Optimal linea state feedback control. The linear optimal regulator problems. Observers, full-order observers. Th optimal observer design.

Prerequisite: ME 413 or Equivalent

ME 558 Rotordynamics (3-0-3)

The basic rotor components, disk, shaft, and bearings. Simple rotor models, natural frequencie Campbell diagram, instability, and mass unbalance. Finite element modeling of rotor component Dynamic modal characteristics of rotors, modal transformations, reduced-order equations. Numeric solution of the rotor equations.

Prerequisite: ME 552

ME 559 Random Vibrations (3-0-3)

Introduction to random vibrations and stochastic processes. Spectral analysis and frequency respons

methods. Auto correlation, Cross correlation, Power-spectral density. Random load transmissio Vibration data processing. Digital and fast Fourier transform. Response of continuous systems to rando excitation. Wavelet analysis.

Prerequisite: ME 482 or Equivalent

ME 560 Smart Materials and Structures (3-0-3)

Analysis, design, and implementation of smart structures and systems: modeling of beams and plate with induced strain actuation, piezoelectric ceramics and polymers, shape memory alloys, electr rheological fluids. Piezoelectric and magnetostrictive sensors and actuators, and fiber optic sensor Integration mechanics. Damage detection and repair. Applications.

Prerequisite: Graduate Standing

ME 562 Vibration Measurement and Analysis (3-0-3)

Analysis of lumped and distributed parameter systems. Concepts of torsional vibration. Resonances. Frequency response and transfer function methods. Modal analysis. Mathematical modeling using experimental data. Digital Fourier analysis and Fast Fourier Transform. Signal processing. Data acquisition. Data formats. Transducer measurement considerations. Vibration data processing and instrumentation. Typical vibration problems. Fault diagnosis techniques of rotating machinery. Basic balancing of rotors. Resonance and critical speed testing. Machine analysis case studies.

Prerequisite: ME 413 or Equivalent

ME 563 Ultrasonic Testing Techniques (3-0-3)

Theory and principles of elastic wave propagation. Reflection, refraction, and transmission of plane waves. Dispersion and scattering. Guided wave modes. Signal processing. Ultrasonic transducers. Inspection principles of ultrasonic testing. Ultrasonic testing equipment. Material characterization. Ultrasonic flaw detection. Testing of metals. Inspection of non-metals and adhesive bonds. Case studies.

Prerequisite: Graduate Standing

ME 564 Noise and Vibration Control (3-0-3)

Analysis and measurement of sound and vibration as applied to noise control. Review of fundamentals and principles, noise generators. Measurement and analysis of noise and vibration. Noise control; noise criteria, sound absorption and insulation, noise barriers, acoustic enclosures, silencers. Vibration isolation criteria, damping materials, vibration isolating mounts. Studies of machine element noise, fan and flow induced noise, combustion and furnace noise. Fluid piping noise, compressor and pump noise, internal factory noise.

Prerequisite: Graduate Standing

ME 565 Dynamics of Multibody Systems I (3-0-3)

Definition of a multibody system; Mechanical joints and their kinematic constraints; Equations of motion for a multibody system, the constrained form of Lagrange’s equation, Lagrange multipliers, joint reaction forces; Coordinate partitioning, the Lagrangian form with embedded constraints; Dynamics of spatial

multibody systems, coordinate transformations using Euler parameters, formulation of the joint constraints, Dynamic equations of motion; Introduction to computational methods in dynamics.

Prerequisite: ME 552

ME 570 Experimental Methods in Materials and Processes (3-0-3)

Laboratory investigations of the mechanical, physical, and surface properties of materials. Experimental investigations of materials' behavior during processing and in various operating environments. Experimental design and evaluation of results.

Prerequisite: Graduate Standing

ME 572 Analysis of Manufacturing Processes (3-0-3)

Analytical treatment of the machining and metal-working processes. Metallurgical and economic considerations. Machine tools dynamics and vibration. Trends of current research.

Prerequisite: ME 206 or Equivalent

ME 573: Probabilistic Concepts in Design and Production (3-0-3)

Review of probabilistic concepts and distributions used in design and manufacturing engineering. Linear and nonlinear combination of random variables in probabilistic design. Error propagation and tolerance analysis. Stress-strength interference theory and reliability computations. Monte Carlo simulation . Products and systems failure rates and reliability models. Reliability testing and failure data analysis from complete and censored data using maximum likelihood estimation, method of moments, and graphical techniques using probability papers and computer software. Accelerated life testing, Reliability growth models and analysis. Preventive and corrective maintenance. Some applications in manufacturing.

Prerequisites: STAT 319 or Consent of Instructor.

ME 574 Advanced Materials Science (3-0-3)

Review on crystal structures of materials. Mechanical properties of materials. Solid solutions and phas diagrams. Influence of alloying on transformation and critical cooling rates of steels. Surface treatment metals and alloys. Structure and mechanical properties of polymers. Structure and mechanical propertie of ceramics. Special materials for biomedical and aerospace applications.

Prerequisite: Graduate Standing

ME 575 Advanced Corrosion Engineering (3-0-3)

Corrosion thermodynamics and kinetics. Effect of environmental factors on major forms of corrosion. Environmental conditioning. Mass transfer and corrosion. Anodic and cathodic protection of metals. Organic and nonmetallic coating. Design for corrosion prevention. Testing, monitoring and inspection. Materials selection for corrosion resistance.

Prerequisite: Graduate Standing

ME 576 Tribology (3-0-3)

Classification of wear modes. Adhesion. Abrasion. Rolling-sliding wear, Erosion, Corrosion, Combine

wear modes. Friction and heat transfer calculations. Wear models and testing. Design of wear resistai systems. Selection of wear resistant materials.

Prerequisite: ME 307 or Equivalent

ME 578 Mechanical Properties of Engineering Polymers (3-0-3)

General introduction to polymers and their applications. Types of mechanical behavior. Hookean and rubber elasticity. Plastic deformation. Fracture. Linear viscoelasticity. Dynamic mechanical behavior and testing. Experimental methods. Mechanical properties of polymeric composites.

Prerequisite: ME 574

ME 579 Advanced Mechanical Behavior of Materials (3-0-3)

Description of stress, strain, strain rate and elastic properties of materials. Fundamental aspects of crystal plasticity. Theory and characteristics of dislocations. Strengthening mechanisms at low temperature. Deformation at elevated temperatures and deformation maps. Emphasizing the relationships between microscopic mechanisms and macroscopic behavior of materials.

Prerequisite: ME 574

ME 580 Principles of Metal Forming (3-0-3)

Stress-strain behavior of metals. Introduction to plasticity. Homogeneous and redundant works. Plastic anisotropy. Slab methods. Upper-bound analysis. Slip line field theory. Open and closed die forging. Extrusion of metals. Mechanics of wire drawing, hot and cold rolling, stretch forming, sheet bending. Analysis of deep drawing, tube drawing and tube making.

Prerequisite: ME 572

ME 581 Computer Integrated Manufacturing (3-0-3)

A study of the impact of computers and automation on discrete parts manufacturing. Flexible manufacturing and assembly equipment. CAD/CAM concepts and applications. Process planning and manufacturing scheduling. Materials handling. Robotics. Quality assurance. Tooling and fixtures for CNC systems.

Prerequisite: ME 572

ME 583 Fatigue and Fracture of Engineering Materials (3-0-3)

Stress/Strain controlled Fatigue-Life prediction laws. Continuum fracture mechanics. Fracture modes. Fracture mechanics and microscopic plastic deformation/fracture mechanics combined approach. Cleavage, ductile fracture, fatigue, creep-fatigue and environmental cracking phenomena.

Prerequisite: ME 307 or Equivalent

ME 584 Quality Engineering (3-0-3)

Statistical process control techniques for quality and productivity improvement in production processes. Quality control charts for variable data and attribute data. Process capability analysis. Acceptance proceedures based on the quality of the product. Taguchi's ideas of quality. Experience with statistical quality control software. Case studies. The course will also address documentaion using ISO 9000 and

other quality standards.

Prerequisite: STAT 319 or Equivalent (not to be taken for credit with SE 534)

ME 585 Advanced Physical Metallurgy (3-0-3)

Review of structure of metals, analytical methods, dislocation and plastic deformations, diffusion, solidification of metals, nucleation and growth kinetics, phase diagrams, thermally activated plastic deformations, fracture and fracture mechanics.

Prerequisite: ME 574

ME 586 Finite Element Analysis in Metal Forming (3-0-3)

General introduction to FEM and metal forming processes. Basic formulation for elastic deformation. Introduction to plasticity and viscoplasticity. Introduction to finite element nonlinear analysis. Small-deformation elastic-plastic analysis. Finite-strain formulation for metal forming analysis. Implementation of the finite-strain formulation. Practical applications; plain strain problems of rolling and bending, axisymmetric isothermal forging, steady-state processes of extrusion and drawing. Sheet metal forming. Thermo-viscoplastic analysis. Future developments.

Prerequisite: ME 206 or Equivalent

ME 591 Special Topics in Thermofluid Sciences I (3-0-3)

Advanced topics are selected from thermofluid area of mechanical engineering. Contents of the course will be provided in detail one semester before its offering. Approval of the Departmental Graduate Committee and the Graduate Council must be secured before offering this course.

Prerequisite: Graduate Standing

ME 595 Special Topics in Engineering Mechanics I (3-0-3)

Advanced topics are selected from engineering mechanics area of mechanical engineering. Contents of the course will be provided in detail one semester before its offering. Approval of the Departmental Graduate Committee and the Graduate Council must be secured before offering this course.

Prerequisite: Graduate Standing

ME 597 Special Topics in Materials & Manufacturing I (3-0-3)

Advanced topics are selected from materials and manufacturing area of mechanical engineering. Contents of the course will be provided in detail one semester before its offering. Approval of the Departmental Graduate Committee and the Graduate Council must be secured before offering this course.

Prerequisite: Graduate Standing

ME 599 Seminar (1-0-0)

Graduate students working towards M.S. degree, are required to attend the seminars given by faculty, visiting scholars, and fellow graduate students. Additionally each student must present at least one seminar on a timely research topic. Among other things, this course is designed to give the student an

overview of research in the department, and a familiarity with the research methodology, journals and professional societies in his discipline. Graded on a Pass or Fail basis.

Prerequisite: Graduate Standing

ME 610 MS Thesis (0-0-6)

ME 611 Statistical Thermodynamics (3-0-3)

Quantum mechanics and statistics. Kinetic description of dilute gases. Classical statistics of independent particles. Elementary kinetic theory of transport processes. Thermostatics, properties of ideal gases, kinetic theory of dilute gases. Statistical mechanical ensembles. Thermostatic properties of real substances. Applications.

Prerequisite: Graduate Standing

ME 612 Phase Change Heat Transfer and Two Phase Flow (3-0-3)

Fundamental mechanisms of evaporation and condensation. Bubble equilibrium, nucleation criteria. Pool and flow boiling models and correlations. Two-phase flow models and governing equations. Flow regime transitions. Pressure drop calculations. Measurement techniques. Drop-wise and film-wise condensation, flow and non-flow systems. Enhanced surface boiling and condensation.

Prerequisite: ME 536

ME 632 Advanced Fluid Mechanics II (3-0-3)

Stability of laminar flow and causes of transition to turbulence. Conservation equations and Reynolds stresses. Turbulent boundary layer equations, integral and other methods of solution. Free turbulence, wakes and jets. Statistical analysis; scales of turbulence, correlation functions, spectra. Measuring techniques.

Prerequisite: ME 532

ME 658 Fracture Mechanics (3-0-3)

Fracture modes and stress fields at the crack tip. stress intensity factors. Griffith and Irwin theories. Crac initiation and propagation. Fracture tests, fracture toughness. Fatigue crack growth. Elastic-plast fracture mechanics. Numerical methods in fracture mechanics. Mechanisms and mechanics of fracture engineering components.

Prerequisite: ME 551

ME 661 Nonlinear Systems Dynamic Analysis (3-0-3)

Fundamentals of quantitative and qualitative analysis techniques of nonlinear dynamic systems. Elements of nonlinear systems. Phase plane diagrams, stability and bifurcation of equilibrium and limit cycles, attractors, Lyapunov stability, Poincare' map. Harmonic balance, K-B averaging, Linstedt-Poincare' and multiple-time scales methods. Sub-harmonic, super-harmonic, combination and internal resonances. Parametrically excited systems, Mathieu's equation, and Floquet theory. One and two dimensional maps, structural stability and chaotic attractors, correlation dimensions, Lyapunov exponents and Melnikov's function. Trends in current research.

Prerequisite: MATH 301 or Equivalent

ME 665 Dynamics of Multibody Systems II (3-0-3)

Review of rigid multibody dynamics, kinematics joints, constraints, and transformation of generalized coordinates. Constrained and unconstrained equations of motion. The mechanics and deformable bodies; rods, beams, and blades. Formulation of the rigid-elastic multibody equations of motion and constrained equations. Computational techniques for deformable mechanisms and multibody flexible systems. Applications.

Prerequisite: ME 565

ME 666 Dynamics and Control of Mechanical Systems (3-0-3)

Dynamics of mechanical systems. Mechanics of ground and flight vehicles. Introduction to inertia guidance and navigation. Nonlinear control systems; fundamentals of Lyapunov theory, Describing function analysis, feedback linearization, Sliding control. Improving system response via control techniques. Optimal control design. Case studies by computer.

Prerequisite: ME 557

ME 671 Electrode Kinetics (3-0-3)

Application of principles of thermodynamics. Reversible and irreversible electrode processes. Interfacial phenomena. Principles of kinetics. Absorption. Field effects and gas-metal interface. Principles and applications of anodic and cathodic processes to electroplating and extraction of metals. Fuel cells. Case studies.

Prerequisite: ME 575

ME 672 Control of Manufacturing Processes (3-0-3)

Application of computer-based control system techniques to batch manufacturing processes. A brief review of control concepts and servomechanisms with an in-depth study of modeling and control problems associated with several manufacturing processes. These include, but not restricted to, metal cutting, metal forming and welding processes as well as the control problem associated with manipulated robotic arms in a manufacturing context.

Prerequisite: ME 572

ME 673 Metallurgical Processes and Thermodynamics (3-0-3)

Thermodynamic principles. Solutions. Heterogeneous reactions in metallurgy. Kinetics and catalysis. Physico-chemical principles as applied to extraction. Conversion and refining of metals. Applications of metallurgical processes.

Prerequisite: ME 574

ME 675 Phase Transformation in Metals (3-0-3)

Examines the thermodynamics and fundamentals of rate processes in metals. Phenomen-ological and atomistic points of view are considered. Kinetics of liquid-solid, solid-solid transformations and transport of matter in solids are discussed.

Prerequisite: ME 574

ME 691 Special Topics in Thermofluid Sciences II (3-0-3)

Advanced topics are selected from thermofluid area of mechanical engineering. Contents of the course will be provided in detail one semester before its offering. Approval of the Departmental Graduate Committee and the Graduate Council must be secured before offering this course.

Prerequisite: Graduate Standing

ME 695 Special Topics in Engineering Mechanics II (3-0-3)

Advanced topics are selected from the broad area of mechanical engineering. Contents of the course will be provided in detail one semester before its offering. Approval of the Departmental Graduate Committee and the Graduate Council must be secured before offering this course.

Prerequisite: Graduate Standing

ME 697 Special Topics in Materials & Manufacturing II (3-0-3)

Advanced topics are selected from the broad area of mechanical engineering. Contents of the course will be provided in detail one semester before its offering. Approval of the Departmental Graduate Committee and the Graduate Council must be secured before offering this course.

Prerequisite: Graduate Standing

ME 699 Seminar (1-0-0)

Graduate students working towards Ph.D. degree, are required to attend the seminars given by faculty, visiting scholars, and fellow graduate students. Additionally each student must present at least one seminar on a timely research topic. Among other things, this course is designed to give the student an overview of research in the department, and a familiarity with the research methodology, journals and professional societies in his discipline. Graded on a Pass or Fail basis.

ME 710 Ph.D. Dissertation (0-0-12)