MECHANICAL ENGINEERING AND AEROSPACE ENGINEERING

Undergraduate Program Information

The mission of the Mechanical and Aerospace Engineering Department at New Mexico State University is threefold:

- to educate those who will advance knowledge and become the future leaders of industry and academia;
- to conduct both basic and applied research in mechanical and aerospace engineering and related interdisciplinary areas; and
- to provide service to the profession, to the State of New Mexico, to the country, and to the future development of engineering worldwide.

A critical focus within the department is to afford undergraduates of varying backgrounds and abilities every opportunity for achieving success in the mechanical and aerospace engineering professions. To address this focus, the faculty of the Mechanical and Aerospace Engineering Department, with input from other constituents, have established the following program educational objectives that inform the overall undergraduate programs:

- Our graduates will gain relevant employment and/or pursue a graduate degree.
- Our graduates will advance in their level of workplace responsibility.

Graduate Program Information

Graduate programs of study are available leading to the degrees of:

- Doctor of Philosophy in Aerospace Engineering
- Doctor of Philosophy in Engineering with a concentration in Mechanical Engineering
- Master of Science in Aerospace Engineering
- Master of Science in Mechanical Engineering
- Master of Engineering in Aerospace Engineering
- Master of Engineering in Mechanical Engineering.

Areas of active research in mechanical engineering include the following:

- Computational fluid dynamics
- Hypersonics
- Vortex dynamics
- Energy systems and components
- Thermal management
- Surface engineering
- Computational mechanics with application to material properties
- Composite materials and nanomaterials
- Structural damage diagnosis and prognosis
- Nonlinear dynamics and vibrations
- Reduced order modeling in multibody dynamics
- Fluid-structure interactions
- Renewable energy / energy harvesting
- Bio-inspired and bio-mimetic robotics
- Robotics and autonomous systems
- Multi-robot systems
- Advanced manufacturing and medical device
- Structure property relations and degradation / corrosion of materials.

Areas of active research in aerospace engineering include the following:

- Computational, theoretical, and experimental fluid dynamics
- Hypersonics
- Flow control
- Aero-optics
- Multi-phase, multi-scale, and reacting flows
- Rarefied gas dynamics
- Propulsion
- Aeroelasticity
- Structural health monitoring / damage detection
- Guidance, navigation, and control of space systems
- Small satellite missions
- Unmanned aerial systems.

Laboratory facilities supporting graduate research include a large low-speed wind tunnel facility; a shock tunnel facility for hypersonics; computational fluid dynamics lab; robotics, unmanned vehicles, and intelligent systems control lab; autonomous systems lab; mechanical design and advanced materials & structures lab; nonlinear dynamics & energy harvesting lab; computational mechanics of materials and structures lab; non-destructive evaluation lab; medical device & microfabrication research lab; surface-environment interaction research lab; and renewable energy and thermal systems lab. A mechanical testing lab is also available in the College of Engineering.

In addition to fulfilling the basic requirements for admission to the Graduate School, applicants are expected to have an undergraduate degree equivalent to a BS in mechanical or aerospace engineering from a university accredited by ABET. Graduate students whose BS degree is in a discipline other than A E or M E will normally be required to take undergraduate courses in M E or A E in order to prepare for graduate course work; such undergraduate preparatory work will be determined by the graduate coordinator on a case by case basis. A candidate for *Master of Science* degree is required to complete a Thesis, whereas that for *Master of Engineering* is to complete the required coursework only. Both degrees require a minimum of 30 credits of graduate study.

A doctoral candidate must complete a program of study determined by the student and his / her advisory committee. The student must successfully pass a written qualifying examination (administered during the student’s first year of full-time study) and an oral comprehensive examination which is administered after the student completes at least 80 percent of the course work and demonstrates sufficient progress in their research. The student must submit and defend an acceptable dissertation based on independent investigation in a field of study approved by the advisory committee.

Degrees for the Department

Bachelor Degree(s)

- Aerospace Engineering - Bachelor of Science in Aerospace Engineering (https://catalogs.nmsu.edu/nmsu/engineering/mechanical-aerospace-engineering/aerospace-engineering-bachelor-science-aerospace-engineering/)
- Mechanical Engineering - Bachelor of Science in Mechanical Engineering (https://catalogs.nmsu.edu/nmsu/engineering/

mechanical-aerospace-engineering/mechanical-engineering-bachelor-science-mechanical-engineering/)

Master Degree(s)

- Aerospace Engineering - Master of Engineering in Aerospace Engineering (https://catalogs.nmsu.edu/nmsu/graduate-school/aerospace-engineering-master-engineering/)
- Aerospace Engineering - Master of Science (https://catalogs.nmsu.edu/nmsu/graduate-school/aerospace-engineering-master-science/)
- Mechanical Engineering - Master of Engineering in Mechanical Engineering (https://catalogs.nmsu.edu/nmsu/graduate-school/mechanical-engineering-master-engineering/)
- Mechanical Engineering - Master of Science in Mechanical Engineering (https://catalogs.nmsu.edu/nmsu/graduate-school/mechanical-engineering-master-science-mechanical-engineering/)

Doctoral Degree(s)

- Aerospace Engineering - Doctor of Philosophy (https://catalogs.nmsu.edu/nmsu/graduate-school/aerospace-engineering-doctor-philosophy/)
- Engineering (Mechanical Engineering) - Doctor of Philosophy (https://catalogs.nmsu.edu/nmsu/graduate-school/engineering-mechanical-engineering-doctor-philosophy/)

Minors for the Department

- Aerospace Engineering - Undergraduate Minor (https://catalogs.nmsu.edu/nmsu/engineering/mechanical-aerospace-engineering/aerospace-engineering-undergraduate-minor/)
- Mechanical Engineering - Undergraduate Minor (https://catalogs.nmsu.edu/nmsu/engineering/mechanical-aerospace-engineering/mechanical-engineering-undergraduate-minor/)

Department Head: Jay Frankel, Ph. D.

Associate Department Head: Young Lee, Ph. D.

Professors Abdelkefi, Chaitanya, Frankel, Gross, Park; ***Associate Professors*** Drach, Haghshenas-Jaryani, Kota, Kuravi, Lee, Shashikanth, Shu, Wang; ***Assistant Professors*** Alaie, Guerrero-Bonilla, Liu, Mohammadshahi, Torres Herrador; ***Professors of Practice*** Waller, Dobbin

A. Abdelkefi, Ph.D. (Virginia Tech)– Nonlinear dynamics, energy harvesting, aeroelasticity, fluid-structure interaction, vibration and controls; S. Alaie, Ph.D. (UNM)– Implantable microsensors, advanced manufacturing and medical devices; V. Chaitanya, Ph.D. (Johns Hopkins)– Structure-property relations of materials, material degradation / corrosion / electrochemistry, additive manufacturing, biomaterials, engineering failure analysis; D. Dobbin, MS (NMSU & Georgia Tech)-Aerodynamics, mechanical design and mechanisms; B. Drach, Ph.D. (New Hampshire)– Composite materials, additive manufacturing, biomechanics; J. Frankel, Department head, Ph.D. (Virginia Tech)– Heat transfer, hypersonics; A. Gross, DEngr. (Aachen, Germany)– Computational fluid dynamics, fluid mechanics, aircraft design and propulsion, unmanned aerial systems, wind energy; L. Guerrero-Bonilla, Ph.D. (UPenn) - Robotics and autonomous systems, multi-robot systems; M. Haghshenas-Jaryani, Ph.D. (UT Arlington)– Soft robotics, bio-inspired and bio-mimetic robotics, dynamics and control; K. Kota, Ph.D. (Central Florida)– Heat transfer, functional surfaces, surface-environment interactions, thermal management, space transportation, engineering in public health and medicine; S. Kuravi, Ph.D. (Central Florida)– Renewable energy, thermal systems, concentrating solar power, thermal desalination, energy storage; Y. Lee, Associate Department Head, Ph.D. (UIUC)- Nonlinear dynamics, fluid-structure interactions; Q. Liu, Ph.D. (Universidad Politécnica de Madrid, Spain)-Computational fluid mechanics, modal analysis, data science, rarefied gas dynamics and multiphase flow; S. Mohammadshahi, Ph.D. (Pusan National University, South Korea & U of Massachusetts Dartmouth)-Experimental fluid dynamics, turbulent flows, flow control, surface engineering; Y. Park, Ph.D. (Iowa)– Design optimization, computational solid mechanics, atomistic and molecular simulations; B. Shashikanth, Ph.D. (Southern California)– Fluid mechanics, dynamical systems, controls; F. Shu, Ph.D. (Purdue)– Experimental fluid dynamics, biofluidics, microfluidics, flow control, and hypersonics; F. Torres Herrador, Ph.D. (VUB & UGent, Belgium)– Hypersonics, material characterization, multiscale modeling, thermal protection systems; J. Waller, Ph.D. (U Akron)– Nondestructive evaluation, additive manufacturing and materials; Y. Wang, Ph.D. (Penn State)– Computational fluid dynamics, multi-phase & reacting flows, aerospace propulsion, bio/micro-Fluidics.

Aerospace Engineering Courses

A E 339. Aerodynamics I
3 Credits (3)
Fluid properties, conservation equations, incompressible 2-dimensional flow; Bernoulli's equation; similarity parameters; subsonic aerodynamics: lift and drag, analysis and design of airfoils.
Prerequisite: C- or better grades in ENGR 234 and (M E 228 or MATH 3160).

Learning Outcomes

1. Ability to understand fundamental concepts of incompressible flows.
2. Ability to use Bernoulli equation to solve flow problems under specific conditions.
3. Ability to understand and use potential flow theory for canonical flows.
4. Ability to derive and use similarity parameters to design experiments and simulations.
5. An ability to understand fundamental concepts of lift and drag forces and their coefficients.

A E 362. Orbital Mechanics
3 Credits (3)
Dynamics of exoatmospheric flight of orbiting and non-orbiting bodies; 2-body orbital dynamics and Kepler's laws; orbits in 3 dimensions; orbit determination; orbit design and orbital maneuvers; lunar and interplanetary trajectories.
Prerequisite: C- or better grades in (M E 228 or MATH 3160), ENGR 234, and M E 261.

Learning Outcomes

1. Ability to understand dynamics of exo-atmospheric flight of orbiting and non-orbiting bodies; 2-body orbital dynamics and Kepler's laws; orbits in 3 dimensions; orbit determination; orbit design and orbital maneuvers; lunar and interplanetary trajectories.
2. Ability to identify, formulate, and solve engineering problems on orbital mechanics.
3. Ability to use the techniques, skills, and modern tools for orbital mechanics and engineering practice.

A E 363. Aerospace Structures
3 Credits (3)
Advanced concepts of stress and strain, introduction to the analysis of aero structures, complex bending and torsion, thin walled sections and shells, computational techniques. May be repeated up to 3 credits.

Prerequisite: C- or better grades in C E 301.

Learning Outcomes

1. An ability to formulate and solve some fundamental linearly-elastic problems.
2. Application of basic failure theory and perform thermal shock analysis for composite materials.
3. An ability to perform simplified dynamic loading analysis on aerospace structures.
4. Calculation of various area properties for nonhomogeneous cross-sections of a beam, and their principal values and directions.
5. Understanding of the formulations of stresses and strains in a beam under various loading and boundary conditions.

A E 364. Flight Dynamics and Controls
3 Credits (3)
Standard atmosphere and various definitions of altitudes, static and dynamic flight performance evaluations, 6-degree-of-freedom aircraft flight dynamics, static and dynamic flight stability and controls.
Prerequisite: C- or better grades in (M E 228 or MATH 3160), ENGR 234, and M E 261.

Learning Outcomes

1. Ability to evaluate static and dynamic flight performance.
2. Ability to understand static stability design for longitudinal / lateral/ directional flights.
3. Ability to use the 6-degree-of-freedom, rigid body equations of motion of aircraft.
4. Evaluation of longitudinal / lateral / directional dynamic stabilities of aircraft.

A E 400. Undergraduate Research
1-3 Credits (1-3)
Performed with the direction of a department faculty member. May be repeated for a maximum of 6 credits.
Prerequisite(s): Consent of faculty member.

A E 405. Special Topics
3 Credits (3)
Topics of modern interest to be offered by the departmental staff. Consent of instructor required.

A E 419. Propulsion
3 Credits (3)
Propulsion systems, thermodynamic cycles, combustion, specific impulse; principles of gas turbines, jet engines, and rocket propulsion systems. May be repeated up to 3 credits.
Prerequisite: C- or better grades in A E 439.

Learning Outcomes

1. Knowledge of relevant fluid and thermodynamics.
2. Understanding of jet engine operating principles.
3. Ability to carry out parametric analysis of jet engine and turbomachinery.
4. Knowledge of how to analyze rocket propulsion systems.

A E 424. Aerospace Systems Engineering
3 Credits (3)
Basic principles of top down systems engineering and current practice; preliminary and detailed design of aircraft and space vehicles, including requirement, subsystem interaction, and integration, tradeoffs, constraints and non-technical aspects. May be repeated up to 3 credits.
Prerequisite: C- or better grades in A E 362.

Learning Outcomes

1. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
2. An ability to communicate effectively with a range of audiences.
3. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
4. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

A E 428. Aerospace Capstone Design
3 Credits (3+2P)
Team Project-analysis, design, hands-on build test, evaluate. May be repeated up to 3 credits.
Prerequisite: A E 363.
Corequisite: A E 424.
Prerequisite/Corequisite: A E 447.

Learning Outcomes

1. An ability to function as mechanical engineer within an engineering design and development group.
2. An ability to complete a real-life design task, to transform a client's needs into a tangible, tractable project definition, and to see the project through to completion.
3. An ability to understand and use a formal engineering design method, with emphasis on building concurrent engineering procedures into the basic design method.
4. Proficiency in collaboratively preparing and reviewing formal technical design package related to an engineering design including final design binder and report.

A E 439. Aerodynamics II
3 Credits (3)
Principles of compressible flow, momentum and energy conservation; thermal properties of fluids; supersonic flow and shock waves; basics of supersonic aerodynamics; lift and drag for airfoils and wings under incompressible and compressible flow conditions. May be repeated up to 3 credits.
Prerequisite: C- or better grades in (A E 339 or M E 338), M E 240, and (M E 328 or PHYS 395).

Learning Outcomes

1. Understanding of fundamentals of compressible flow.
2. An ability to solve 1D and 2D compressible flow problems including isentropic flow, shock wave and expansion wave flow problems.
3. An ability to understand and solve Fanno-line flow and Rayleigh-line flow problems.
4. Calculation of lift and drag coefficients of airfoils and wings under flow regimes.

A E 447. Aerofluids Laboratory
3 Credits (2+3P)
Use of subsonic and hypersonic wind tunnels and other flow facilities to study basic flow phenomena and methods of fluid measurement and visualization. May be repeated up to 3 credits.
Prerequisite: M E 345 or PHYS 325.
Prerequisite/Corequisite: A E 439.

Learning Outcomes

1. An ability to design fluid experiments using similarity law.
2. An ability to design and conduct fluid experiments in low-speed and hypersonic wind tunnel with various flow measurement and visualization techniques.
3. Use of data acquisition systems to acquire experimental data and conduct data processing, including particle image velocimetry.
4. An ability to write professional technical reports.

A E 451. Aircraft Design
3 Credits (3)
Conceptual design of aircraft based on existing designs, empirical relationships, and theory. Dimensioning, structural design, and performance analysis of major subcomponents such as fuselage, wing, and propulsion system. Static stability and control analysis. May be repeated up to 3 credits.
Prerequisite: (A E 339 and A E 363) or consent of instructor.
Learning Outcomes

1. Ability to design aircraft for specific mission and to carry out all necessary analyses.
2. Familiarization with different design options for various aircraft components.
3. Understanding of multi-disciplinary nature of conceptual aircraft design and tradeoffs in airplane design, and of how contradicting design requirements will lead to design compromises.
4. Ability to work as part of a team to accomplish the stated objectives of a design project.
5. Knowledge of how to use spreadsheets and engineering analysis methods for conceptual aircraft design.
6. Ability to carry out airfoil aerodynamic analysis using XFLR5 and to create a visual representation of an aircraft using OpenVSP.

A E 452. Control System Design
3 Credits (3)
Introduction to the control of dynamical systems, with a focus on mechanical and aerospace systems, including basic systems theory, controllability / observability, feedback and stabilization, PID controls, root-locus plot, and Bode diagram. May be repeated up to 3 credits.
Prerequisite: M E 261, M E 328 and ENGR 234.
Learning Outcomes

1. Construction of a block diagram of control systems to find a transfer function for a dynamical system.
2. Analysis of control systems by utilizing various linear control theories such as root-locus design method, bode, and lead / lag compensation techniques.
3. Design and simulation of PID control systems for mechanical / aerospace engineering applications.
4. Derivation of state space representation of a dynamical systems.

A E 464. Advanced Flight Dynamics and Controls
3 Credits (3)
Advanced airplane flight dynamics and stability control system design, longitudinal and lateral autopilots, missile/rocket control systems, and guidance systems.
Prerequisite: A E 364 or consent of instructor.
Learning Outcomes

1. An ability to construct a block diagram to find a transfer function for a dynamical system.
2. An ability to perform a control systems design by utilizing various linear control theories such as root-locus design method, bode / Nyquist plots, and lead / lag compensation techniques.
3. Understanding of longitudinal / directional / lateral dynamic flight stability controls associated with airplane designs.
4. Design and analysis of autopilot systems of an airplane with some knowledge in flight instrumentation.

A E 469. Hypersonic Aerothermodynamics
3 Credits (3)
Challenges of hypersonic flight. Large Mach number approximations. High-temperature effects. Vibrational and chemical non-equilibrium. Viscous high-temperature flows. Taught with A E 569. May be repeated up to 3 credits.
Prerequisite/Corequisite: A E 439.
Learning Outcomes

1. Awareness of challenges of hypersonic flight.
2. Understanding of vibrational and chemical non-equilibrium effects.
3. Governing equations for viscous high-temperature flows.

A E 509. Individualized Study
3 Credits (3)
Individualized study covering specialized topics in aerospace engineering. Consent of instructor required. Restricted to A E & M E majors.

A E 510. Special Topics
1-6 Credits (1-6)
Topics in aerospace engineering. May be repeated for a maximum of 6 credits. Consent of instructor required.

A E 512. Vibrations
3 Credits (3)
Free and forced vibrations for discrete and continuous systems with single or multiple degrees of freedom. Introduction to nonlinear and random vibration and solution techniques for such systems.
Prerequisite: M E 511 or consent of instructor.
Learning Outcomes

1. Ability to derive equations of motion of single- and multi-degree-of-freedom (DOF) systems.
2. Ability to analyze free and forced vibrations of single- and multi-DOF systems.
3. Ability to perform modal analysis of single- and multi-DOF systems.
4. Ability to derive equations of motion of continuous systems including beams, strings, and rods.
5. Ability to solve the governing equations of motion for several dynamical systems.

A E 527. Linear Systems Theory
3 Credits (3)
Introduction to control of linear multi-input-multi-output (MIMO) systems. Topics include representation of system dynamics using the state-space model, linearization, internal and input-to-output stability, controllability, observability, optimal control, linear quadratic regulator, and observer. May be repeated up to 3 credits.
Prerequisite: M E 452 or A E 452 or consent of instructor.
Learning Outcomes

1. Modeling of linear dynamical systems using state space methods.
2. Analysis of stability, controllability, and observability of linear systems.

3. Design of controllers and observers for linear systems using pole placement methods.

A E 530. Intermediate Fluid Mechanics
3 Credits (3)
Application of exact and empirical solutions to fundamental flow problems, including viscous and inviscid behavior. These applications establish a theoretical basis for the origin and physical role of common terms in the governing equations.
Prerequisite: M E 338 or A E 339 or consent of instructor.
Learning Outcomes
1. A basic knowledge of incompressible, viscous flows of Newtonian fluids, boundary layers and boundary layer behavior, vortex dynamics and 1D isentropic compressible flows, shocks and expansion waves.

A E 533. Numerical Methods for Fluid Mechanics and Heat Transfer
3 Credits (3)
Development of numerical techniques for the solution of ordinary and partial differential equations that arise in heat transfer and fluid mechanics; classification of equations, methods of solutions, examples.
Prerequisite: M E 530 or consent of instructor.
Learning Outcomes
1. An ability to understand fundamental aspects of solving differential equations using finite difference methods.
2. An ability to understand fundamental concepts such as stability, accuracy, consistency, systematic errors (phase/amplitude errors), artificial diffusion, etc.
3. An ability to implement and test algorithms for the solution of ordinary and partial differential equations.
4. An ability to develop ability to analyze numerical results and report results in a meaningful way.

A E 564. Advanced Flight Dynamics and Controls
3 Credits (3)
Advanced airplane flight dynamics and stability control system design, longitudinal and lateral autopilots, missile / rocket control systems, and guidance systems. May be repeated up to 3 credits.
Prerequisite: A E 364 or consent of instructor.
Learning Outcomes
1. An ability to construct a block diagram to find a transfer function for a dynamical system.
2. An ability to perform a control systems design by utilizing various linear control theories such as root-locus design method, bode / Nyquist plots, and lead / lag compensation techniques.
3. Understanding of longitudinal / directional / lateral dynamic flight stability controls associated with airplane designs.
4. Design and analysis of autopilot systems of an airplane with some knowledge in flight instrumentation.

A E 575. Propulsion
3 Credits (3)
Propulsion systems, thermodynamic cycles, combustion, specific impulse; principles of gas turbines, jet engines, and rocket propulsion systems. May be repeated up to 3 credits.
Prerequisite: A E 439 or consent of instructor.
Learning Outcomes
1. Knowledge of relevant fluid and thermodynamics.
2. Understanding of jet engine operating principles.
3. Ability to carry out parametric analysis of jet engine and turbomachinery.
4. Knowledge of how to analyze rocket propulsion systems.

A E 598. Special Research Programs
1-3 Credits (1-3)
Individual investigations, either analytical or experimental. May be repeated for a maximum of 6 credits. Restricted to A E & M E majors.

A E 599. Master's Thesis
1-15 Credits (1-15)
Thesis. Graded: Thesis/Dissertation.

A E 600. Doctoral Research
1-15 Credits (1-15)
This course number is used for assigning credit for research performed prior to successful completion of the doctoral qualifying examination. Graded: Thesis/Dissertation.

A E 700. Doctoral Dissertation
15 Credits (15)
Dissertation. Graded: Thesis/Dissertation.

Mechanical Engineering Courses

M E 228. Engineering Analysis I
3 Credits (3)
Introduction to engineering analysis with emphasis on engineering applications. Topics include ordinary differential equations, linear algebra, and vector calculus with focus on analytical methods. May be repeated up to 3 credits.
Prerequisite: C- or better grades in MATH 2530G.
Learning Outcomes
1. An ability to derive differential equation models of phenomena relevant to mechanical and aerospace engineering.
2. An ability to use basic methods for solution of these ordinary and partial differential equations.
3. An ability to apply the solutions to simple analysis and design situations.

M E 234. Mechanics-Dynamics
3 Credits (3)
Kinematics and dynamic behavior of solid bodies utilizing vector methods. May be repeated up to 3 credits.
Prerequisite: A grade of C- or better grade in the following: C E 233 and PHYS 1310G and MATH 1521G or MATH 1521H.
Learning Outcomes
1. Student will be able to apply concepts of kinematics and accelerated motion.

M E 240. Thermodynamics
3 Credits (3)
First and second laws of thermodynamics, irreversibility and availability, applications to pure substances and ideal gases.
Prerequisite: C- or better grades in PHYS 1310G.
Learning Outcomes
1. An ability to apply the first law of thermodynamics to energy systems.
2. Understanding and application of thermodynamic concepts and properties to analyze systems with pure substances and ideal gases.

M E 261. Numerical Methods
3 Credits (2+3P)
Introduction to programming syntax, logic, and structure. Numerical techniques for root finding, solution of linear and nonlinear systems of

equations, integration, differentiation, and solution of ordinary differential equations will be covered. Multi function computer algorithms will be developed to solve engineering problems. May be repeated up to 3 credits.
Prerequisite: C- or better grades in MATH 1521G or MATH 1521H or ENGR 190.
Learning Outcomes
1. Ability to use a variety of numerical methods in both basic and advanced engineering calculations.
2. Ability to formulate algorithms and write programs to solve engineering problems.
3. Ability to develop an appreciation for the hazards and limitations of numerical solutions, including accuracy, stability, and computer limitations of memory and speed.

M E 326. Mechanical Design
3 Credits (3)
Kinematics and dynamics of machinery, analytical and computer-aided design of kinematics, mechanism synthesis involving linkages, cam and gear design, and motion analysis and balancing of forces. Project-based learning of multi-mechanism system design, analysis, fabrication, and evaluation. May be repeated up to 3 credits.
Prerequisite: C- or better in ENGR 234 and C E 301.
Learning Outcomes
1. An ability to perform motion analysis of mechanisms involving various mechanical components such as linkages, cams, and gears.
2. An ability to analyze and balance dynamic forces in machines.
3. Knowledge of how to design mechanism synthesis that can function as required in machines.
4. Understanding of ethics and professional responsibilities in engineering design.

M E 328. Engineering Analysis II
3 Credits (3)
Advanced engineering analysis with emphasis on engineering applications. Topics include systems of ordinary differential equations, Fourier analysis, partial differential equations, and functions of complex variable with focus on analytical methods.
Prerequisite: C- or better grades in M E 228.
Learning Outcomes
1. An ability to use basic properties of Laplace Transforms and apply to initial value problems.
2. Understanding of basics of phase space analysis for ordinary differential equations.
3. An ability to obtain Fourier Series representations of functions.
4. An ability to apply the method of separation of variables to solve linear homogeneous partial differential equations.
5. An ability to perform basic operations involving complex numbers.

M E 331. Intermediate Strength of Materials
3 Credits (3)
Covers stress and strain, theories of failure, curved flexural members, flat plates, pressure vessels, buckling, and composites. May be repeated up to 3 credits.
Prerequisite: C E 301 and M E 328.
Learning Outcomes
1. An ability to perform stress and strain analysis for bending of straight and curved beams, torsion of prismatic bars, and complex loading cases.
2. Application of governing equations of elasticity.
3. Use of common failure theories for failure prediction of ductile metals.

M E 332. Vibrations
3 Credits (3)
Vibration of single and n-degree of freedom systems considering free, forced, and damped motion. Lagrange s equations. Dynamic stability. Controls. Matrix iteration. May be repeated up to 3 credits.
Prerequisite: M E 328, ENGR 234, and M E 261.
Learning Outcomes
1. Ability to analyze free and forced vibrations of a single degree-of-freedom (DOF).
2. Ability to analyze free and forced vibrations of multi-DOF systems.
3. Ability to perform modal analysis for engineering structures to understand mechanical vibrations in terms of normal modes.

M E 333. Intermediate Dynamics
3 Credits (3)
Three dimensional kinematics and kinetics, orbal motion, Lagrange s equations, dynamic stability, and controls. May be repeated up to 3 credits.
Prerequisite: M E 328 and ENGR 234.
Learning Outcomes
1. An ability to derive the equations of motion for particles and rigid bodies based on analytical dynamics theories.
2. Analysis of linear / nonlinear dynamical systems with their equations of motion by finding the associated solutions and by performing simulations.
3. Application of dynamics theory to engineering applications in vehicle dynamics, gyroscopes, aircraft / spacecraft dynamics, and celestial mechanics.

M E 338. Fluid Mechanics
3 Credits (3)
Properties of fluids. Fluid statics and fluid dynamics. Applications of the conservation equations continuity, energy, and momentum to fluid systems.
Prerequisite: C- or better grade in ENGR 234 and in (M E 228 or MATH 3160).
Learning Outcomes
1. Ability to apply knowledge of mathematics, science, and engineering.
2. Ability to design and conduct experiments, as well as to analyze and interpret data.
3. Ability to design a system, component or process to meet desired needs within realistic constraints.
4. Ability to identify, formulate, and solve engineering problems.

M E 340. Applied Thermodynamics
3 Credits (3)
Thermodynamic cycles, availability, Maxwell relations, Gibbs and Helmholtz functions, mixtures, psychrometrics, implications for engineering materials.
Prerequisite: C- or better grades in M E 240.
Learning Outcomes
1. A thorough understanding of the transfer of work, heat, and energy by various thermodynamic processes in open and closed systems, and which processes and allowed and not allowed, and spontaneous and non-spontaneous.
2. An applied knowledge predicated on the four laws of thermodynamics and application to work producing and consuming devices where efficiency must optimized by selection of appropriate fuels,

energy sources, working fluids, and design considerations for engineering devices such as nozzles, turbines, condensers, diffusers, regenerators, intercoolers, and feedwater systems.

3. The skills necessary to be successful in their professional duties in employment or further educational pursuits related to the automotive, commercial aviation, space, and energy sectors, and to be able to clearly identify, communicate, formulate, analyze, and deduce solutions to technical problems in the field of thermodynamics with peers in engineering and allied fields.

M E 341. Heat Transfer
3 Credits (3)
Heat balance equation. Fundamentals of conduction, convection, and radiation. Design of heat transfer systems.
Prerequisite: C- or better grades in M E 240 and in (M E 338 or A E 339).
Learning Outcomes

1. A thorough understanding of the three modes of heat transfer (conduction, convection, and radiation).
2. Basic knowledge required to apply heat transfer principles to practical and contemporary engineering problems (primarily in thermal management of electronics such as in data centers and smart phones, buildings, automobiles, and energy and power generation systems).
3. The skills necessary to be successful in their professional duties in employment or further educational pursuits and be able to clearly identify, communicate, formulate, analyze, and deduce solutions to technical problems in the field of heat transfer.

M E 345. Experimental Methods I
3 Credits (2+3P)
Emphasis on experimental techniques, basic instrumentation, data acquisition and analysis, and written presentation of results. Includes experiments in dynamics and deformable body mechanics. May be repeated up to 3 credits.
Prerequisite: C- or better grades in (M E 228 or MATH 3160), in (ENGR 140 or PHYS 2140), and in ENGR 234.
Prerequisite/Corequisite: C E 301.
Learning Outcomes

1. A thorough understanding of how to work in a laboratory with a focus on safety (use of PPE, waste disposal, and knowledge of common laboratory hazards and their mitigation).
2. An ability to implement good laboratory practice (GLP) to ensure proper documentation of results, accuracy of results, and adherence to written procedures to allow replication of results.
3. Hands-on laboratory skills using lab equipment (sensors, data-recording software, scales, calipers, micrometers, strain gages, tensile testing machines/load cells, vibration generators, oscilloscopes, function generators, power supplies, Wheatstone bridges, physical reference standards, and specimen preparation equipment) along with various tools and equipment accessories.
4. An ability to corroborate experimental findings with theoretical predictions.
5. An ability to apply the scientific method to experiments, including hypothesis, deduction, extrapolation (trend analysis), and inference.
6. Experience reducing data including error analysis, basic statistics, basic plotting and graphing, outlier identification, propagation of errors, SI/English units, and appropriate use of implied precision and significant figures.
7. Technical writing skills as a team and individual, effective team presentation skills, and delivering peer review.

M E 349. MAE Career Seminar
1 Credit (1)
Seminar course covering topics relevant to mechanical and aerospace engineering juniors (job placement, interviewing techniques, resume preparation, etc.). May be repeated up to 3 credits. Restricted to: M E and A E majors.
Prerequisite: Sophomore Standing.
Learning Outcomes

1. Students will learn how to prepare for their future career by learning job placement, resume preparation, interview skills, and others.

M E 400. Undergraduate Research
1-3 Credits
Performed with the direction of a department faculty member. May be repeated for a maximum of 6 credits.
Prerequisite: consent of faculty member.

M E 401. Building Energy and Environment
3 Credits (3)
Building energy and greenhouse gas emissions; energy usage distribution in residential and commercial buildings, HVAC, other end use entities (lighting, water heating, refrigeration, and computers and electronics), energy efficiency in buildings, indoor air quality, air filtration and purification, economics.
Prerequisite: C- or better grades in M E 340 and M E 341.
Learning Outcomes

1. Understanding of the energy usage in buildings and their impact on the environment.
2. Calculation of the energy loads for various end use entities and understand their role in building energy.
3. Analysis of HVAC systems and heat transfer and apply the knowledge for realizing energy efficiency in buildings.
4. An ability to write a technical term paper discussing the current and future trends on the topics of building energy and environmental impact and indoor air quality.

M E 405. Special Topics
3 Credits (3)
Topics of modern interest to be offered by the departmental staff. May be repeated up to 12 credits.
Prerequisite(s): Senior standing.

M E 425. Design of Machine Elements
3 Credits (3)
Design and analysis of machinery for load-bearing and power transmission by considering material failure modes such as yielding, fracture, and fatigue. Design and selection of machine elements including threaded fasteners, springs, rolling-element bearings, cams, gears and friction drives.
Prerequisite: C- or better grades in M E 326.
Learning Outcomes

1. An ability to incorporate analysis and design methods for designing and prototyping machine elements.
2. An ability to recognize the design process, to breakdown this complex process into a series of simple tasks, and to carry out those tasks to achieve the desired design.
3. Knowledges of how to apply the industrial specifications and requirements regarding the design of machine elements.
4. Implementation of these knowledge and experiences to real-world engineering projects with finite element method.

M E 445. Experimental Methods II
3 Credits (2+3P)
Emphasis on experimental techniques, instrumentation and data acquisition in fluid mechanics, heat transfer, and thermodynamics. Laboratory results will be presented in written and verbal formats. May be repeated up to 3 credits.
Prerequisite: C- or better grades in (M E 338 or A E 339), M E 340, M E 341, and M E 345.
Learning Outcomes
1. A thorough understanding of how to work in a laboratory with a focus on safety (use of PPE, waste disposal, and knowledge of common laboratory hazards and their mitigation).
2. An ability to implement good laboratory practice (GLP) to ensure proper documentation of results, accuracy of results, and adherence to written procedures to allow replication of results.
3. Hands-on laboratory skills using lab equipment (sensors, data-recording software, scales, calipers, micrometers, straingages, tensile testing machines/load cells, vibration generators, oscilloscopes, function generators, power supplies, Wheatstone bridges, physical reference standards, and specimen preparation equipment) along with various tools and equipment accessories.
4. An ability to corroborate experimental findings with theoretical predictions.
5. An ability to apply the scientific method to experiments, including hypothesis, deduction, extrapolation (trend analysis),and inference.
6. Experience reducing data including error analysis, basic statistics, basic plotting and graphing, outlier identification, propagation of errors, SI/English units, and appropriate use of implied precision and significant figures.
7. Technical writing skills as a team and individual, effective team presentation skills, and delivering peer review.

M E 452. Control System Design
3 Credits (3)
Introduction to the control of dynamical systems, with a focus on mechanical and aerospace systems, including basic systems theory, controllability / observability, feedback and stabilization, PID controls, root-locus plot, and Bode diagram. May be repeated up to 3 credits.
Prerequisite: M E 261, M E 328 and ENGR 234.
Learning Outcomes
1. Construction of a block diagram of control systems to find a transfer function for a dynamical system.
2. Analysis of control systems by utilizing various linear control theories such as root-locus design method, bode, and lead / lag compensation techniques.
3. Design and simulation of PID control systems for mechanical / aerospace engineering applications.
4. Derivation of state space representation of a dynamical systems.

M E 456. Experimental Modal Analysis
3 Credits (3)
Emphasis on hands-on techniques for structural vibration tests for practical applications. Interpretation of experimental results by means of advanced signal processing tools, basic system identification methodology, and reduced-order modeling procedures.
Prerequisite: M E 328 and M E 261 or consent of instructor.
Learning Outcomes
1. An ability to understand fundamentals of linear vibrations theory for discrete and continuous systems.
2. An ability to perform basic numerical and experimental modal analysis of structures.
3. An ability to utilize basic and advanced signal processing tools.
4. An ability to extract system parameters for a mathematical model from a physical model.

M E 457. Engineering Failure Analysis
3 Credits (3)
Introduction to failure theories and causes. Topics include general procedures for failure analysis, ductile and brittle modes of failure, elements of fracture mechanics, fractography, and failures in various engineering applications due to fatigue, wear, corrosion, design or processing defects.
Prerequisite: Grade of C- or better in C E 301 and CHME 361 or consent of instructor.
Learning Outcomes
1. An ability to systematically conduct failure analysis, identify cause(s) of failure, suggest remedial steps to prevent failures and/or improve performance for a variety of engineering applications involving metals, polymers, ceramics and composites.
2. Use of skills and knowledges in any industry and engineering applications such as in aerospace, mechanical, microelectronics, construction, chemical, automotive, energy, and medical areas.

M E 458. Properties and Mechanical Behavior of Materials
3 Credits (3)
Understanding the microstructure of engineering materials and their influence on mechanical behavior. Topics include Material Structure and Physical Properties, Thermodynamics and Kinetics of Materials, Mechanical Properties, Strengthening Mechanisms, Time and Temperature Dependent Behavior, Degradation, Fatigue, and Fracture.
Prerequisite: (Grade of C- or better in C E 301 and CHME 361) or consent of instructor.
Learning Outcomes
1. An ability to correlate mechanical behavior of materials with their microstructure, processing history and composition.
2. An ability to recognize impact of operating conditions, predict life span, and design materials to improve reliability and efficiency.
3. An ability to select appropriate materials for a given application from class of materials such as metals, polymers, ceramics and composites.

M E 460. Applied Finite Elements
3 Credits (3)
Introduction to the practical aspects of structural finite element modeling. Course focuses on providing a working knowledge of how to effectively incorporate finite element techniques into the design process.
Corequisite: M E 425 or consent of instructor.
Learning Outcomes
1. Use of direct stiffness and potential energy approaches to assemble global system of linear equations for static elastic and steady state heat transfer problems (bar, beam, plane stress / strain elements).
2. An ability to solve the global system of linear equations for unknown degrees of freedom (displacements or temperatures).
3. An ability to postprocess the solution to find stresses, strains, or temperature gradients.
4. An ability to solve two-dimensional and three-dimensional problems of elasticity and heat transfer using commercial general purpose finite element analysis software.

M E 481. Alternative and Renewable Energy
3 Credits (3)
Current and future energy needs of the United States and the world will be considered primarily from the standpoint of renewable energy sources such as solar, wind, ocean, and biomass. Technical, economic, and environmental aspects of each technology will be addressed.
Prerequisite: (M E 338 or A E 339) and M E 340 or consent of instructor.
Prerequisite/Corequisite: M E 341.
Learning Outcomes
1. Understanding of current and future energy needs of the United States and the whole world.
2. Understanding of the role of renewable and alternative energy sources such as solar, wind, ocean, and biomass.
3. An ability to conduct basic techno-economic analysis of various renewable and alternative energy technologies.

M E 483. Introduction to Combustion
3 Credits (3)
Introduction to combustion kinetics, combustion thermochemistry, flame dynamics, flame stability, and pollutant formation. Course coverage includes laminar and turbulent flames, premixed and diffusion flames, and detonations. Emphasis is placed on the role of chemical kinetics, heat transfer, mass transfer, and fluid dynamics on flame structure and flame stability. May be repeated up to 3 credits.
Prerequisite: M E 228 and M E 340 or consent of instructor.
Learning Outcomes
1. Understanding of reaction rates of chemical processes.
2. Derivation of simplified reactor models based on coupled chemical and thermal analysis.
3. Knowledge of conservation / transport equations for reacting flows.
4. Calculation of structure and propagation limits of laminar premixed combustion waves.
5. Analysis of structure and controlling processes in laminar diffusion flames, time and spatial scales in turbulent flames, and basic issues in turbulent combustion.

M E 486. Introduction to Robotics
3 Credits (3)
This course provides students with an introduction to the theories and methods for analysis, design, and control of robotic manipulators. This course is devoted to understanding the spatial descriptions and transformations, kinematics, and dynamics of these mechanisms and how to practically implement these concepts into actual robotic manipulators.
Prerequisite: M E 328 and ENGR 234.
Learning Outcomes
1. An ability to develop spatial description and transformations of rigid body motion and coordinate frames.
2. An ability to derive the kinematics and dynamics of robotic manipulators in forward and inverse forms.
3. An ability to plan motion and trajectories, program, and control these robotic platforms.
4. Application of the theoretical methods into industrial robots, and implementation of the knowledge and experiences to real-world engineering projects.

M E 487. Mechatronics
3 Credits (2+3P)
Introduction to the analysis and design of computer-controlled electromechanical systems, including data acquisition and conversion, force and motion sensors, actuators, mechanisms, feedback control, and robotic devices. Students required to work in teams to construct and test simple robotic systems.
Prerequisite: M E 345.
Learning Outcomes
1. An ability to define a mechatronic system and its primary elements.
2. An ability to exercise a computational model of the mechatronic system and evaluate the system response.
3. An ability to design, formulate and implement an appropriate closed-loop controller.
4. An ability to design and demonstrate a functional physical device that solve a practical problem while meets system requirements.
5. Knowledge of contemporary issues.

M E 502. Elasticity I
3 Credits (3)
Introduction to the theory of elastic media with emphasis on understanding the fundamental principles and solution methods used in the analysis of elastic solids and structures. Cartesian tensors are introduced for formulations of general deformations and states of stress. May be repeated up to 3 credits.
Learning Outcomes
1. An ability to understand the fundamental principles and solution methods used in the analysis of elastic solids and structures.
2. Use of cartesian tensors for formulations of general deformations and states of stress.

M E 503. Thermodynamics
3 Credits (3)
A comprehensive study of the first and second laws of thermodynamics, nonequilibrium processes, equations of state, and statistical thermodynamics.
Prerequisite: C- or better grade in M E 340 or consent of instructor.
Prerequisite/Corequisite: M E 570.
Learning Outcomes
1. Application of 1st law and 2nd law of thermodynamics to closed and open systems for analysis of thermodynamic cycles with and without phase change and for pure substances and mixtures as the working fluids.
2. Understanding of thermodynamic properties and their relationships, thermodynamics equilibrium and stability.
3. Understanding of the basics of statistical thermodynamics and its differences from classical thermodynamics.

M E 504. Continuum Mechanics
3 Credits (3)
Introduction to the fundamentals of the mechanics for continuous media. This covers the concepts and general principles common to all branches of mechanics to facilitate further study in various fields such as elasticity, plasticity, fluid, and continuum damage mechanics. Computational aspects of the theory are also discussed. May be repeated up to 3 credits.
Learning Outcomes
1. An ability to understand the fundamentals of the continuum mechanics, which covers the concepts and general principles common to all branches of mechanics to facilitate further study in various fields such as elasticity, plasticity, fluid, and continuum damage mechanics.

M E 509. Individualized Study
3 Credits (3)
Individualized study covering specialized topics in mechanical and aerospace engineering. Consent of instructor required.

M E 510. Special Topics
1-6 Credits
Topics in mechanical engineering. May be repeated for a maximum of 6 credits.
Prerequisite: consent of the department head.

M E 511. Dynamics
3 Credits (3)
An advanced study of the dynamical behavior of systems of particles and rigid bodies, with emphasis on the theoretical background of dynamics.
Prerequisite: ENGR 234 and M E 328.
Learning Outcomes
1. Knowledge of the techniques to describe the motion of mechanical systems.
2. Ability to derive the equations of motion of dynamical systems.
3. Understanding of the difference between several methodologies used to derive the governing equations of systems.
4. Ability to find and classify the dynamical responses of systems.

M E 512. Vibrations
3 Credits (3)
Free and forced vibrations for discrete and continuous systems with single or multiple degrees of freedom. Introduction to nonlinear and random vibration and solution techniques for such systems.
Prerequisite: M E 511 or consent of instructor.
Learning Outcomes
1. Ability to derive equations of motion of single- and multi-degree-of-freedom (DOF) systems.
2. Ability to analyze free and forced vibrations of single- and multi-DOF systems.
3. Ability to perform modal analysis of single- and multi-DOF systems.
4. Ability to derive equations of motion of continuous systems including beams, strings, and rods.
5. Ability to solve the governing equations of motion for several dynamical systems.

M E 517. Nonlinear Dynamics and Chaos
3 Credits (3)
Singular points, periodic solutions, stability, and local bifurcations for ODEs and maps; phase space methods, invariant manifolds, and Poincare maps; nonsmooth, periodic, time-delay, and Hamiltonian systems; perturbation, averaging, and harmonic balance methods; center manifold reduction and normal forms; strange attractors, Liapunov exponents, attractor dimension; dissipative and Hamiltonian chaos. May be repeated up to 3 credits.
Learning Outcomes
1. Ability to qualitatively and quantitatively understand and determine the dynamical response of nonlinear systems.
2. Understanding of various nonlinear behaviors and concepts.
3. Ability to use several perturbation techniques to solve the governing equations of motion.
4. Ability to characterize the response of a nonlinear dynamical system.

M E 518. Finite Element Analysis
3 Credits (3)
Introduction to finite element method. Topics include mathematical modeling, variational formulation, shape functions, truss, beam, solid, and shell elements. Includes static, dynamic, and nonlinear analysis.

M E 527. Linear Systems Theory
3 Credits (3)
Introduction to control of linear multi-input-multi-output (MIMO) systems. Topics include representation of system dynamics using the state-space model, linearization, internal and input-to-output stability, controllability, observability, optimal control, linear quadratic regulator, and observer.
Prerequisite: M E 452 or A E 452 or consent of instructor.
Learning Outcomes
1. Modeling of linear dynamical systems using state space methods.
2. Analysis of stability, controllability, and observability of linear systems.
3. Design of controllers and observers for linear systems using pole placement methods.

M E 530. Intermediate Fluid Mechanics
3 Credits (3)
Application of exact and empirical solutions to fundamental flow problems, including viscous and inviscid behavior. These applications establish a theoretical basis for the origin and physical role of common terms in the governing equations.
Prerequisite: M E 338 or A E 339 or consent of instructor.
Learning Outcomes
1. A basic knowledge of incompressible, viscous flows of Newtonian fluids, boundary layers and boundary layer behavior, vortex dynamics and 1D isentropic compressible flows, shocks and expansion waves.

M E 533. Numerical Methods for Fluid Mechanics and Heat Transfer
3 Credits (3)
Development of numerical techniques for the solution of ordinary and partial differential equations that arise in heat transfer and fluid mechanics; classification of equations, methods of solutions, examples.
Prerequisite: M E 530 or consent of instructor.
Learning Outcomes
1. An ability to understand fundamental aspects of solving differential equations using finite difference methods.
2. An ability to understand fundamental concepts such as stability, accuracy, consistency, systematic errors (phase/amplitude errors), artificial diffusion, etc.
3. An ability to implement and test algorithms for the solution of ordinary and partial differential equations.
4. An ability to develop ability to analyze numerical results and report results in a meaningful way.

M E 536. Hydrodynamic Stability and Turbulence
3 Credits (3)
Introduction to fundamentals of hydrodynamic stability, classical linear stability analysis of parallel shear flows and rotating flows, nonlinear stability, basic concepts in turbulence theory.
Prerequisite/Corequisite: M E 530.
Learning Outcomes
1. An ability to understand fundamentals of hydrodynamic stability.
2. An ability to apply classical linear / nonlinear stability analysis of parallel shear flows and rotating flows.
3. Understanding of basic concepts in turbulence theory.

M E 540. Intermediate Heat Transfer
3 Credits (3)
Fundamentals of conduction, convection, and radiation heat transfer. Emphasis on the application of combined heat transfer to the solution of problems not accessible at the undergraduate level.
Prerequisite: M E 341.
Prerequisite/Corequisite: M E 570.

Learning Outcomes

1. An ability to solve heat transfer problems involving conduction, convection, and radiation.
2. Use of algebra and differential and integral calculus to obtain solutions to heat transfer problems.
3. Understanding of the final solution for a heat transfer problem and predict its correctness using fundamental heat transfer principles.

M E 557. Engineering Failure Analysis
3 Credits (3)
Introduction to failure theories and causes. Topics include general procedures for failure analysis, ductile and brittle modes of failure, elements of fracture mechanics, fractography, and failures in various engineering applications due to fatigue, wear, corrosion, design or processing defects. May be repeated up to 3 credits.

M E 558. Properties and Mechanical Behavior of Materials
3 Credits (3)
Understanding the microstructure of engineering materials and their influence on mechanical behavior. Topics include Material Structure and Physical Properties, Thermodynamics and Kinetics of Materials, Mechanical Properties, Strengthening Mechanisms, Time and Temperature Dependent Behavior, Degradation, Fatigue, and Fracture. May be repeated up to 3 credits.
Prerequisite: CHME 361.

M E 570. Engineering Analysis I
3 Credits (3)
Introduction to engineering analysis with emphasis on engineering applications. Topics include linear algebra, linear ordinary differential equations, and linear partial differential equations with focus on analytical methods.
Prerequisite: M E 328 or PHYS 395 or equivalent.
Learning Outcomes

1. Proficient knowledge of Laplace Transforms and application to initial value problems.
2. Basic knowledge of phase space analysis for ODEs.
3. Proficient knowledge of Fourier Series representations of functions, and basic knowledge of Fourier Transforms.
4. Proficient knowledge of linear, homogeneous boundary value PDEs; basic knowledge of nonhomogeneous BVP, Poisson's equation and Green's Functions.
5. Proficient knowledge of elementary complex functions, basic knowledge of theory of analytic functions, contour integral theorems, Laurent Series and Residue Theorem.

M E 583. Introduction to Combustion
3 Credits (3)
Introduction to combustion kinetics, combustion thermochemistry, flame dynamics, flame stability, and pollutant formation. Course coverage includes laminar and turbulent flames, premixed and diffusion flames, and detonations. Emphasis is placed on the role of chemical kinetics, heat transfer, mass transfer, and fluid dynamics on flame structure and flame stability. May be repeated up to 3 credits.
Prerequisite: (M E 228 and M E 340) or consent of instructor.
Learning Outcomes

1. Understanding of reaction rates of chemical processes.
2. Derivation of simplified reactor models based on coupled chemical and thermal analysis.
3. Knowledge of conservation / transport equations for reacting flows.
4. Calculation of structure and propagation limits of laminar premixed combustion waves.
5. Analysis of structure and controlling processes in laminar diffusion flames, time and spatial scales in turbulent flames, and basic issues in turbulent combustion.

M E 586. Introduction to Robotics
3 Credits (3)
This course provides students with an introduction to the theories and methods for analysis, design, and control of robotic manipulators. This course is devoted to understanding the spatial descriptions and transformations, kinematics, and dynamics of these mechanisms and how to practically implement these concepts into actual robotic manipulators.
Prerequisite: M E 328 and ENGR 234 or consent of instructor.
Learning Outcomes

1. An ability to develop spatial description and transformations of rigid body motion and coordinate frames.
2. An ability to derive the kinematics and dynamics of robotic manipulators in forward and inverse forms.
3. An ability to plan motion and trajectories, program, and control these robotic platforms.
4. Application of the theoretical methods into industrial robots, and implementation of the knowledge and experiences to real-world engineering projects.

M E 587. Mechatronics
3 Credits (2+3P)
Introduction to the analysis and design of computer-controlled electromechanical systems, including data acquisition and conversion, force and motion sensors, actuators, mechanisms, feedback control, and robotic devices. Students required to work in teams to construct and test simple robotic systems. Crosslisted with: M E 487.
Prerequisite: M E 345.
Learning Outcomes

1. An ability to define a mechatronic system and its primary elements.
2. An ability to exercise a computational model of the mechatronic system and evaluate the system response.
3. An ability to design, formulate and implement an appropriate closed-loop controller.
4. An ability to design and demonstrate a functional physical device that solve a practical problem while meets system requirements.
5. Knowledge of contemporary issues.

M E 598. Special Research Programs
1-3 Credits
Individual investigations, either analytical or experimental. May be repeated for a maximum of 6 credits.

M E 599. Master's Thesis
15 Credits
Thesis.

M E 600. Doctoral Research
1-15 Credits
This course number is used for assigning credit for research performed prior to successful completion of the doctoral qualifying examination.

M E 698. Special Research Programs
1-3 Credits
May be repeated for a maximum of 6 credits.

M E 700. Doctoral Dissertation
15 Credits
Dissertation.

Name: Margaret Vasquez, Program Specialist, Department of Mechanical and Aerospace Engineering

Office Location: Jett Hall Rm. 104

Phone: (575) 646-3502

Website: https://mae.nmsu.edu/ (http://mae.nmsu.edu)