A E-AEROSPACE ENGINEERING

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.