MECHANICAL & AEROSPACE ENGINEERING (MAE)

MAE 500 Selected Topics (1-6 Credits)
Engineering & Comp Sci
Exploration of a topic (to be determined) not covered by the standard curriculum but of interest to faculty and students in a particular semester. Repeatable

MAE 510 Nuclear Reactor Design, Operation and Safety (3 Credits)
Engineering & Comp Sci
Cross-listed with NUC 510
Principles of fission reactor analysis and design; reactor kinetics, operation and control; reactor thermo-fluid-dynamics; reactor safety; reactor accident case studies.
Prereq: NUC 301 and MAE 551

MAE 512 Technology Management (3 Credits)
Engineering & Comp Sci
This course develops a foundation for the concepts of ethics, technology life-cycles, product life cycles, concurrent engineering, managing people, project evaluation, leading technology teams, managing R&D and innovation and managing risks in order to support the planning, scheduling, and controlling activities required for successful completion of technologically innovative projects.
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/); Communication Skills (https://coursecatalog.syracuse.edu/shared-competencies/communication-skills/)

MAE 525 Soft Robotics: Materials, Mechanics, and Machines (3 Credits)
Engineering & Comp Sci
Soft robotics offers many advantages over conventional robotics. This course explores relevant materials and mechanics for recent progress in soft robotics through lectures, literature surveys, and course projects where students work in teams to repeat part of recent soft robotics papers.
Advisory recommendation Prereq: ECS 325
Shared Competencies: Information Literacy and Technological Agility (https://coursecatalog.syracuse.edu/shared-competencies/information-literacy-and-technological-agility/)

MAE 530 Introduction to Design Optimization (3 Credits)
Engineering & Comp Sci
Theory and use of numerical design optimization methods. Problem formulation, practical application, and results analysis. Unconstrained nonlinear problems, constrained linear and nonlinear problems, and multi-objective optimization. Graduate students will do additional work in surrogate models and optimizing under uncertainty. Extensive use of Matlab functions and programming.
Prereq: MAT 485
Shared Competencies: Information Literacy and Technological Agility (https://coursecatalog.syracuse.edu/shared-competencies/information-literacy-and-technological-agility/)

MAE 536 Composite Materials (3 Credits)
Engineering & Comp Sci
Design, analysis, and manufacturing of fiber-reinforced composite materials. Emphasis is on polymeric composites for general aerospace and automotive applications, and on ceramic matrix composites for hypersonic applications.
Prereq: ECS 325
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/)

MAE 545 Applications of Fluid Mechanics (3 Credits)
Engineering & Comp Sci
Selected topics in applied fluid mechanics, to be determined by the instructor. Tools employed include control volume analysis, Bernoulli equation, exact and simplified solutions of the Navier-Stokes equations, and test correlations.
Prereq: MAE 341

MAE 548 Engineering Economics and Technology Valuation (3 Credits)
Engineering & Comp Sci
Cross-listed with CEE 548
Value-based assessment and management of engineering/technology projects: equivalence; discounted cash flow; taxes/depreciation; financial statements. Risk-adjusted valuation: risk/uncertainty in staged projects; Monte Carlo simulations; decision trees; real options; project portfolio management.
Prereq: MAT 296
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/)

MAE 551 Energy Conversion (3 Credits)
Engineering & Comp Sci
Cross-listed with CEE 551
Energy demand and resources. Fundamentals of combustion. Power plants, refrigeration systems. Turbines and engines. Advanced systems. Direct energy conversion. Alternate energy sources. Energy storage. Costs and environmental impact.
Prereq: MAE 251

MAE 552 Building Environmental Measurements and Controls (3 Credits)
Engineering & Comp Sci
Cross-listed with CEE 552
Fundamentals of building ventilating methods for measuring and controlling indoor environmental conditioning, thermal comfort, and indoor air quality.
Prereq: MAE 341 and 355

MAE 553 HVAC Systems Analysis and Design (3 Credits)
Engineering & Comp Sci
Cross-listed with CEE 553
Fundamentals of moist air properties, basic air conditioning processes, heat transfer in building structures, heating and cooling load calculations, and air distribution systems.
Prereq: MAE 251
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/)

MAE 554 Principles of Refrigeration (3 Credits)
Engineering & Comp Sci
Basic thermodynamic analysis of refrigeration cycles. Components selection. Environmental issues and recent developments in the refrigeration and the air conditioning industry.
Prereq: MAE 251

MAE 555 Fundamentals of Nano-Science & Nano-Engineering (3 Credits)
Engineering & Comp Sci
Definition of nano-, micro- and macro- scales. Overview of nanotechnology. Molecular and surface forces at the nanoscale. Atomistic definitions of continuum properties. Molecular Simulations. Principles of nanofabrication. Characterization of nanomaterials. Additional paper for graduate students.
Prereq: PHY 212 and MAT 485

MAE 571 Applications of Computational Fluid Dynamics (3 Credits)
Engineering & Comp Sci
Use of commercial Computational Fluid Dynamics (CFD) softwares to solve problems of practical interest. Modeling of fluid/thermal systems. Introduction to CFD algorithms. Simulation, evaluation, and interpretation of CFD results.
Prereq: MAE 341
Shared Competencies: Information Literacy and Technological Agility (https://coursecatalog.syracuse.edu/shared-competencies/information-literacy-and-technological-agility/)

MAE 573 Application of Finite Element Analysis (3 Credits)
Engineering & Comp Sci
Formulation of mechanics and heat transfer problems by finite element analysis. Application of the finite element method using commercial software in the static and dynamic analysis of mechanical components.
Prereq: ECS 325 and MAT 485
Shared Competencies: Information Literacy and Technological Agility (https://coursecatalog.syracuse.edu/shared-competencies/information-literacy-and-technological-agility/)

MAE 580 International Course (1-12 Credits)
Engineering & Comp Sci
Offered through SUAbroad by educational institution outside the United States. Student registers for the course at the foreign institution and is graded according to that institution's practice. SUAbroad works with the SU academic department to assign the appropriate course level, title, and grade for the student's transcript.
Repeatable

MAE 585 Principles of Turbomachines (3 Credits)
Engineering & Comp Sci
Fluid dynamics and thermodynamics of turbomachines. Performance characteristics and analysis of axial and radial turbomachines. Cascade theory. Radial equilibrium equation. Meridional flow analysis. Three dimensional flow characteristics of turbomachines.
Prereq: MAE 251 and MAE 341
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/)

MAE 587 Design of Solar Energy System (3 Credits)
Engineering & Comp Sci
Fundamentals of solar radiation, collectors and storage. Design of solar space heating, cooling; water heating systems. Study of solar electric systems. Economics of solar design; application to heat pumps, energy conservation techniques.
Prereq: MAE 251

MAE 588 Principles of Wind Turbines (3 Credits)
Engineering & Comp Sci
Cross-listed with CEE 588, ECS 588
Aerodynamics, performance, control, and electrical aspects wind turbines.
Prereq: MAE 341

MAE 600 Selected Topics (1-6 Credits)
Engineering & Comp Sci
Exploration of a topic (to be determined) not covered by the standard curriculum but of interest to faculty and students in a particular semester.
Repeatable

MAE 611 Analytical and Computational Dynamics (3 Credits)
Engineering & Comp Sci
Modern analytical rigid body dynamics formulation and computational techniques applied to multibody systems. Kinematics of motion, analytical and computational determination of inertia properties, Kane¿s equations, holonomic and nonholonomic constraints, recursive algorithms, collisions.

MAE 613 New Product Development (3 Credits)
Engineering & Comp Sci
Methods of product concept generation, understanding of the market and customer needs. Design with a view to the entire product life cycle, from feasibility through disposal. Product development encompassing engineering and manufacturing issues, and management of the processes and intellectual property.

MAE 615 Instrumentation (3 Credits)
Engineering & Comp Sci
Basic theory of electronics, modulation, recording, and measurement combined with basic fundamentals in mechanical engineering, such as acoustics, vibration, heat transfer, stain, and turbulence.

MAE 617 Applied Engineering Simulation (3 Credits)
Engineering & Comp Sci
Fundamentals of advanced numerical methods. Applications of engineering simulation across various engineering disciplines. Features, capabilities, and limitations of commercial engineering simulation tools. Integration of simulation-based modeling and analysis into engineering design workflows.

MAE 621 Failure Analysis of Composite Materials (3 Credits)
Engineering & Comp Sci
Review of mechanical behavior of composites. Failure predictions for composites based on macroscopic mechanisms. Fatigue and fracture. Damage, delamination and debond growth. Residual strength and life predictions. Damage tolerance and nondestructive inspection.

MAE 625 Fracture Mechanics (3 Credits)
Engineering & Comp Sci
Introduction to basic elements: elastic and elastic-plastic crack tip stress and strain fields, stress intensity factor, crack extension form, J integral, fracture toughness, fatigue crack growth, and the applications of fracture mechanics.

MAE 626 Vibration of Mechanical Systems (3 Credits)
Engineering & Comp Sci
Fundamental physical and mathematical aspects of vibration phenomena in linear systems. Theory of transients, eigenvalue problems, vibration isolation and measurement techniques.

MAE 627 Advanced Helicopter Dynamics (3 Credits)
Engineering & Comp Sci
Mathematics of rotating systems, rotary wing dynamics, and calculation of aerodynamic forces both in rotating and fixed frames.

MAE 628 Linear Systems (3 Credits)
Engineering & Comp Sci
Introduction to control theory and linear time invariant systems. Feedback and stabilization, controllability, observability, and application of control design methods to systems of relevance in mechanical and aerospace engineering.

MAE 630 Advanced Practical Optimization (3 Credits)
Engineering & Comp Sci
Advanced theory and application of numerical optimization. Topics may include: Unconstrained/constrained linear and nonlinear problems; multiobjective, discrete and global optimization; optimization under uncertainty; evolutionary optimization. Knowledge of Linear Algebra and Ordinary Differential Equations required. Matlab used.

MAE 633 Theory of Materials (3 Credits)
Engineering & Comp Sci
Double-numbered with MAE 433
Introduction to basic science, fundamentals and properties of materials. Processes and analysis techniques for fabricating nano, micro, and macro devices. Additional work required of graduate students.
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/)

MAE 635 Advanced Mechanics of Materials (3 Credits)
Engineering & Comp Sci
Stress analysis. Beam-column analysis by series and variational techniques, beams on elastic foundation, torsion with restrained warping, deflections due to transverse shear, introductory problems in plates and shells.
Advisory recommendation Prereq: ECS 325.

MAE 640 Nonlinear Control (3 Credits)
Engineering & Comp Sci
Nonlinear analysis and control systems theory. Tools to analyze and design feedback control systems for complex nonlinear systems including examples from engineering and robotics.

MAE 641 Adaptive Control (3 Credits)
Engineering & Comp Sci
Adaptive-based control methods for uncertain nonlinear systems. A Lyapunov-based framework is used for the synthesis and analysis of the controllers including direct and indirect adaptive methods, neural networks, and learning-based approaches.

MAE 643 Fluid Dynamics (3 Credits)
Engineering & Comp Sci
Cross-listed with CEN 643
Review of undergraduate fluids; kinematics, vorticity; dynamics, stresses, Euler and Navier-Stokes equations; energy, Bernoulli's equation; potential flows; Stokes flows; boundary layers; flow separation; other applications.
Advisory recommendation Prereq: MAE 341 or CEN 333

MAE 644 Applied Fluid Dynamics (3 Credits)
Engineering & Comp Sci
Fundamental flow phenomena encountered in practical engineering situations. Topics may include: flow separation, turbulent mixing, bluffbody aerodynamics, three dimensional flow, flow control, high-lift devices, cavitation, fan stall, flow-structure interaction.
Advisory recommendation Prereq: MAE 643

MAE 645 Fluid Dynamics Measurements (3 Credits)
Engineering & Comp Sci
Measurement of pressure, density, and velocity in low- and high-speed flows. Hot wire anemometry and laser Doppler anemometry. Flow visualizations and image analysis. Digital data acquisition and time series analysis. Uncertainty estimation. Lecture and laboratory sessions.

MAE 647 Gas Dynamics (3 Credits)
Engineering & Comp Sci
Equations of motion for compressible perfect fluids. Crocco's equation. Wave equation. Acoustic speed. Unsteady flows. Shock formation. Normal and oblique shocks. Prandtl-Meyer expansion. Wave interactions. Method of characteristics. Supersonic diffuser, nozzle jet flows.

MAE 648 Biofluid Dynamics (3 Credits)
Engineering & Comp Sci
Cross-listed with BEN 648
Principles of momentum transfer in bioengineering systems. Flight and swimming in nature including flagellar propulsion. Newtonian and non-Newtonian fluid phenomena, including low-Reynolds-number flow, pulsatile and separated flows. Flow past bifurcations. Respiratory and blood circulatory flows.

MAE 651 Advanced Thermodynamics (3 Credits)
Engineering & Comp Sci
Review of thermodynamic laws and macroscopic coordinates of general systems. Reversibility, equilibrium and exergy. Introduction to statistical thermodynamics.
Advisory recommendation Prereq: MAE 251

MAE 655 Advanced Heat Transfer (3 Credits)
Engineering & Comp Sci
Theory and application of heat transfer by conduction and radiation for both steady and unsteady state conditions. Mathematical, graphical, and numerical methods of solution.

MAE 657 Convective Heat and Mass Transfer (3 Credits)
Engineering & Comp Sci
Fluid properties and transport equations. Introduction to turbulent transport. Laminar and turbulent heat transfer in internal and external flows. Free convection. Heat transfer in high-speed flow. Convective mass transfer. Special topics.
Advisory recommendation Prereq: MAE 643

MAE 658 Building Environmental Modeling and Simulations (3 Credits)
Engineering & Comp Sci
Cross-listed with CEE 648
Building environmental analysis; contaminant source and sink models; single-zone, multizone, and computational fluid dynamics models.
Advisory recommendation Prereq: MAE 341 and MAE 355

MAE 659 Building Materials and Envelope (3 Credits)
Engineering & Comp Sci
Cross-listed with CEE 649
Understanding of heat, air and moisture transfer effects on building envelope/enclosure through linking material properties, assembly design and hygorthermal performance with structural and mechanical considerations. Introduction to advanced computational tools for building enclosures.

MAE 670 Experience Credit (1-6 Credits)
Engineering & Comp Sci
Participation in a discipline or subject related experience. Student must be evaluated by written or oral reports or an examination. Permission in advance with the consent of the department chairperson, instructor, and dean. Limited to those in good academic standing.
Repeatable

MAE 671 Numerical Methods in Mechanical Engineering (3 Credits)
Engineering & Comp Sci
Derivation and use of numerical methods for polynomial approximation, extraction of roots, evaluation of determinants, eigenvectors and eigenvalues, orthogonal transformations, angles of orthogonal transformation, robotics, differential equations, mechanism analysis, Fourier representation.

MAE 672 Engineering Data Analytics (3 Credits)
Engineering & Comp Sci
This course introduces students the fundamental concepts of engineering data techniques including data collection, cleaning, transformation, management and analysis. It also provides students with hands-on experiences exploring key concepts related to data science and engineering field.

MAE 673 Fundamentals of Photovoltaics (3 Credits)
Engineering & Comp Sci
Fundamental topics on photovoltaic materials and devices. Analysis of different photovoltaic materials and performance evaluation of photovoltaic devices. Solar cell structures and fabrication technologies.

MAE 675 Methods of Analysis in Mechanical Engineering (3 Credits)
Engineering & Comp Sci
Methods of analyzing linear mechanical systems based on theorems in linear algebra, tensor calculus, and linear differential equations. Vector spaces, linear transformations, tensor fields, and eigenvalue problems.

MAE 682 Computational Solid Mechanics (3 Credits)
Engineering & Comp Sci
Theory and implementation of the finite element method (FEM). Boundary value problems in solid mechanics. Commercial and open source FEM software.

MAE 683 Applied Environmental Acoustics and Noise Control (3 Credits)
Engineering & Comp Sci
Double-numbered with MAE 483
Introductory to environmental acoustics, sound propagation, psychoacoustics, noise criteria for design, noise sources, absorption, noise isolation, design of critical spaces, sound measurement, vibration isolation, product noise ratings, sound quality.
Shared Competencies: Critical and Creative Thinking (https://coursecatalog.syracuse.edu/shared-competencies/critical-and-creative-thinking/)

MAE 686 Advanced Fuel Cell Science and Technology (3 Credits)
Engineering & Comp Sci
The scientific challenges of fuel cells will be discussed: fundamental electrochemistry, thermodynamics and kinetics of electrode process, with emphasis on fundamental principles of fuel cells, mass transport processes and performance of fuel cells. Department Consent Required.

MAE 688 Machine Learning for Mechanical Engineers (3 Credits)
Engineering & Comp Sci
This course mainly focuses on applications of state-of-the-art machine learning (ML) techniques in mechanical engineering. It also covers the fundamentals of probability and statistical learning theory. This class requires basic/intermediate-level programming in Python.

MAE 690 Independent Study (1-6 Credits)
Engineering & Comp Sci
Exploration of a problem, or problems, in depth. Individual independent study upon a plan submitted by the student. Admission by consent of supervising instructor(s) and the department.
Repeatable

MAE 700 Selected Topics: Mechanical & Aerosapce Engineering (1-6 Credits)
Engineering & Comp Sci
Exploration of a topic (to be determined) not covered by the standard curriculum but of interest to faculty and students in a particular semester.
Repeatable

MAE 721 Theory of Elasticity (3 Credits)
Engineering & Comp Sci
General theorems governing the mechanics of linear elastic solids. Cartesian tensor analysis. Kinematics of infinitesimal deformations and force transmission. Balance principles and linear elastic constitutive theory. Plane and three- dimensional problems in elastostatics and elastodynamics.

MAE 723 Asymptotic Methods for Engineering Applications (3 Credits)
Engineering & Comp Sci
Introduction including problems in vibrations and fluid mechanics. Regular and singular perturbations; asymptotic matching. Boundary value problems; distinguished limits. Multiple scale expansions, WKB theory.

MAE 728 Geometric and Optimal Control (3 Credits)
Engineering & Comp Sci
Linear controllability and observability. Introduction to geometric control: Lie algebras, distributions, nonlinear controllability and observability. Control of mechanical systems: geometric mechanics, Lagrangian and Hamiltonian methods. Optimal control: Pontryagin¿s Maximum Principle for systems on manifolds.

MAE 731 Bending of Plates and Shells I (3 Credits)
Engineering & Comp Sci
Small-deflection theory of plates. Analysis of variously shaped plates under various loading and support conditions. Membrane theory of shells. Bending theory of cylindrical shells.
Advisory recommendation Prereq: MAE 635

MAE 735 Buckling Problems (3 Credits)
Engineering & Comp Sci
Physical and mathematical aspects of buckling. Analysis of elastic buckling phenomena for columns, beams, arches, rings, plates, and shells under various loading and support conditions. Buckling due to thermal stress, inelastic buckling, creep buckling.
Advisory recommendation Prereq: MAE 635

MAE 741 Fundamentals of Turbulence (3 Credits)
Engineering & Comp Sci
Qualitative description, main parameters and scaling variables; similarity analysis of mixing layers, jet boundary layers, pipe flows; extension to transport and mixing with emphasis on K-E models.
Advisory recommendation Prereq: MAE 643

MAE 746 Viscous Fluids (3 Credits)
Engineering & Comp Sci
Exact solutions of Navier-Stokes equations. Low Reynolds-number flows. Hydrodynamic theory of lubrication. Boundary-layer equations, exact and approximate methods of solution. Compressible viscous flows.
Advisory recommendation Prereq: MAE 643

MAE 765 Combustion Phenomena in Engineering (3 Credits)
Engineering & Comp Sci
Reacting gases-equilibrium composition and kinetics. Kinetically and diffusionally controlled combustion. Ignition. Flames in premixed gases. Laminar flame speed. Turbulent flames. Detonation Diffusion flames. Applications to combustion equipment.
Advisory recommendation Prereq: MAE 651

MAE 771 Computational Fluid Mechanics (3 Credits)
Engineering & Comp Sci
Numerical solutions using finite difference methods and other techniques. Principles of approximations; accuracy considerations. Applications including boundary-layer and potential flow solutions.

MAE 785 Continuum Mechanics (3 Credits)
Engineering & Comp Sci
Foundations of the mechanics of deformable bodies. Elements of tensor calculus. Kinematics of deformation and transmission of force. Balance principles. Theory of constitutive equations and an introduction to hyperelastic solids and Stokesian fluids.

MAE 849 Advanced Topics in Fluid Mechanics (3 Credits)
Engineering & Comp Sci
Topics dealing with fluid flow, such as theories of turbulence, jets, wakes, cavities, magnetohydrodynamics.
Repeatable 2 times for 6 credits maximum

MAE 879 Advanced Topics in Mechanical Design (3 Credits)
Engineering & Comp Sci
Selected topics dealing with problems in mechanical design, such as theory of lubrication and bearings, balancing problems, high-speed mechanisms.
Repeatable 2 times for 6 credits maximum

MAE 889 Selected Topics (3 Credits)
Engineering & Comp Sci
Selected topics dealing with the theory and design of steam and gas turbines, centrifugal and axial flow compressors.
Repeatable 2 times for 6 credits maximum

MAE 990 Independent Study (1-6 Credits)
Engineering & Comp Sci
In-depth exploration of a problem or problems. Individual independent study upon a plan submitted by the student. Admission by consent of supervising instructor or instructors and the department.
Repeatable

MAE 994 Capstone Project (0 Credits)
Engineering & Comp Sci
Review technical papers or reports in the open literature related to student's field of interest. Students prepare oral presentation to the faculty summarizing the technical content of the document.

MAE 995 Graduate Seminar (0 Credits)
Engineering & Comp Sci

MAE 997 Master's Thesis (1-9 Credits)
Engineering & Comp Sci
Repeatable

MAE 999 Dissertation (1-15 Credits)
Engineering & Comp Sci
Repeatable