WASHINGTON UNIVERSITY
DEPARTMENT OF MECHANICAL ENGINEERING & MATERIALS SCIENCE
MASTER OF SCIENCE DEGREE COURSE OPTION. (Revised 4-28-2025)

The Department offers the Master of Science degree in Mechanical or Aerospace Engineering without thesis. The quantitative requirement for the degree is 30 credit hours (normally 10 courses) completed with a grade-point average of 2.7 or better. Course programs may be composed from one area of specialization below (MSME) or in aerospace engineering (MSAE). They must conform to the following distribution:

Applied Mathematics: 6 credits. Specialization: 15 credits. Electives: 9 credits

Electives may be chosen in any area of engineering or mathematics at 4000-level or higher. Of the 30 units, a minimum of 24 must be 5000-level courses. No more than 6 units may be 4000-level courses; but core requirements for the BSME are not allowed (with the exception of MEMS 4320 Modeling, Systems and Control). A maximum of 3 credits of Independent Study, MEMS 4000/5000, may be used. A minimum of 15 units must be in MEMS. Non-engineering courses (e.g., T-courses, finance, etc.) do not count. Full-time MS students are required every semester to take MEMS 5000 Seminar, which is a zero-unit pass-fail course.

Degree candidates will plan their course programs with the help of a departmental advisor. Given below are partial listings of courses recommended for satisfaction of requirements in each area.

APPLIED MATHEMATICS

ESE 4150	Optimization
ESE 5010-5020	Mathematics of Modern Engineering I, II
ESE 5200	Probability and Stochastic Processes
Math 4101	Intro to Analysis
Math 4160	Complex Variables
Math 4301-4302	Linear Algebra, Modern Algebra
Math 4501	Numerical Applied Mathematics
Physics 5010-5020	Theoretical Physics (must know quantum mechanics)
MEMS 4240	Introduction to Finite Element Methods for Structural Analysis
MEMS 5301	Nonlinear Vibrations
MEMS 5403	Conduction and Convection Heat Transfer
MEMS 5500	Elasticity
MEMS 5501	Mechanics of Continua
MEMS 5510	Finite Element Analysis
MEMS 5610	Quantitative Materials Science and Engineering

AREAS OF SPECIALIZATION for MS in Mechanical Engineering

APPLIED MECHANICS

MEMS 5301	Nonlinear Vibrations
MEMS 5302	Theory of Vibrations
MEMS 5401	General Thermodynamics
MEMS 5410-11	Fluid Dynamics I and II (Fluids I is not required for Fluids II)
MEMS 5414	Aeroelasticity and Flow-Induced Vibrations
MEMS 5416	Turbulence
MEMS 5428	Structure and Rheology of Complex Fluids
MEMS 5500	Elasticity
MEMS 5501	Mechanics of Continua
MEMS 5506	Experimental Methods in Solid Mechanics
MEMS 5507	Fatigue and Fracture Mechanics
MEMS 5510	Finite Element Analysis
MEMS 5562	Cardiovascular Mechanics
MEMS 5564	Orthopaedic Biomechanics-Cartilage/Tendon
MEMS 5565	Mechanobiology of Cells and Matrices
MEMS 5566	Engineering Mechanobiology
MEMS 5601	Mechanical Behavior of Materials
MEMS 5613	Biomaterials Processing
BME 4xxx, 5xxx	All Biomechanics courses in BME

DYNAMICS/MECHANICAL DESIGN

ESE 4410	Control Systems
ESE 4460	Robotics, Robotics Laboratory
ESE 5430	Control Systems Design by State-Space Methods
ESE 5470	Robust and Adaptive Control
MEMS 4120	Manufacturing Processes
MEMS 4240	Introduction to Finite Element Methods for Structural Analysis
MEMS 5104	CAE-Driven Mechanical Design
MEMS 5205	Machine Learning Applications in Mechanical Engineering
MEMS 5206	Modern Robotics
MEMS 5207	Robot Design
MEMS 5301	Nonlinear Vibrations
MEMS 5302	Theory of Vibrations
MEMS 5414	Aeroelasticity and Flow-Induced Vibrations
MEMS 5428	Structure and Rheology of Complex Fluids
MEMS 5500	Elasticity
MEMS 5501	Mechanics of Continua
MEMS 5502	Plates and Shells
MEMS 5507	Fatigue and Fracture Mechanics
MEMS 5510	Finite Element Analysis
MEMS 5601	Mechanical Behavior of Materials
MEMS 5605	Mechanical Behavior of Composite Materials
MEMS 5607	Introduction to Polymer Blends and Composites
MEMS 5608	Introduction to Polymer Science and Engineering
MEMS 5611	Principles and Methods of Micro and Nanofabrication
MEMS 5615	Metallurgy and Design of Alloys
MEMS 5616	Defects in Materials
MEMS 5617	Advanced Study of Solid-State Electronics
MEMS 5621	Materials Selection in Design
MEMS 5703	Analysis of Rotary-Wing Systems
MEMS 5704	Aircraft Structures
MEMS 5705	Wind Energy Systems
MEMS 5706	Aircraft Performance
MEMS 5707	Flight Dynamics
MEMS 5708	Aircraft Design
MEMS 5801	Micro-Electrical Mechanical Systems
MEMS 5803	Nanotechnology Concepts and Applications

SOLID MECHANICS/MATERIALS SCIENCE

MEMS 4240	Introduction to Finite Element Methods for Structural Analysis
MEMS 5205	Machine Learning Applications in Mechanical Engineering
MEMS 5428	Structure and Rheology of Complex Fluids
MEMS 5500	Elasticity
MEMS 5501	Mechanics of Continua
MEMS 5502	Plates and Shells
MEMS 5506	Experimental Methods in Solid Mechanics
MEMS 5507	Fatigue and Fracture Mechanics
MEMS 5508	Image-based Measurement of Shape, Motion, and Deformation
MEMS 5510	Finite Element Analysis
MEMS 5601	Mechanical Behavior of Materials
MEMS 5602	Non-Metallics
MEMS 5603-5604	Materials Characterization I and II
MEMS 5605	Mechanical Behavior of Composite Materials
MEMS 5606	Soft Nanomaterials
MEMS 5607	Introduction to Polymer Blends and Composites
MEMS 5608	Introduction to Polymer Science and Engineering
MEMS 5610	Quantitative Materials Science and Engineering
MEMS 5611	Principles and Methods of Micro and Nanofabrication
MEMS 5612	Atomistic Modeling of Materials

MEMS 5613	Biomaterials Processing
MEMS 5614	Polymeric Material Synthesis and Modification
MEMS 5615	Metallurgy and Design of Alloys
MEMS 5616	Defects in Materials
MEMS 5617	Advanced Study of Solid-State Electronics
MEMS 5618	Electronic Behavior of Materials
MEMS 5619	Thermodynamics of Materials
MEMS 5620	Kinetics of Materials
MEMS 5621	Materials Selections
MEMS 5704	Aircraft Structures
MEMS 5801	Micro-Electrical Mechanical Systems
MEMS 5803	Nanotechnology Concepts and Applications

FLUID/THERMAL SCIENCES

EECE 5080	Combustion Phenomenon
MEMS 5401	Thermodynamics
MEMS 5402	Radiation Heat Transfer
MEMS 5403	Conduction and Convection Heat Transfer
MEMS 5410-11	Fluid Dynamics I and II (Fluids I is not required for Fluids II)
MEMS 5412-5413	Computational Fluid Dynamics I, II
MEMS 5414	Aeroelasticity and Flow-Induced Vibrations
MEMS 5417	Physical Acoustics
MEMS 5422	Solar Energy Thermal Processes
MEMS 5424	Thermo-Fluid Modeling of Sustainable Energy Systems
MEMS 5427	Fundamentals of Fuel Cells
MEMS 5428	Structure and Rheology of Complex Fluids
MEMS 5501	Mechanics of Continua
MEMS 5700	Aerodynamics
MEMS 5701	Aerospace Propulsion
MEMS 5703	Analysis of Rotary-Wing Systems
MEMS 5705	Wind Energy Systems
MEMS 5706	Aircraft Performance
MEMS 5801	Micro-Electrical Mechanical Systems

AEROSPACE ENGINEERING (results in receiving MS in Aerospace Engineering)

EECE 5080	Combustion Phenomenon
ESE 5430	Control Systems Design by State-Space Methods
ESE 5470	Robust and Adaptive Control
MEMS 4240	Introduction to Finite Element Methods for Structural Analysis
MEMS 5102	Materials Selection
MEMS 5301	Nonlinear Vibrations
MEMS 5302	Theory of Vibrations
MEMS 5401	Thermodynamics
MEMS 5402	Radiation Heat Transfer
MEMS 5403	Conduction and Convection Heat Transfer
MEMS 5410-11	Fluid Dynamics I and II (Fluids I is not required for Fluids II)
MEMS 5412-5413	Computational Fluid Dynamics I, II
MEMS 5414	Aeroelasticity and Flow-Induced Vibrations
MEMS 5416	Turbulence
MEMS 5417	Physical Acoustics
MEMS 5500	Elasticity
MEMS 5501	Mechanics of Continua
MEMS 5507	Fatigue and Fracture Mechanics
MEMS 5510	Finite Element Analysis
MEMS 5521	Structure and Rheology of Complex Fluids
MEMS 5601	Mechanical Behavior of Materials
MEMS 5602	Non-Metallics
MEMS 5605	Mechanical Behavior of Composite Materials

MEMS 5607	Introduction to Polymer Blends and Composites
MEMS 5608	Introduction to Polymer Science and Engineering
MEMS 5700	Aerodynamics
MEMS 5701	Aerospace Propulsion
MEMS 5703	Analysis of Rotary-Wing Systems
MEMS 5704	Aircraft Structures
MEMS 5705	Wind Energy Systems
MEMS 5706	Aircraft Performance
MEMS 5707	Flight Dynamics
MEMS 5708	Aircraft Design
MEMS 5801	Micro-Electrical Mechanical Systems

OTHER SPECIALIZED TRACKS FOR M.S. in Mechanical Engineering

ENERGY CONVERSION AND EFFICIENCY (MS in Mechanical Engineering)

The curriculum is designed to provide mechanical engineering skills in energy applications, renewable energy, and the technologies that improve energy conversion and efficiency. The quantitative requirement for the degree is 30 credit hours completed with a GPA of 2.75 or better. The course program must conform to the following distribution:

Area of specialization	*15 credits*
Electives (graduate level engineering or math)	*9 credits*
Energy Analysis & Design Project or Thesis	*6 credits*

Courses from which one must choose 15 units of specialization (any 5 courses)

EECE 5080	Combustion Phenomenon
MEMS 5401	General Thermodynamics
MEMS 5402	Radiation Heat Transfer
MEMS 5403	Conduction and Convection Heat Transfer
MEMS 5410-5411	Fluid Dynamics I and II (Fluids I is not required for Fluids II)
MEMS 5412-5413	Computational Fluid Dynamics I, II
MEMS 5416	Turbulence
MEMS 5422	Solar Energy Thermal Processes
MEMS 5423	Sustainable Environmental Building Systems
MEMS 5424	Thermo-Fluid Modeling of Renewable Energy Systems
MEMS 5427	Fundamentals of Fuel Cells
MEMS 5705	Wind Energy Systems

MS in Mechanical or Aerospace Engineering—Thesis Option

Replace any two courses in the above concentrations (except Energy Conversion and Efficiency or Numerical Simulation) with 6 units of MEMS 7998 Research (an MS thesis). No more than 3 units of Independent Study allowed.

For Energy Conversion and Efficiency, the 6 units of design project are replaced by a thesis with six units of MEMS 7998 Research. No thesis option for Numerical Simulation.