

SUGGESTED COURSE LISTS

MS/PhD Breadth Requirement: Acceptable Courses

MS students in the general (non-specialization) program, and PhD students entering without an MS degree, must fulfill the breadth requirement by taking at least one course from four of the eight subareas: (1) Solids, (2) Fluids/-Thermodynamics/Energy, (3) Robotics/Dynamics/Controls, (4) Design/Manufacturing/Tribology, (5) MEMS/-Nanotechnology, (6) Biomedical/Biology, (7) Mathematics/Science/Data Science, and (8) Engineering Management.

Suggested courses for each category are listed below. Note that these lists are not meant to be exhaustive, especially for non-MECH_ENG courses. For questions about whether a certain course can count toward a given category, MS students should contact the MS Program Director (Prof. Manohar Kulkarni), while PhD students should contact the Director of Graduate Studies (Prof. Oluwaseyi Balogun).

However, note that not all courses, including those offered in the ME department, will necessarily fill any breadth requirement category. If an existing course does not appear on this list, it may be that it has been deemed not to fill any category. Again, contact the MS Program Director or Director of Graduate Studies with questions about specific courses.

A course may be used for meeting only one breadth area, even if it is listed here under multiple areas. Some existing graduate-level MECH_ENG or McCormick courses do not fill any breadth requirement category.

Finally, note that not all courses listed here are offered every academic year.

Solids

MECH_ENG 327	Finite Elements for Stress Analysis
MECH_ENG 328	Computational Forensics and Failure Analysis
MECH_ENG 362	Stress Analysis
MECH_ENG 395	Machine Learning in Experimental Mechanics
MECH_ENG 412	Fracture Mechanics
MECH_ENG 413	Experimental Solid Mechanics
MECH_ENG 414-1	Mechanics of Composite Materials I
MECH_ENG 414-2	Mechanics of Composite Materials II
MECH_ENG 415	Mechanics of Manufacturing Processes
MECH_ENG 417	Multi-Scale Modeling and Simulation in Solid Mechanics
MECH_ENG 419	Wave Propagation in Elastic Solids
MECH_ENG 421	Elasticity of Soft Materials
MECH_ENG 426-1	Advanced Finite Elements I
MECH_ENG 426-2	Advanced Finite Elements II
MECH_ENG 456	Mechanics of Advanced Materials
MECH_ENG 457	Metamaterials
MECH_ENG 466	Inelastic Constitutive Relations for Solids
MECH_ENG 495	Mechanics of Thin Films
MECH_ENG 495	Fracture of Soft Materials
MECH_ENG 495	Machine Learning in Experimental Mechanics
*CIV_ENV 413	Experimental Solid Mechanics
*CIV_ENV 415	Theory of Elasticity
*CIV_ENV 417-1	Mechanics of Continua I
MAT_SCI 406	Mechanical Properties of Materials

Fluids/Thermo/Energy

MECH_ENG 322	Thermodynamics and Statistical Mechanics II
MECH_ENG 364	Introduction to Aerospace Engineering
MECH_ENG 367	Quantitative Methods in Life Cycle Analysis
MECH_ENG 373	Engineering Fluid Mechanics

* Course may be considered a MECH_ENG course toward the minimum number of required MECH_ENG courses

MECH_ENG 377	Heat Transfer
MECH_ENG 378	Applied Computational Fluid Dynamics and Heat Transfer
MECH_ENG 380	Thermal Energy Systems Design
MECH_ENG 395/495	Propulsion
MECH_ENG 418	Multi-Scale Modeling and Simulation in Fluid Mechanics
MECH_ENG 420	Micro- and Nanoscale Fluid Dynamics
MECH_ENG 422	Statistical Mechanics for Applications
MECH_ENG 423	Intro to Computational Fluid Dynamics
MECH_ENG 424	Advanced Topics in Computational Fluid Dynamics
MECH_ENG 425	Fundamentals of Fluid Dynamics
MECH_ENG 427	Viscous Fluid Dynamics
MECH_ENG 430	Turbulence and Combustion
MECH_ENG 467	Industrial Energy Management and Utilization
MECH_ENG 470	High Performance Computing for Multiphysics Applications
MECH_ENG 495	Aerodynamics
MECH_ENG 495	Nanoscale Thermal Transport
CIV_ENV 440	Environmental Transport Processes
ES_APPM 426	Theory of Flows With Small Inertia
ES_APPM 429	Hydrodynamic Stability Theory
BMD_ENG 478	Transport Fundamentals
MAT_SCI 314	Thermodynamics of Materials

Robotics/Dynamics/Control

MECH_ENG 302	Artificial Life
MECH_ENG 314	Machine Dynamics
MECH_ENG 333	Introduction to Mechatronics
MECH_ENG 363	Mechanical Vibrations
MECH_ENG 390	Intro to Dynamic Systems
MECH_ENG 395	Orbital Mechanics
MECH_ENG 395	Vehicle Dynamics and Design
MECH_ENG 409	Swarms and Multi-Robot Systems
MECH_ENG 410	Autonomous Quadrotor Design and Control
MECH_ENG 433	Advanced Mechatronics
MECH_ENG 448	Flexible Automation and Robotics
MECH_ENG 449	Robotic Manipulation
MECH_ENG 450	Embedded Systems in Robotics
MECH_ENG 455	Active Learning in Robotics
MECH_ENG 469	Machine Learning and Artificial Intelligence for Robotics
MECH_ENG 495	Computational Nanodynamics
MECH_ENG 495	Sensing Navigation and Machine Learning for Robotics
MECH_ENG 495	Soft Robotics
ELEC_ENG 360	Introduction to Feedback Systems
ELEC_ENG 374	Introduction to Digital Control
ELEC_ENG 495	Introduction to Nonlinear Control Theory

Design/Manufacturing/Tribology

MECH_ENG 302	Artificial Life
MECH_ENG 316	Mechanical Systems Design
MECH_ENG 320	Micro- and Nanomechanical Properties of Surfaces
MECH_ENG 340-1	Computer Integrated Manufacturing: Manufacturing Processes
MECH_ENG 340-2	Computer Integrated Manufacturing: CAD/CAM
MECH_ENG 340-3	Computer Integrated Manufacturing: Automation
MECH_ENG 341	Computational Methods for Engineering Design
MECH_ENG 346	Introduction to Tribology
MECH_ENG 366	Finite Elements for Design & Optimization
MECH_ENG 395	Industry 4.0 Manufacturing

MECH_ENG 395	Design and Manufacturing of Medical Devices
MECH_ENG 395/495	Characterization of Materials
MECH_ENG 415	Mechanics of Manufacturing Processes
MECH_ENG 439	Computer Control in Manufacturing
MECH_ENG 441	Engineering Optimization for Product Design and Manufacturing
MECH_ENG 442	Metal Forming
MECH_ENG 443	Metal Cutting
MECH_ENG 444-1	Additive Manufacturing -- Polymers
MECH_ENG 444-2	Additive Manufacturing -- Metals and Ceramics
MECH_ENG 445	Micromanufacturing
MECH_ENG 446	Advanced Tribology
MECH_ENG 447	AI in Manufacturing
MECH_ENG 451	Micromachining
MECH_ENG 495	Manufacturing Process Mechanics
MECH_ENG 495	Sustainable Manufacturing Systems
MECH_ENG 495	Computational Statistics for Design
MECH_ENG 495	Introduction to Additive Manufacturing
MAT_SCI 318	Materials Selection

MEMS/Nanotechnology

MECH_ENG 381	Introduction to Micro-electro-mechanical Systems
MECH_ENG 382	Experiments in Micro- and Nano-Science and Engineering
MECH_ENG 385	Nanotechnology
MECH_ENG 395/495	Characterization of Materials
MECH_ENG 416	Computational Nanodynamics
MECH_ENG 417	Multi-Scale Modeling and Simulation in Solid Mechanics
MECH_ENG 418	Multi-Scale Modeling and Simulation in Fluid Mechanics
MECH_ENG 420	Micro- and Nanoscale Fluid Dynamics
MECH_ENG 445	Micromanufacturing
MECH_ENG 451	Micromachining
MECH_ENG 495	Mechanics of the Cell and BioMEMS
MECH_ENG 495	Metamaterials
MECH_ENG 495	Nanoscale Thermal Transport
BMD_ENG 353	Bioelectronics
MAT_SCI 353	Bioelectronics

Biomedical/Biology

MECH_ENG 302	Artificial Life
MECH_ENG 434	Bio-Inspired Surface Engineering
MECH_ENG 495	Mechanics of the Cell and BioMEMS
MECH_ENG 495	Decision-making in the wild: Measurement and models
MECH_ENG 495	Mechanophysiology of Organs for Disease Diagnosis and Classification
BMD_ENG 317	Biochemical Sensors
BMD_ENG 325	Introduction to Medical Imaging
BMD_ENG 353	Bioelectronics
BMD_ENG 462	Sensory Acquisition
BMD_ENG 463	Advanced Signal Processing Methods in Neuropathophysiology
BMD_ENG 465	Biomechanical Modeling & Simulation of Human Movement
BMD_ENG 467	Biomedical Robotics
BMD_ENG 469	Critical Issues in Sensorimotor Control
BMD_ENG 495	NUvention: Medical Innovation
MAT_SCI 353	Bioelectronics

Mathematics/Science/Data Science

MECH_ENG 395	Machine Learning for Mechanical Sciences
COMP_SCI 349	Machine Learning

COMP_SCI 449	Deep Learning
ES_APPM 311-0,1	Methods of Applied Mathematics
ES_APPM 322	Applied Dynamics Systems
ES_APPM 346	Modeling and Computation in Science & Engineering
ES_APPM 370	Introduction to Computational Neuroscience
ES_APPM 411-1,2,3	Differential Equations of Mathematical Physics
ES_APPM 412	Methods of Nonlinear Analysis
ES_APPM 420-1,2,3	Asymptotic and Perturbation Methods in Applied Mathematics
ES_APPM 421-1	Models in Applied Mathematics
ES_APPM 426	Theory of Flows With Small Inertia
ES_APPM 429	Hydrodynamic Stability Theory
ES_APPM 430	Wave Propagation
ES_APPM 440	Integral Equations & Applications
ES_APPM 442	Stochastic Differential Equations
ES_APPM 445	Iterative Methods for Elliptic Equations
ES_APPM 446-1,2	Numerical Solution of Partial Differential Equations
ES_APPM 451	Mathematical Models in Biology
ES_APPM 495	Geophysical and Astrophysical Fluid Dynamics
MECH_ENG 432	The Calculus of Variations and Its Applications
ELEC_ENG 435	Deep Learning: Foundations, Applications, and Algorithms
ELEC_ENG 473	Deep Reinforcement Learning
ELEC_ENG 475	Machine Learning: Foundations, Applications, and Algorithms
IEMS 304	Statistical Learning for Data Analysis
IEMS 308	Data Science and Analytics
IEMS 455	Machine Learning

Engineering Management

MECH_ENG 467	Industrial Energy Management and Utilization
MECH_ENG 495	Tech Innovation
DSGN 450	Differentiation by Design
IEMS 345	Negotiations and Conflict Resolution for Engineers
ENTREP 325	Engineering Entrepreneurship

Cross-Cutting Research Areas: Suggested Courses

The ME department has identified 7 cross-cutting research areas that draw on the strengths and expertise of faculty members from all core disciplines in the department: Advanced Manufacturing, AI and Design, Biosystems and Health, Computational Engineering, Energy and Sustainability, Micro- and Nanoengineering, and Robotics and Autonomy. Students interested in or doing research in these areas may take related courses from the department or across McCormick. The tables below list suggested courses in each research area.

Note that these 7 research areas are distinct from the 8 breadth requirement categories listed in the previous section. Courses in these 7 lists are suggestions, and not requirements. More information about the 7 research areas, including a Research Areas Matrix listing department faculty associated with each area, can be found on the department web site: <https://www.mccormick.northwestern.edu/mechanical/research/areas/>

Offerings listed below are tentative and should be confirmed in Caesar and in updated course schedules.

Course schedules for the current academic year in the ME, and links to schedules in other departments, can also be found on the department web site: <https://www.mccormick.northwestern.edu/mechanical/academics/courses/>

Not all courses listed will be offered in the coming academic year, but those that are not have been offered recently and may be offered again in the future.

Advanced Manufacturing

Course Number	Title	2026-27 Quarter
MECH_ENG 327	Finite Elements Methods in Mechanics	F
MECH_ENG 340-1,2	Computer Integrated Manufacturing I, II	F,W
MECH_ENG 363	Mechanical Vibrations	S
MECH_ENG 395	Industry 4.0 Manufacturing	--
MECH_ENG 395/495	Characterization of Materials	F
MECH_ENG 412	Fracture Mechanics	--
MECH_ENG 415	Mechanics of Manufacturing Processes	S
MECH_ENG 416	Computational Nanodynamics	W
MECH_ENG 419	Wave Propagation in Elastic Solids	S
MECH_ENG 421	Elasticity of Soft Materials	F
MECH_ENG 422	Statistical Mechanics and Applications	F
MECH_ENG 426-1	Advanced Finite Element Methods 1	W
MECH_ENG 433	Advanced Mechatronics	S
MECH_ENG 439	Computer Control in Manufacturing	--
MECH_ENG 441	Engineering Optimization for Product Design and Manufacturing	--
MECH_ENG 444-1	Additive Manufacturing – Polymers	S
MECH_ENG 444-2	Additive Manufacturing – Metals and Ceramics	F
MECH_ENG 445	Micromanufacturing	--
MECH_ENG 446	Advanced Tribology	--
MECH_ENG 447	AI in Manufacturing	W
MECH_ENG 451	Micromachining	--
MECH_ENG 457	Metamaterials	W
MECH_ENG 466	Inelastic Constitutive Relations for Solids	--

MECH_ENG 470	High Performance Computing for Multiphysics Applications	--
CHEM_ENG 451	Applied Molecular Modeling	W
CIV_ENV 415-0	Theory of Elasticity	W
CIV_ENV 417-1	Mechanics of Continua: 1	F
CIV_ENV 426-1	Advanced Finite Element Methods 1	W
CIV_ENV 426-2	Advanced Finite Element Methods 2	--
ES_APPM 414	Differential Equations of Mathematical Physics	W

AI and Design

Course Number	Title	2026-27 Quarter
MECH_ENG 395	Machine Learning in Experimental Mechanics	S
MECH_ENG 395	Machine Learning for Mechanical Sciences	W
MECH_ENG 395	Vehicle Design and Dynamics	--
MECH_ENG 410	Quadrotor Design and Control	S
MECH_ENG 433	Advanced Mechatronics	S
MECH_ENG 441	Engineering Optimization for Product Design and Manufacturing	--
MECH_ENG 447	AI in Manufacturing	W
MECH_ENG 450	Embedded Systems in Robotics	F
MECH_ENG 455	Active Learning in Robotics	S
MECH_ENG 469	Machine Learning and Artificial Intelligence for Robotics	--
MECH_ENG 472-1	Robot Design Studio 1	W
MECH_ENG 472-2	Robot Design Studio 2	S
COMP_SCI 330	Human Computer Interaction	F,Sum
COMP_SCI 337	Intro to Natural Language Processing	--
COMP_SCI 348	Intro to Artificial Intelligence	F,W,S,Sum
COMP_SCI 349	Machine Learning	F,W,S,Sum
COMP_SCI 353	Natural & Artificial Vision	F
COMP_SCI 368/468	Programming Massively Parallel Processors with CUDA	W,Sum
COMP_SCI 449	Deep Learning	F,W
COMP_SCI 461	Deep Learning for Natural Language Processing	F,S
COMP_SCI 463	Generative Deep Models	S
COMP_SCI 454	Computational Optics	S
ELEC_ENG 375/475	Machine Learning: Foundation, Algorithms, and Applications	F
ELEC_ENG 422	Random Processes in Communications and Control I	W
ES_APPM 448	Numerical Methods for Random Processes	W
IEMS 304	Statistical Learning for Data Analysis	F,W,S
IEMS 351	Optimization Methods in Data Science	--

IEMS 401	Applied Mathematical Statistics	F
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Biosystems and Health

Course Number	Title	2026-27 Quarter
MECH_ENG 302	Artificial Life	W
MECH_ENG 381	Introduction to MEMS	--
MECH_ENG 382	Micro/Nano Science and Engineering	S
MECH_ENG 434	Bio-Inspired Surface Engineering	--
MECH_ENG 495	Decision-making in the wild	--
MECH_ENG 495	Mechanophysiology of Organs for Disease Diagnosis and Classification	--
BMD_ENG 311	Computational Genomics	--
BMD_ENG 312	Biomedical Applications in Machine Learning	S
BMD_ENG 317	Biochemical Sensors	F
BMD_ENG 333	Modern Optical Microscopy and Imaging	F
BMD_ENG 407	Experimental Design and Measurement	F
BMD_ENG 429	Advanced Physical and Applied Optics	--
IBIS 410	Quantitative Biology	F
IBIS 432	Statistics for Life Sciences	S

Computational Engineering

Course Number	Title	2026-27 Quarter
MECH_ENG 327	Finite Elements Methods in Mechanics	F
MECH_ENG 328	Computational Forensics and Failure Analysis	S
MECH_ENG 329	Mechanistic Data Science for Engineering	--
MECH_ENG 362	Stress Analysis	S
MECH_ENG 378	Applied Computational Fluid Dynamics and Heat Transfer	W
MECH_ENG 395	Deep Learning Discrete Calculus for Engineering	--
MECH_ENG 395	Machine Learning for Mechanical Sciences	W
MECH_ENG 395	Machine Learning in Experimental Mechanics	S
MECH_ENG 412	Fracture Mechanics	--
MECH_ENG 416	Computational Nanodynamics	--
MECH_ENG 418	Multiscale Modeling and Simulation in Fluid Mechanics	--
MECH_ENG 423	Introduction to Computational Fluid Dynamics	F
MECH_ENG 424	Advanced Computational Fluid Dynamics	--
MECH_ENG 426-1/ CIV ENV 426-1	Advanced Finite Element Methods I	W
MECH_ENG 426-2/ CIV ENV 426-2	Advanced Finite Element Methods 2	--
MECH_ENG 441	Engineering Optimization for Product Design and Manufacturing	--

MECH_ENG 470	High Performance Computing for Multiphysics Applications	--
CHEM_ENG 451	Applied Molecular Modeling	W
CIV_ENV 320	Structural Analysis - Dynamics	W
CIV_ENV 417-1	Mechanics of Continua: 1	F
COMP_SCI 368/468	Programming Massively Parallel Processors with CUDA	W,Sum
ELEC_ENG 435	Deep Learning Foundations from Scratch	W
ELEC_ENG 473	Deep Reinforcement Learning from Scratch	--
ELEC_ENG 475	Machine Learning: Foundations, Applications, and Algorithms	F
ES_APPM 444	High Performance Scientific Computing	S
ES_APPM 446-1	Numerical Solution of Partial Differential Equations	F
MAT_SCI 458	Computational Materials Science	W

Energy and Sustainability

Course Number	Title	2026-27 Quarter
MECH_ENG 322	Thermodynamics & Statistical Mechanics II	S
MECH_ENG 367	Quantitative Methods in Life Cycle Analysis	S
MECH_ENG 373	Engineering Fluid Mechanics	W
MECH_ENG 377	Heat Transfer	W,S
MECH_ENG 378	Applied Computational Fluid Dynamics and Heat Transfer	W
MECH_ENG 380	Thermal Energy Systems Design	S
MECH_ENG 395	Bio-inspired Surface Engineering	--
MECH_ENG 425	Fundamentals of Fluid Dynamics	--
MECH_ENG 467	Industrial Energy Management and Utilization	W
MECH_ENG 495	Nanoscale Thermal Transport	--
CHEM_ENG 365	Sustainability, Technology and Society	S
CIV_ENV 303	Environmental Law and Policy	F
CIV_ENV 346	Ecohydrology	W
CIV_ENV 364	Sustainable Water Systems	W
CIV_ENV 368	Sustainability: The City	F
CIV_ENV 440	Environmental Transport Processes	F
ES_APPM 311	Methods of Applied Mathematics	F
ISEN 410	Contemporary Energy and Climate Change	--
ISEN 420	NUvention Energy	F
MAT_SCI 381	Energy Materials	F
MAT_SCI 382	Electrochem Energy Materials and Devices	F
MAT_SCI 385	Electronic and Thermal Properties of Materials	--

Micro- and Nanoengineering

Course Number	Title	2026-27 Quarter
MECH_ENG 381	Introduction to MEMS	--
MECH_ENG 382	Micro/Nano-Science and Engineering	S
MECH_ENG 395	Machine Learning in Experimental Mechanics	S
MECH_ENG 395/495	Characterization of Materials	F
MECH_ENG 413	Modern Experimental Solid Mechanics	S
MECH_ENG 416	Computational Nanodynamics	W
MECH_ENG 426-1/ CIV_ENV 426-1	Advanced Finite Element Methods 1	W
MECH_ENG 426-2/ CIV_ENV 426-2	Advanced Finite Element Methods 2	--
MAT_SCI 401	Chemical and Statistical Thermodynamics of Materials	F
MAT_SCI 405	Physics of Solids	W
MAT_SCI 451	Physics of Materials	F
MAT_SCI 458	Computational Materials Science	W

Robotics and Autonomy

Course Number	Title	2026-27 Quarter
MECH_ENG 302	Artificial Life	W
MECH_ENG 314	Theory of Machines: Dynamics	F,S
MECH_ENG 333	Intro to Mechatronics	W
MECH_ENG 390	Introduction to Dynamic Systems	F,S
MECH_ENG 409	Swarms and Multi-Robot Systems	F
MECH_ENG 410	Quadrotor Design and Control	S
MECH_ENG 433	Advanced Mechatronics	S
MECH_ENG 441	Engineering Optimization for Product Design and Manufacturing	--
MECH_ENG 449	Robotic Manipulation	F
MECH_ENG 450	Embedded Systems in Robotics	F
MECH_ENG 455	Active Learning in Robotics	S
MECH_ENG 469	ML and AI for Robotics	--
MECH_ENG 472-1,2	Robot Design Studio	W,S
MECH_ENG 495	Sensing, Navigation and Machine Learning for Robotics	W
MECH_ENG 495	Soft Robotics	--
COMP_SCI 348	Intro to Artificial Intelligence	F,W,S,Sum
ELEC_ENG 326	Electronic System Design I	W
ELEC_ENG 360	Introduction to Feedback Systems	W