ME Undergraduate Curriculum/Concentrations (http://tiny.cc/me-curriculum)

Updated October 23, 2026

- To declare the concentration, students should use MAS Degree audit. For older catalog years use, https://tinyurl.com/MechConc
- Any desired ME 399 registration is allowed only with a Concentration Declaration, unless ME 399 is to be used as an Unrestricted Elective.
- Link to the ME course listing web page: Courses | Academics | Mechanical Engineering

The mechanical engineering degree provides tremendous flexibility to customize the curriculum to the student's interests and professional goals. This flexibility also reflects the expertise of the faculty and rapidly emerging areas of mechanical engineering. Curricular flexibility is provided in the form of six courses chosen from a set of *concentrations*: an ME Breadth concentration, providing advanced training in core and emerging areas of mechanical engineering, and several specialized concentrations, including Aerospace Engineering; Design; Energy Systems and Sustainability; Manufacturing; Mechanical Sciences; and Robotics.

Overview

Curriculum Details

Flowchart Overview of the undergraduate curriculum

Concentrations

ME BREADTH

AEROSPACE ENGINEERING

DESIGN

ENERGY SYSTEMS AND SUSTAINABILITY

MANUFACTURING

MECHANICAL SCIENCES

ROBOTICS

Overview

The 48 units of the ME degree consist of 5 units of unrestricted electives; 7 social sciences/humanities units toward the theme; 4 units of mathematics; 3 units of engineering foundation and computer proficiency; 4 units of basic science; 3 units of design and communication; 3 units of mechanical engineering foundation; 11 units of mechanical engineering core courses; 6 units toward a concentration; and 2 units of capstone design. The latter 22 units make up the ME major program.

In Fall 2020, the ME curriculum was revised to provide greater flexibility and to offer more substantive concentrations (six courses instead of three). In Fall 2026, the curriculum was further revised (to align with the changed McCormick requirements) where the prior 4 units of engineering analysis plus ME 224 plus Math/Sci 3xx were replaced by 3 units of engineering foundation and computer proficiency units (GE 150, 231, 241) and 3 units of mechanical engineering foundation (GE 211, 212, 251).

Curriculum Details

In addition to 5 units of unrestricted electives and 7 social sciences/humanities units toward the theme, the following 36 units are required for the ME degree. Course information can be found at Courses | Academics | Mechanical Engineering

- 4 units of mathematics courses
    - MATH 220-1,2, 228-1,2 Calculus

- 3 units of engineering foundation and computer proficiency
    - GEN_ENG 150 Programming for Engineers
    - GEN_ENG 231 Probability and Statistics for Engineers
    - GEN_ENG 241 Linear Algebra for Engineers

- 4 units of basic science (consisting of **three** courses and their labs)

    - PHYSICS 135-2,3 General Physics, along with PHYSICS 136-2,3 General Physics Laboratory
    - CHEM 131 General Chemistry and CHEM 141 General Chemistry Laboratory
        - May be replaced by CHEM 151 and 161, or by CHEM 171 and 181

- 3 units of design and communication
    - Design Thinking and Communication: DSGN 106-1,2 and ENGLISH 106-1,2
    - COMM_ST 102 Public Speaking or PERF_ST 103 Analysis & Performance of Literature or PERF_ST 203 Performance Culture and Communication

- 5 units of mechanical engineering foundation
    - GEN_ENG 211 Engineering Physics - Statics
    - GEN_ENG 212 Engineering Physics - Dynamics
    - GEN_ENG 251 Applied Ordinary Differential Equations

- 11 units of mechanical engineering core courses
    - CIV_ENV 216 Mechanics of Materials
    - MAT_SCI 201 Principles of the Properties of Materials
    - MECH_ENG 222 Thermodynamics and Statistical Mechanics I (may not be taken with CHEM 342-1 Thermodynamics or CHEM_ENG 211 Thermodynamics)
    - MECH_ENG 233 Electronics Design
    - MECH_ENG 240 Intro to Mechanical Design and Manufacturing
    - MECH_ENG 241 Fluid Mechanics I
    - MECH_ENG 314 Theory of Machines - Dynamics
    - MECH_ENG 315 Theory of Machines - Design of Elements
    - MECH_ENG 340-1 Computer Integrated Manufacturing I: Manufacturing Processes

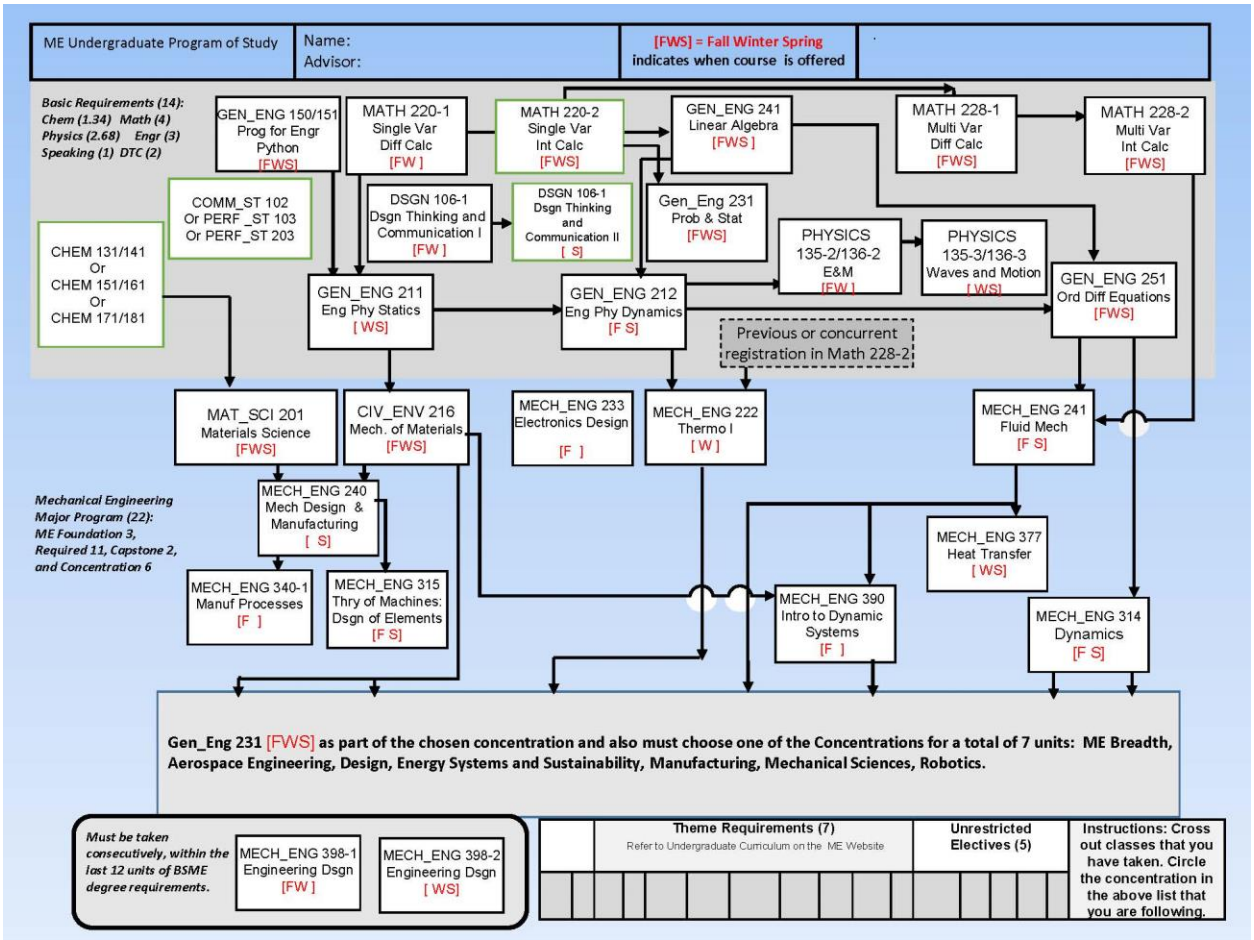
    - MECH_ENG 377 Heat Transfer
    - MECH_ENG 390 Introduction to Dynamic Systems

- 6 units toward a concentration
    - See concentration descriptions below

- 2 units of capstone design
    - ME 398-1,2 Engineering Design, or as specified in the concentration. These courses must be taken sequentially, and they must be within the final 12 units of the BSME requirements.

Flowchart

The flowchart below is an efficient summary and rubric for planning.



Concentrations

Courses used to satisfy certificate, minor, or second major requirements may be counted toward the ME concentration. Concentration requirements cannot be mix-and-matched. If a student does not want to complete the requirements of one of the specialized concentrations, the student should satisfy the requirements of the ME Breadth concentration. The specialized concentrations are

ME BREADTH

AEROSPACE ENGINEERING

DESIGN

ENERGY SYSTEMS AND SUSTAINABILITY

MANUFACTURING

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ME 399 Independent Research Policy and Procedure Independent Research Policy and Procedure

A maximum of one unit of ME 399 can be used to satisfy the concentration requirement. Students should follow the three step process below if they want to do a ME 399 project:

1. Contact the professor who is potentially your ME 399 guide with expression of interest.

2. If the professor agrees, email respective concentration lead with brief description of proposed project (cc the professor willing to serve as a guide)

3. Once the lead approves your ME 399 as being concentration relevant, the student forwards Professor Kulkarni the confirmation email to get a permission number.

ME BREADTH *(Faculty Lead: Prof. Manohar Kulkarni)* BREADTH (Faculty Lead: Prof. Manohar Kulkarni)

The *ME Breadth* concentration gives students the flexibility to tailor their academic program to their own interests in this rapidly diversifying field, encompassing areas such as robotics, automated manufacturing, biological molecular machines, thermodynamics, fluid dynamics, computational mechanics, composite materials, and tribology.

- Solid mechanics (1):
    - ME 327 Finite Elements Methods in Mechanics
    - ME 328 Computational Forensic Failure Analysis
    - ME 362 Stress Analysis
- Fluid mechanics and thermodynamics (1):
    - ME 322 Thermodynamics & Statistical Mechanics II
    - ME 373 Engineering Fluid Mechanics
- Dynamics and control (1):

    - ME 333 Introduction to Mechatronics
    - ME 363 Mechanical Vibrations
    - EE 360 Introduction to Feedback Systems (ME 390 is a sufficient prereq for this)
- Two 300-level or higher courses in ME (but no more than one ME 399 Independent Study)
- One 300-level or higher course either in mathematics, or basic sciences, or engineering (including ME) that is 0% General Education content. **This is in addition to GEN_ENG 231 which is a ME program requirement.**

AEROSPACE ENGINEERING *(Faculty Lead: Prof. Sridhar Krishnaswamy)* ENGINEERING (Faculty Lead: Prof. Sridhar Krishnaswamy)

The *Aerospace Engineering* concentration includes the design and development of aerial and space vehicles. It emphasizes a combination of mechanics (solids and thermo-fluids), materials science (such as advanced composites, ceramics, and polymers), and control systems.

Required Courses (3)

- ME 362 Stress Analysis
- ME 364 Introduction to Aerospace Engineering
- ME 373 Engineering Fluid Mechanics

Electives: (3) from list

- ME 341 Computational Methods for Engineering Design (offered in alternating years with ME 441)
- ME 363 Mechanical Vibrations
- ME 378 Applied Computational Fluid Dynamics and Heat Transfer

- ME 395 Orbital Mechanics
- ME 395 Propulsion
- ME 399 Independent Study (aero-related, need prior approval)
- ME 410 Autonomous Quadrotor Design and Control
- ME 413 Experimental Solid Mechanics
- ME 414 Mechanics of Composite Materials I
- ME 423 Introduction to Computational Fluid Dynamics (offered in alternating years with ME 425)
- ME 425 Fundamentals of Fluid Dynamics (offered in alternating years with ME 423)
- ME 430 Turbulence and Combustion
- ME 441 Engineering Optimization for Product Design and Manufacturing (offered in alternating years with ME 341)
- ME 495 Aerodynamics
- CIV_ENV 417 Mechanics of Continua I
- EE 360 Introduction to Feedback Systems (ME 390 is a sufficient prereq for this)

DESIGN *(Faculty Lead: Prof. Michael Beltran)* (Faculty Lead: Prof. Michael Beltran)

The *Design* concentration educates students on the methodologies for product design supported by innovations, systematic design processes, and computational design methods, and on design thinking while incorporating manufacturing and other life cycle considerations.

Required Courses (1)

One core design method class from one of the following two categories:

Computational Methods for Design

- ME 341 Computational Methods for Engineering Design (offered in alternating years with ME 441)

- ME 441 Engineering Optimization for Product Design and Manufacturing (offered in alternating years with ME 341)

Human-Centered Design

- DSGN 306 UX Design
- DSGN 308 Human Centered Product Design

Elective Courses (5)

Five courses, including any additional courses from the list above, with other courses chosen from at least two of the following areas:

Modeling and Simulation

- ME 327 Finite Elements Methods in Mechanics
- ME 328 Computational Forensics and Failure Analysis
- ME 362 Stress Analysis
- ME 378 Applied Computational Fluid Dynamics and Heat Transfer

Manufacturing and Automation

- ME 333 Introduction to Mechatronics
- ME 340-2 Computer-Integrated Manufacturing CAD/CAM
- ME 346 Introduction to Tribology (offered in alternating years with ME 446)
- ME 395 Industry 4.0 Manufacturing
- MSc 318 Materials Selection
- DSGN 345 Computer-Aided Manufacturing (½) and DSGN 348 Advanced Topics: Rapid Prototyping (½)

Energy and Sustainability

- ME 367 Quantitative Methods in Life Cycle Analysis
- ME 373 Engineering Fluid Mechanics
- ME 380/ISEN390 Thermal Energy Systems Design

- ME 395 Bio-inspired Surface Engineering
- CIV-ENG 353 Energy Geostructures and Geosystems

Design Experience

**** (In this category, a maximum of one course is allowed) ****

- ME 395 Vehicle Dynamics and Design
- ME 399 Independent Study
- CIV-ENG 385-1 Architectural Engineering and Design
- CS 330 Human Computer Interaction
- DSGN 305 Human Centered Service Design
- DSGN 380-1 Industrial Design Projects
- DSGN 380-2 Industrial Design Projects II
- DSGN 384-1 or 2: Interdisciplinary Design Project

Data Science

- ME 395: Machine Learning for Mechanical Sciences
- IEMS 304 Statistical Learning for Data Analysis
- IEMS 307 Quality Improvement by Experimental Design
- IEMS 308 Data Science & Analytics
- IEMS 351 Optimization Methods in Data Science
- CS 349 Machine Learning
- CS 449 Deep Learning

Human Organization and Management

- IEMS 342 Organizational Behavior
- IEMS 343 Project Management
- IEMS 365 Analytics for Social Good

ENERGY SYSTEMS AND SUSTAINABILITY *(Faculty Lead: Prof. Manohar Kulkarni)* SYSTEMS AND SUSTAINABILITY (Faculty Lead: Prof. Manohar Kulkarni)

The *Energy Systems and Sustainability* concentration emphasizes the mechanical engineering aspects of energy conversion, life cycle analysis, conservation, policy, and energy economics and management.

Choose a total of six courses from the following lists.

At least three ME courses from the following list:

- ME 322 Thermodynamics & Statistical Mechanics II
- ME 367 Quantitative Methods in Life Cycle Analysis
- ME 373 Engineering Fluid Mechanics
- ME 380/ISEN 390 Thermal Energy Systems Design
- ME 395 Bio-inspired Surface Engineering
- ME 399 Independent Study Research on an energy-and-sustainability related topic
- ME 467/ISEN 495 Industrial Energy Management and Utilization
- ME 495 Sustainable Manufacturing Systems

At least two courses from the following list:

- ME 346 Introduction to Tribology (offered in alternating years with ME 446)
- ME 446 Advanced Tribology (offered in alternating years with ME 346)
- ISEN 410 Topics in Contemporary Energy and Climate Change
- ISEN 420 NUvention Energy
- ISEN 495/ME 467 Special Topics in Energy and Sustainability

- CHEM_ENG 365 Sustainability, Technology and Society
- CIV_ENV 303 Environmental Law and Policy
- CIV_ENV 308 Environmental Justice
- CIV_ENV 309 Climate and Energy - Law and Policy
- CIV_ENV 368 Sustainability: The City
- CIV_ENV 370 Emerging Organic Contaminants
- MAT_SCI 381 Materials for Energy-Efficient Technology
- MAT_SCI 382 Electrochem Energy Mat and Dev
- MAT_SCI 395 Electronic/Thermal Prop of Mat
- ENVR_SCI 390 Special Topics in Environmental Sciences

Note: ISEN stands for the Institute for Sustainability and Energy at Northwestern. ISEN 200-level courses cannot count as concentration courses but may be taken as unrestricted electives. Another interesting unrestricted elective is CIV_ENV 203: Earth in the Anthropocene.

MANUFACTURING *(Faculty Lead: Prof. Ping Guo)* (Faculty Lead: Prof. Ping Guo)

The *Manufacturing* concentration is directed toward planning and selecting manufacturing methods, design for manufacture, computer-aided flexible automation and robotics, digital manufacturing, and increasing the efficiency and productivity of current and emerging manufacturing technologies.

<u>Required (2)</u>

- ME 340-2 Computer-Integrated Manufacturing: CAD/CAM
- DSGN 345: Computer-Aided Manufacturing (½) and DSGN 348: Advanced Topics: Rapid Prototyping (½)

Choose one course from each of the following three groups and an additional course from any of the three groups.

Group 1: Processes and Automation

- ME 333 Introduction to Mechatronics
- ME 340-3 Computer Integrated Manufacturing Ill: Manufacturing Automation
- ME 363 Mechanical Vibration
- ME 395 Industry 4.0 Manufacturing
- ME 433 Advanced Mechatronics
- ME 439 Computer Control in Manufacturing
- ME 445 Micromanufacturing
- ME 447 AI in Manufacturing
- ME 495 Additive Manufacturing
- ME 495 Metal and Ceramic Additive Manufacturing
- DSGN 407 Making Things

Group 2: Materials and Mechanics

- ME 327 Finite Element Methods
- ME 346 Introduction to Tribology (offered in alternating years with ME 446)
- ME 362 Stress Analysis
- ME 395 Machine Learning in Experimental Mechanics
- ME 395 Machine Learning for Mechanical Sciences
- ME 395/495 Characterization of Materials
- ME 413 Experimental Solid Mechanics
- ME 414-1 Mechanics of Composite Materials
- ME 415 Mechanics of Manufacturing Processes
- ME 426-1 Advanced Finite Element Methods I

- MAT_SCI 318 Material Selection
- MAT_SCI 332 Mechanical Behavior of Solids
- CIV_ENV 417-1 Mechanics of Continua I

Group 3: Operations and Design

- ME 341 Computational Methods for Engineering Design (offered in alternating years with ME 441)
- ME 367 Quantitative Methods in Life Cycle Analysis
- ME 380 Thermal Energy Systems Design
- ME 395 Vehicle Dynamics and Design
- ME 441 Engineering Optimization for Product Design and Manufacturing (offered in alternating years with ME 341)
- DSGN 308 Human-Centered Product Design
- DSGN 320 Introduction to Industrial Design Methods
- DSGN 386 Manufacturing Engineering Design
- IEMS 307 Quality Improvement by Experimental Design
- IEMS 381 Supply-chain Modeling and Analysis
- IEMS 382 Production Planning and Scheduling
- IEMS 383 Service Operations Management

ME 399 Independent Study (max 1 unit) on a manufacturing-related topic may be used to fulfill the fourth elective course requirement

MECHANICAL SCIENCES *(Faculty Lead: Prof. Jeremy Keys)* SCIENCES (Faculty Lead: Prof. Jeremy Keys)

The *Mechanical Sciences* concentration is designed to prepare students for graduate study in Mechanical Engineering through an emphasis on experimental and computational

methods used in research and providing a broad introduction to techniques used in more specialized engineering fields.

Stress Analysis (Choose **One**)

- ME 327 Finite Element Methods
- ME 362 Stress analysis

Independent Study (**One** required)

- ME 399 Independent Study

Choose one course in **either** Experimental Engineering or Computational Mechanics

- Experimental Engineering
    - ME 382 Experiments in Micro and Nano Science and Engineering
    - ME 395 Experimental interfacial phenomena
    - ME 395 Machine Learning in Experimental Mechanics
    - ME 413 Experimental Solid Mechanics
- Modeling and Advanced Computational Methods
    - ME 328 Computational Forensics and Failure Analysis
    - ME 341 Computational Methods for Engineering Design (offered in alternating years with ME 441)
    - ME 378 Applied computational fluid dynamics and heat transfer
    - ME 395 Machine Learning for Mechanical Sciences
    - ME 416 Computational Nanodynamics
    - ME 423 Introduction to Computational Fluid Dynamics (offered in alternating years with ME 425)
    - ME 424 Advanced Computational Fluids Dynamics (offered in alternating years with ME 470)
    - ME 426-1 Advanced Finite Element Methods
    - ME 441 Engineering Optimization for Product Design and Manufacturing (offered in alternating years with ME 341)

- CS 349 Machine Learning

Choose **Three** more courses from at least **Two** of the above ***or*** below categories:

- Fundamental Physics & Statistical Mechanics
  - ME 419 Wave Propagation in Elastic Solids
  - CHEM_ENG 330 Molecular Engineering and Statistical Mechanics
  - Chem_Eng 395 Quantum Mechanics and Path Integrals
  - MAT SCI 351-1 Introductory Physics of Materials
  - PHYSICS 339-1 Quantum mechanics
- Micro/Nano Engineering & Materials
  - ME 302 Artificial Life
  - ME 381 Intro to MEMS and NEMS
  - ME 395 Micro and Nanofabrication
  - ME 395 Bioinspired surface engineering
  - ME 420 Micro and Nano-scale Fluidic Dynamics
  - ME 445 Micromanufacturing
  - ME 495 Nanoscale thermal transport
  - CHEM ENG 372 Bionanotechnology
  - EECS 388 Nanotechnology
  - MAT SCI 376 Nanomaterials
- Materials Science & Solid Mechanics
  - ME 414 Mechanics of Composite Materials I
  - ME 495 Metamaterials
  - ME 495 Mechanics of thin films
  - BME 353/MAT SCI 353 Bioelectronics

    - BME 365 Control of Human Limbs and Their Artificial Replacements
    - BME 371 Mechanics of Biological Tissues
    - CEE 417 Mechanics of Continua I
    - CHEM_ENG 330 Molecular Engineering and Statistical Mechanics
    - MAT SCI 314 Thermodynamics of materials
    - MAT_SCI 370 Biomaterials
    - MAT_SCI 381 Materials for Energy-Efficient Technology
- Fluid Mechanics & Thermal Systems
    - ME 322 Thermodynamics and Statistical Mechanics - II
    - ME 346 Introduction to Tribology (offered in alternating years with ME 446)
    - ME 373 Engineering Fluid Mechanics`
    - ME 380 Thermal Energy Systems Design
    - ME 364 Introduction to Aerospace Engineering
    - ME 422 Statistical Mechanics for Applications
    - ME 425 Fundamentals of Fluid Dynamics (offered in alternating years with ME 423)
    - ME 427 Viscous Fluid Dynamics
    - ME 446 Advanced Tribology (offered in alternating years with ME 346)
    - ME 470 High Performance Computing (offered in alternating years with ME 424)
    - ME 495 Aerodynamics and Propulsion
    - ME 495 Turbulence and Combustion
    - BME 378/BME 478 Transport Fundamentals: Mass and Heat Transfer/Graduate Mass and Heat Transfer
    - BME 452 Transport through Connective Tissues
- Data Science and Applied Mathematics*
    - EE 302 Probabilistic Systems

- ES_APPM 311-0 Methods of Applied Mathematics
- ES_APPM 311-1 Methods of Applied Mathematics
- ES_APPM 312 Complex Analysis
- ES_APPM 311-3 Methods of Applied Mathematics
- ES_APPM 346 Modeling and Computation in Science and Engineering
- STAT 301-1, 2, 3 Data Science with R Sequence
- STAT 303-1, 2, 3 Data Science with Python Sequence
- STAT 320-1 Statistical Theory and Methods
- STAT 330-1 Applied Statistics for Research

**Students may take one of these courses to fulfill the 300-level or higher basic math/science ME Major requirement. The course taken to fulfill this credit will not count towards the 6 required technical electives*.

ROBOTICS *(Faculty Lead: Profs. Michael Rubenstein and Michael Peshkin)* (Faculty Lead: Profs. Michael Rubenstein and Michael Peshkin)

The *Robotics* concentration includes design of robotic hardware, dynamics, motion planning and control, human-robot interaction, sensing, and artificial intelligence for robots.

Learning C++ (and not just C or Python) is often desirable for roboticists, and it is a prerequisite for many courses you will want to take. We suggest that you take CS 211 for this purpose. Students may substitute CS 211 in place of the department's general requirement for Programming in Python.

Required Courses (3)

- ME 333 Introduction to Mechatronics
- EE 360 Introduction to Feedback Systems (ME 390 is a sufficient prereq for this)

- ME 449 Robotic Manipulation

Electives: any 3 from the list below.

Courses typically offered every year, not requiring prerequisites outside the ME curriculum, and generally having good enrollment availability:

- ME/CS 301 Introduction to Robotics Laboratory
- ME/CS 302 Artificial Life
- ME 363 Mechanical Vibrations
- ME 395 Vehicle Dynamics and Design
- ME 399 Independent Study if supervised by one of the Robotics & Biosystems core faculty
- ME 433 Advanced Mechatronics
- ME 454 Optimal Control of Nonlinear Systems (offered in alternating years with ME 455)
- ME 455 Active Learning in Robotics (offered in alternating years with ME 454)
- CS 348 Introduction to AI (spring quarter)
- EE 326 Electronic System Design I
- EE 327 Electronic System Design II
- EE 410 System Theory

Courses that may not be offered every year, or that may have enrollment caps, or require prerequisites beyond the standard ME curriculum:

- CS/ME 409 Swarms and Multi-Robot Systems
- CS/ME 410 Autonomous Quadrotor Design and Control
- CS/ME 469 Machine Learning and Artificial Intelligence for Robotics

- ME 495 Embedded Systems in Robotics
- ME 495 Sensing, Navigation, and Machine Learning for Robotics
- ME 495 Soft Robotics
- CS 331 Computational Photography
- CS 348 Introduction to AI (fall/winter quarters)
- CS 349 Machine Learning
- CS 449 Deep Learning
- EE 332 Computer Vision
- EE 374 Introduction to Digital Control
- EE 470 Introduction to Nonlinear Control Theory

Capstone

ME 472-1,2 Robot Design Studio is approved to serve as the capstone sequence for students taking the robotics concentration, but it is not required. ME 398-1,2 is the default.

Math/Science

Robotics students may wish to consider fulfilling the 300-level or higher basic math/science requirement with courses on statistics and probability (e.g., EE 302 Probabilistic Systems, STAT 320-1) or math or ESAM courses on differential equations, differential geometry, nonlinear systems, numerical methods, or scientific computing. This course is not part of the concentration.