Graduate Course Structure for PhD and MS Students
Specialization areas and their corresponding courses

Note: graduate-level and upper division courses from other departments in the Jacobs School of Engineering are considered Permitted Electives for MAE MS Plan II Students. Plan I Students need approval from their Faculty Advisors before enrolling in courses not found here. Please reach out to the MAE MS Graduate Coordinator with any questions.

Specialization: Fluid Mechanics
Research Areas: Fluid Mechanics
Introductory courses  MAE 210A, B, C  Fluid Mechanics I, II, III

Advanced courses  MAE 212  Introductory Compressible Flow
MAE 214A  Introduction to Turbulence and Turbulent Mixing
MAE 216  Ocean Turbulence and Mixing
MAE 215  Hydrodynamic Stability
MAE 223  Computational Fluid Dynamics
MAE 224A, B  Environmental Fluid Dynamics

Specialization: Biomechanics
Research Areas: Biomechanics
Introductory courses  MAE 209 / BENG 209  Continuum Mechanics Applied to Medicine/Biology

Advanced courses  MAE 261  Cardiovascular Fluid Mechanics
MAE 262  Fluid Mechanics of the Cell
MAE 263  Experimental Methods in Cell Mechanics
MAE 266/MATS 252  Biomaterials and Medical Devices

Specialization: Combustion
Research Areas: Thermal Sciences, Engineering Physics, Energy
Introductory courses  MAE 211  Introduction to Combustion
MAE 212  Introductory Compressible Flow

Advanced courses  MAE 213  Mechanics of Propulsion
MAE 220A,B,C  Physics of Gases; Physical Gasdynamics; Nonequilibrium Gasdynamics
MAE 221A, B  Heat Transfer; Mass Transfer
MAE 256  Radiative Transfer for Energy Applications

Specialization: Solid Mechanics
Research Areas: Materials Sciences, Applied and Solid Mechanics
Introductory courses  MAE 231A,B  Foundations of Solid Mechanics; Elasticity

Advanced courses  MAE 231C  Anelasticity
or  SE 273  Theory of Plasticity and Viscoelasticity
MAE 233A, B  Fracture Mechanics; Micromechanics
MAE 235  Computational Techniques in Finite Elements
MAE 238  Stress Waves in Solids
MAE 267/MATS 253  Nanomaterials and Properties

**Specialization: Environmental Engineering**
Research Areas: Environmental Engineering, Energy

Introductory courses  MAE 210B  Fluid Mechanics II

Advanced courses  MAE 214A  Introduction to Turbulence and Turbulent Mixing
MAE 216  Ocean Turbulence and Mixing
MAE 221A, B  Heat Transfer; Mass Transfer;
MAE 224A, B  Environmental Fluid Dynamics
MAE 254/MATS 256  Energy Materials & Application
MAE 255  Boundary Layer/Renew Energy Meteorology
MAE 256  Radiative Transfer for Energy Applications
SIO 217A, B, C  Atmospheric and Climate Sciences I, II, III

**Specialization: Applied Atmospheric Sciences**
Research Area: Environmental Engineering

SIO 217A, B, C  Atmospheric and Climate Sciences I, II, III
SIO 218  Cloud Dynamics and Climate
SIO 236  Satellite Remote Sensing

**Specialization: Design**
Research Areas: Design

Introductory courses  MAE 291  Design and Mechanics in Computer technology
MAE 292  Computer-Aided Design and Analysis


**Specialization: Linear and Optimal Control**
Research Areas: Dynamics Systems and Control

Introductory courses  MAE 280A, B  Linear Systems Theory; Linear Control Design

Advanced courses  MAE 284  Robust and Multi-Variable Control
MAE 287  Control of Distributed Parameter Systems
MAE 288A  Optimal Control
MAE 288B  Optimal Estimation
MAE 289  Functional Analysis with Applications
MAE 290A, B  Efficient Numerical Methods for Simulation, Optimization and Control; Numerical Methods for Differential Equations
**Specialization: Adaptive Systems and Dynamic Modeling**  
Research Areas: Dynamics Systems and Control

<table>
<thead>
<tr>
<th>Introductory courses</th>
<th>MAE 242</th>
<th>Robot Motion Planning</th>
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<tbody>
<tr>
<td></td>
<td>MAE 247</td>
<td>Cooperative Control of Multi-Agent Systems</td>
</tr>
<tr>
<td></td>
<td>MAE 281A, B</td>
<td>Nonlinear Systems; Nonlinear Control</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Advanced courses</th>
<th>MAE 282</th>
<th>Adaptive Control</th>
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<tbody>
<tr>
<td></td>
<td>MAE 283A</td>
<td>Parametric Identification, Theory &amp; Methods</td>
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<tr>
<td></td>
<td>MAE 283B</td>
<td>Approximate Identification &amp; Control</td>
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<tr>
<td></td>
<td>MAE 286</td>
<td>Hybrid Systems</td>
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<td></td>
<td>MAE 222</td>
<td>Flow Control</td>
</tr>
</tbody>
</table>

**Specialization: Materials Sciences**  
Research Areas: Materials Sciences, Applied and Solid Mechanics

<table>
<thead>
<tr>
<th>Introductory courses</th>
<th>MATS 201A/MAE 271A</th>
<th>Thermodynamics of Solids</th>
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<tbody>
<tr>
<td></td>
<td>MATS 201B/MAE 271B</td>
<td>Solid State Diffusion &amp; Reaction Kinetics</td>
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<table>
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<tr>
<th>Advanced courses</th>
<th>MATS 201C/MAE 271C</th>
<th>Phase Transformations</th>
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<tbody>
<tr>
<td></td>
<td>MATS 205A/MAE 272</td>
<td>Imperfections in Solids</td>
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<tr>
<td></td>
<td>MATS 211/MAE 229A</td>
<td>Mechanical Properties</td>
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<td></td>
<td>MATS 218/MAE 250</td>
<td>Fatigue, Fracture, and Failure</td>
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<td></td>
<td>MATS 227/MAE 251</td>
<td>Structure and Bonding of Solids</td>
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<td></td>
<td>MATS 213A,B</td>
<td>Dynamic Behavior of Materials I &amp; II</td>
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<tr>
<td></td>
<td>MATS 233A,MAE 252A,B</td>
<td>Processing &amp; Synthesis of Advanced Materials</td>
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<td></td>
<td>MATS 236/MAE 253</td>
<td>Ceramic &amp; Glass Technology</td>
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<tr>
<td></td>
<td>MATS 251/MAE 265</td>
<td>Structure &amp; Properties of Electronic, Magnetic, Photonic Materials</td>
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<td></td>
<td>MATS 252/MAE 266</td>
<td>Biomaterials and Medical Devices</td>
</tr>
<tr>
<td></td>
<td>MAE 253/MAE 267</td>
<td>Nanomaterials and Properties</td>
</tr>
<tr>
<td></td>
<td>MAE 254/MATS 256</td>
<td>Energy Materials &amp; Application</td>
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<td></td>
<td>MATS 257</td>
<td>Polymer Science and Engineering</td>
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</tbody>
</table>

**Specialization: Applied Plasma Physics**  
Research Areas: Thermal Sciences, Engineering Physics, Energy

<table>
<thead>
<tr>
<th>Introductory courses</th>
<th>MAE 217A</th>
<th>Introduction to Gas Discharge Plasma Physics</th>
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<tbody>
<tr>
<td></td>
<td>MAE 217B</td>
<td>Intro to Non-magnetized Plasma Physics</td>
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<tr>
<td></td>
<td>MAE 217C</td>
<td>Intro to Magnetized Plasma Physics</td>
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<tr>
<td></td>
<td>MAE 218A</td>
<td>Intro to High Energy Density Physics (MHD and Pinches)</td>
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<td>MAE 218B</td>
<td>Intro to High Energy Density Physics (Laser-Plasma Interactions)</td>
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<thead>
<tr>
<th>Advanced courses</th>
<th>MAE 227A</th>
<th>Fundamentals of Modern Plasma Physics (Magnetized Plasma)</th>
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<tbody>
<tr>
<td></td>
<td>MAE 227B</td>
<td>Fundamentals of Modern Plasma Physics (Laser-Plasma Interactions)</td>
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<tr>
<td></td>
<td>MAE 228</td>
<td>Selected Topics in Plasma Physics</td>
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<tr>
<td></td>
<td>PHYS 218A,B,C</td>
<td>Plasma Physics</td>
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<tr>
<td></td>
<td>PHYS 228</td>
<td>High Energy Astrophysics and Compact Objects</td>
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<td></td>
<td>PHYS 235</td>
<td>Nonlinear Plasma Theory</td>
</tr>
<tr>
<td></td>
<td>ECE 240A</td>
<td>Laser and Optics</td>
</tr>
</tbody>
</table>
Specialization: Mathematics

Research Areas: Applied and Solid Mechanics, Material Sciences, Fluid Mechanics, Thermal Sciences, Engineering Physics, Dynamics Systems and Controls, Environmental Engineering, Biomechanics, Design

**MAE 208** Mathematics for Engineers
**MAE 289** Functional Analysis and Applications
**MAE 294A,B,C** Methods in Applied Mechanics I, II, III
**MAE 290A,B** Efficient Numerical Methods for Simulation, Optimization and Control; Numerical Methods for Differential Equations
**MATH 210A,B,C** Mathematical Methods in Physics and Engineering
**MATH 211** Fourier Analysis on Finite Groups
**MATH 212A** Introduction to the Mathematics of Systems and Control
**MATH 220A,B,C** Complex Analysis
**MATH 221A,B,C** Topics in Several Complex Variables
**MATH 227A,B,C** Topics In Complex Analysis
**MATH 231A,B,C** Partial Differential Equations
**MATH 233** Singular Perturbation Theory for Differential Equations
**MATH 240A,B,C** Real Analysis
**MATH 241A,B,C** Functional Analysis
**MATH 247A** Topics in Real Analysis
**MATH 250A,B,C** Differential Geometry
**MATH 270A,B,C** Numerical Mathematics
**MATH 271A,B,C** Numerical Optimization
**MATH 272A,B,C** Numerical Partial Differential Equations
**MATH 273A,B,C** Scientific Computation
**MATH 274A** Topics in Real Analysis
**MATH 280A,B,C** Probability Theory
**MATH 285A, B** Stochastic Processes
**MATH 286** Stochastic Differential Equations
**MATH 287A,B,C** Time Series Analysis; Multivariate Analysis; Nonparametric Analysis
**MATH 290A,B,C** Topology

Specialization: Basic Science

Research Areas: Applied and Solid Mechanics, Material Sciences, Fluid Mechanics, Thermal Sciences, Engineering Physics, Dynamics Systems and Controls, Environmental Engineering, Biomechanics, Design

**CHEM 213** Chemistry of Macromolecules
**CHEM 214** Molecular and Cellular Biochemistry
**ECE 220** Space Plasma Physics
**ECE 222** Applied Electromagnetic Theory
**ECE 253A** Digital Image Analysis
**ECE 270A, B** Neurocomputing
**PHYS 200A,B** Theoretical Mechanics
**PHYS 201** Mathematical Physics
**PHYS 203A,B** Advanced Classical Electrodynamics
**PHYS 211A,B** Solid-State Physics
**SIO 203A,B,C** Methods of Applied Analysis

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Not all courses will be offered every year. Consult the course offerings for the current year.

A Note About MAE 207’s:

MAE 207, Topics in Engineering Science, is often used to develop new courses before an actual course number is assigned. You may use 207’s as many as two times. The topics must be different from one another. If you want to use more, please consult with your faculty advisor or the MAE Graduate Advisor.

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