

Master of Science Degree in Mechatronics Requirements

Required courses (8)

EET 5144 Real Time Robotics (4)
EET 5373 Advanced PLC (3)
EET 5400 Industrial Safety (1)

Selected Electrical and Mechanical Electives – Pick one from each group (12-15)

Coursework is subject to a limitation of 12 credits at the 3000-4000 level

Disciplinary Breadth Requirement

Choose a minimum of 3 credits with an EE or EET prefix AND

Choose a minimum of 3 credits with an MET or MEEM prefix

from the following 3 groups. Courses that are cross-listed between EE/EET and MET/MEEM cannot be used to satisfy this requirement.

Autonomous Robotic Platforms (3-4)

EE 5531 Introduction to Robotics (3)
MEEM 5705 Introduction to Robotics and Mechatronics (4)
EET 5147 Industrial Robotic Vision System (4)
MET 5800 Dynamics and Kinematics of Robotics Platforms (3)

Controls of Industrial Systems (3-4)

EE 4262 Digital and Non-Linear Control (3)
EE/MEEM 5750 Model-Based Embedded Control System Design (3)
MEEM 4775 Analysis and Design of Feedback Control Systems (4)
EET 5311 Advanced Circuits and Controls (4)
MET 5801 Controls of Dynamic Systems (3)
MET 5802 Vibrations of Mechanical Systems (3)

Signal Processing of Electromechanical Systems (3-4)

EE 4252 Digital Signal Processing and Applications (3)
EET 5142/4142 Digital Signal and Image Processing (4)
MEEM 5700 Dynamic Measurements/Signal Analysis (4)

Selected Electives in Cyber Security of Industrial Processes (3)

EE 4723 Network Security (3)
EE 5455/MEEM 5300 Cybersecurity of Industrial Control Systems (3)
MEEM 5315 Cyber Security of Auto Systems (3)
SAT 3812 Cybersecurity I (3)

Internship pathway (0-6)

EET 5995 Mechatronics Internship (Repeatable 1-6)

Electives (0-10)

Remaining courses are subject to advisor approval and the limitation of a maximum of 12 credits at the 3000-4000 level. Example courses are shown below.

Possible Elective Courses by Major

EET 5144/4144 Real Time Robotics
EET 5147/4147 Industrial Robotic Vision System
EET 5373/4373 Advanced PLC
EET 5311/4311 Advanced Circuits and Controls
EET 5142/4142 Digital Signal and Image Processing
EET 3131 – Instrumentation
EET 3141 - Computer Architecture and Design
EET 3373 - Introduction to Programmable Controllers
EET 4141 - Microcontroller Interfacing
EET 4253 - LabVIEW Programming for Data Acquisition
EET 4367 - Wireless Communications

EE 4723 Network Security
EE 5455/MEEM 5300 Cybersecurity of Industrial Control Systems
EE 4262 Digital and Non-Linear Control
EE 4272 Computer Networks
EE/MEEM 5750 Model-Based Embedded Control System Design
EE 5531 Introduction to Robotics
EE 4252 Digital Signal Processing and Applications
EE 4253 Real Time Signal Processing
EE4295 Introduction into Propulsion System for HEV
EE 3160 Signal and Systems
EE 3261 Control Systems

MEEM 5310 Cyber Security of Auto Systems I
MEEM 6320 Cyber Security of Auto Systems II
MEEM 4775 Analysis and Design of Feedback Control Systems
MEEM 4707 - Autonomous Systems
MEEM 4295 - Introduction to Propulsion Systems for Hybrid Electric Vehicles
MEEM 3750 - Dynamic Systems
MEEM 5705 Introduction to Robotics and Mechatronics
MEEM 5700 Dynamic Measurements/Signal Analysis

MET 5801/4801 Controls of Dynamic Systems
MET 5800/4800 Dynamics and Kinematics of Robotics Platforms
MET 5802/4802– Vibrations of Mechanical Systems
MET 5378/4378 – Advanced Hydraulics: Electro-hydraulic Components and Systems

SAT 3812 Cybersecurity I
SAT4812 – Cybersecurity II

EE4272/CS4461: Computer Networks
CS46XX/SAT4XXX/EE4XXX: Computer Vision and Applications (new CS proposed course)

Description of the required courses for MS Degree in Mechatronics:**Required for All Majors:**

EET 5144 Real Time Robotics

- Covers the components of a robot system, safety, concepts of a work-cell system, geometry, path control, automation sensors, programming techniques, hardware, and software.
- Credits: 4.0
- Lec-Rec-Lab: (0-3-3)
- Semesters Offered: On Demand
- Restrictions: Must be enrolled in one of the following Level(s): Graduate
- Pre-Requisite(s): EET 1411 or EET 2220 or PH 2230 or EE 2110 or EE 3010

EET 5373 Advanced PLC

- Using Allen Bradley Control Logix and SLC500 programmable controllers, course covers structured programming, Sequential Function Charts, networking, proportional integral differential control, data acquisition and interfacing. The course requires proposing, executing and defending the graduate level, and related to the course material, project.
- Credits: 3.0
- Lec-Rec-Lab: (0-2-3) Semesters Offered: Spring
- Restrictions: Must be enrolled in one of the following Level(s): Graduate Pre-Requisite(s): EET 3373

EET 5400 Industrial Safety

- Course covers safety training and background on safe operation of pneumatic, electrical and fluid power system. Recitation component includes lab and facility tours to observe properly and improperly installed/operated systems. The course will survey federal regulations and processes to assess safety and usage impacts, understand responsibilities as equipment designers and operators, and provide practice learning to write Standard Operating Procedures. Provides the technical and cultural background necessary to design, operate and manage a safe manufacturing facility.
- Credits: 1.0
- Lec-Rec-Lab: (0-1-0)
- Restrictions: None

Topic 1: Autonomous Robotic Platforms

EE 5531 Introduction to Robotics

- Introduction to autonomous systems and robotics with focus on automated ground vehicles. Project based course using distributed computing to solve problems related to motion planning, perception, and localization. Requires experience with Linux operating systems variants, version control systems, and C++ or Python.
- Credits: 3.0
- Lec-Rec-Lab: (2-0-3)
- Semesters Offered: Spring
- Restrictions: Permission of department required; Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following College(s): College of Engineering

MEEM 5705 Introduction to Robotics and Mechatronics

- Cross-discipline system integration of sensors, actuators, and microprocessors to achieve high-level design requirements, including robotic systems. A variety of sensor and actuation types are introduced, from both a practical and a mathematical perspective. Embedded microprocessor applications are developed using the C programming language. A final project is required including analysis, design, and experimental demonstration. Cannot receive credit for both MEEM4705 and MEEM5705.
- Credits: 4.0
- Lec-Rec-Lab: (0-3-3)
- Semesters Offered: Fall, Spring
- Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Mechanical Engineering, Mechanical Eng-Eng Mechanics, Engineering Mechanics
- Pre-Requisite(s): MEEM 3750

EET 5147 Industrial Robotic Vision System

- Procedures for setting up, teaching, testing, and modifying robot vision systems widely used in industrial automation. Introduces advanced Teach Pendant Programming to develop complex scenarios for integrating robots into industrial cells. Final project must demonstrate proficiency in setting up and programming an advanced robotic vision scenario.
- Credits: 4.0
- Lec-Rec-Lab: (0-3-3) Semesters Offered: Fall, Summer
- Restrictions: Must be enrolled in one of the following Level(s): Graduate Pre-Requisite(s): EET 4144 or EET 5144

MET 5800 Dynamics and Kinematics of Robotics Platforms

- This course covers the dynamics and kinematics of rigid bodies as the foundation for analyzing motion of robots. Robotic kinematics is reviewed by analyzing the motion of the robot. The dynamics is reviewed by analyzing the relation between the joint actuator torques and resulting motion.
- Credits: 3.0
- Lec-Rec-Lab: (0-2-3)
- Semesters Offered: Fall
- Pre-Requisite(s): MET3130

Topic 2: Controls of Industrial Systems

EE 4262 Digital and Non-Linear Control

- Introduction to state space analysis and design (state feedback, observers, and observer feedback); digital control system design and analysis (Z-transforms, difference equations, the discrete-time state model, and digital implementation of controllers); introduction to nonlinear systems (equilibrium states, linearization, phase plane analysis, and describing function analysis); and experiments with physical systems.

- Credits: 3.0
- Lec-Rec-Lab: (2-0-2)
- Semesters Offered: Spring
- Pre-Requisite(s): EE 3261

EE/MEEM 5750 Model-Based Embedded Control System Design

- This course introduces embedded control system design using model-based approach. Course topics include model-based embedded control system design, discrete-event control, sensors, actuators, electronic control unit, digital controller design, and communications protocols. Prior knowledge of hybrid electric vehicles is highly recommended.
- Credits: 3.0
- Lec-Rec-Lab: (0-2-2)
- Semesters Offered: Spring
- Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following College(s): College of Engineering; Must be enrolled in one of the following Major(s): Mechanical Engineering, Mechanical Eng-Eng Mechanics, Engineering Mechanics
- Pre-Requisite(s): MEEM 4700 or MEEM 4775 or EE 4261 or EE 3261

MEEM 4775 Analysis and Design of Feedback Control Systems

- This course covers topics of control systems design. Course includes a review for modeling of dynamical systems, stability, and root locus design. Also covers control systems design in the frequency domain, fundamentals of digital control and nonlinear systems.
- Credits: 4.0
- Lec-Rec-Lab: (0-3-2)
- Semesters Offered: Fall
- Restrictions: Must be enrolled in one of the following Major(s): Mechanical Engineering, Mechanical Eng-Eng Mechanics, Engineering Mechanics
- Pre-Requisite(s): MEEM 3750

EET 5311 Advanced Circuits and Controls

- Graduate-level students are expected to demonstrate ability in modeling/simulation techniques of linear systems. Topics include: Fourier and Laplace transforms, signal comparison techniques and transfer functions. Control techniques addressed will include feedback, cascade, feedforward, multivariable and model-based methods.
- Credits: 4.0
- Lec-Rec-Lab: (0-3-3) Semesters Offered: Fall
- Restrictions: Must be enrolled in one of the following Level(s): Graduate Pre-Requisite(s): EET 3131 or EET 4253

MET 5801 Controls of Dynamic Systems

- This course covers the modeling, analysis, and control of dynamic systems. It uses the controlling equations for the control of mechanical and electrical systems. Theory is verified with simulation and lab testing.

- Credits: 3.0
- Lec-Rec-Lab: (0-2-3)
- Semesters Offered: Spring
- Pre-Requisite(s): MET4800

MET 5802 Vibrations of Mechanical Systems

- This course deals with the modeling and analysis of mixed physical systems. Introduction to modeling and oscillatory response analysis for discrete and continuous mechanical and structural systems. Time and frequency domain analysis of linear system vibrations. Vibration of multi-degree-of-freedom systems. Free vibration eigenvalue problem. Un-damped system response and viscously damped systems. Vibration of continuous systems with modes of vibration.
- Credits: 3.0
- Lec-Rec-Lab: (0-2-3)
- Semesters Offered: Fall
- Pre-Requisite(s): MET2130

Topic 3: Signal Processing of Electromechanical Systems

EE 4252 Digital Signal Processing and Applications

- Digital signal processing techniques with emphasis on applications. Includes sampling, the Z-transform, digital filters and discrete Fourier transforms. Emphasizes techniques for design and analysis of digital filters. Special topics may include the FFT, windowing techniques, quantization effects, physical limitations, image processing basics, image enhancement, image restoration and image coding.
- Credits: 3.0
- Lec-Rec-Lab: (3-0-0)
- Semesters Offered: Fall
- Co-Requisite(s): EE 4259
- Pre-Requisite(s): EE 3160

EET 5142/4142 Digital Signal and Image Processing

- Provides students with digital signal and image processing techniques with emphasis on applications. Covers concepts of sampling, digital filters and discrete Fourier transforms, image processing, enhancement, and restoration. The course requires proposing, executing and defending the graduate level, and related to the course material, project.
- Credits: 4.0
- Lec-Rec-Lab: (0-3-3) Semesters Offered: Spring
- Restrictions: Must be enrolled in one of the following Level(s): Graduate Pre-Requisite(s): EET 4311 or EET 3367 and EET 4141

MEEM 5700 Dynamic Measurements/Signal Analysis

- Assessment of measurement system requirements: transducers, conditioners, and displays of dynamic measurements. Time-, frequency-, probabilistic-, and correlative-domain approaches to

dynamic signal analysis: sampled data, discrete Fourier transforms, digital filtering, estimation errors, system identification, calibration, recording. Introduction to wavelet analysis. All concepts reinforced in laboratory and simulation exercises.

- Credits: 4.0
- Lec-Rec-Lab: (0-3-3)
- Semesters Offered: Fall, Summer
- Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following College(s): College of Engineering

Topic 4: Cyber Security of Industrial Processes

EE 4723 Network Security

- Learn fundamental of cryptography and its application to network security. Understand network security threats, security services, and countermeasures. Acquire background knowledge on well-known network security protocols. Address open research issues in network security.
- Credits: 3.0
- Lec-Rec-Lab: (3-0-0)
- Semesters Offered: Fall, Spring
- Pre-Requisite(s): EE 4272 or CS 4461

EE 5455/MEEM 5300 Cybersecurity of Industrial Control Systems

- General introduction to cybersecurity of industrial control systems and critical infrastructures. Topics include NIST and DHS publications, threat analysis, vulnerability analysis, red teaming, intrusion detection systems, industrial networks, industrial malware, and selected case studies.
- Credits: 3.0
- Lec-Rec-Lab: (0-3-0)
- Semesters Offered: On Demand
- Restrictions: Must be enrolled in one of the following Level(s): Graduate; Must be enrolled in one of the following Major(s): Mechanical Engineering, Mechanical Eng-Eng Mechanics, Engineering Mechanics
- Pre-Requisite(s): MEEM 4700 or MEEM 4775 or EE 3261 or EET4311

MEEM 5315 Cyber Security of Auto Systems

- Modern automotive control and communications systems from a cyber-security perspective. Topics include: V2X communications, vehicle attack surfaces and vulnerabilities, in-vehicle networks, threat analysis and vulnerabilities, security mechanisms and architectures, security requirements analysis, hardware security modules, and standards.
- Credits: 3.0
- Lec-Rec-Lab: (0-3-0)
- Semesters Offered: Spring
- Prerequisite: MEEM5300
- Restrictions: Graduate Student in EME, MEEM, EEE, ECP, or CSS

SAT 3812 Cybersecurity I

- The evolution of information security into cybersecurity and its relationship to nations, organizations, society, and individuals. Exposure to multiple cybersecurity technologies, processes, and procedures; analyzing threats, vulnerabilities and risks present; and developing appropriate strategies to mitigate potential cybersecurity issues. Applied lab to develop cyber security offensive attributes and learn how to prevent and/or mitigate threats.
- Credits: 3.0
- Lec-Rec-Lab: (0-2-2)
- Semesters Offered: Fall, Summer
- Restrictions: Must be enrolled in one of the following Class(es): Junior, Senior
- Pre-Requisite(s): SAT 1200 or CS 1111 or CS 1121 or CS 1131 or CS 1142 or MIS 2100 or EET 2241

Internship Course

EET5995

- Empirical experiences in an approved internship site. Provides practical experience in one or more work settings, assisting the upper level student in making an appropriate career choice. Internships must be approved by the department internship coordinator and work minimum of 150 hours for each credit earned.
- Credits: variable up to 3; Repeatable to a Max of 6
- Semesters Offered: Fall, Spring, Summer
- Restrictions: Permission of department required; Must be enrolled in one of the following Major(s): MS Degree in Mechatronics
- Pre-Requisite(s): None