Mechatronics and Robotics

Mechatronics and Robotics (MERO) is an emerging and rapidly growing program across universities in the USA. It is an integrated engineering program that consists of mechanical engineering, electrical/electronic engineering, control systems, and computer science. There is high demand in this interdisciplinary major to fill the gap between the need of this workforce and educated/trained engineers. MERO is an excellent major for students interested in mechatronics, robotics, automation, advanced/smart manufacturing, Industry 4.0, etc.

At OSU, the MERO curriculum is as rigorous as engineering programs and is nearly identical to the Mechanical and Aerospace Engineering (MAE) and Electrical and Computer Engineering (ECE) curriculums for the first two years, but the upper-level major courses are taught with more emphasis on applications. Multiple MERO major courses are popular among engineering undergraduate and graduate students who find value in their job search and thesis/dissertation research.

An important element in MERO is the use of laboratory experience as a teaching tool. The MERO program has laboratories in mechatronics, industrial robots, Programmable logic controller (PLC), DC/AC circuits, fluid power, materials, basic instrumentation, 3D printing, computer-aided design, manufacturing, and engineering (CAD/CAM/CAE). Senior capstone design courses integrate the knowledge and skills learned during their course of study. The latest computer software is provided and supported for the courses that MERO students take. Where appropriate, laboratories with modern computer data acquisition systems and on-screen displays are available.

In addition to the required mechatronics and robotics courses, students are provided with a solid foundation in calculus, physics, linear algebra, differential equations, statistics, chemistry, and computer science. Minor degree choices are available in mechatronics for other major students or entrepreneurship.

Program Educational Objectives

The Mechatronics and Robotics (MERO) Engineering Technology program at Oklahoma State University focuses on preparing graduates so that they are able to productively contribute at their workplace after a short introductory period. A graduate from the OSU MERO program should be able to:

1. Introduce new technologies and methods into their workplace to maximize value to their employer.
2. Employ the latest design and analysis tools in the mechatronics and robotics discipline.
3. Work independently as well as collaboratively with others while demonstrating the professional and ethical responsibilities of the engineering profession.
4. Demonstrate professionalism in the workplace by using the highest standards of ethics and personal integrity.
5. Be a life-long learner through participation and membership in professional organizations, a continuation of professional/graduate studies, and/or self-study.

Student Outcomes

Students graduating from the MERO program are expected to achieve the following:

1. an ability to apply knowledge, techniques, skills and modern tools of mathematics, science, engineering, and technology to solve broadly-defined engineering problems appropriate to the discipline;
2. an ability to design systems, components, or processes meeting specified needs for broadly-defined engineering problems appropriate to the discipline;
3. an ability to apply written, oral, and graphical communication in broadly defined technical and non-technical environments, and an ability to identify and use appropriate technical literature;
4. an ability to conduct standard tests, measurements, and experiments and to analyze and interpret the results to improve processes; and
5. an ability to function effectively as a member as well as a leader on technical teams.

Courses

MERO 3373 Programmable Logic Controller Fundamentals
Prerequisites: "C" or better in (EET 2544 or MERO 2544).
Description: The course will introduce students with fundamentals of programming logic controllers, sensors and actuaors interfacing and control using Ladder logic programming. Previously offered as EET 3373.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Undergraduate
Schedule types: Lecture
Department/School: Engineering Technology

MERO 4213 Industrial Robots
Prerequisites: ("C" or better in ENSC 2123 or MET 3003) and (MATH 3263 or EET 3423).
Description: This is an introductory course on robotics. The course introduces technology students to the dynamics and kinematics of industrial robots.
Credit hours: 3
Contact hours: Lecture: 2 Lab: 2 Contact: 4
Levels: Undergraduate
Schedule types: Lab, Lecture, Combined lecture and lab
Department/School: Engineering Technology

MERO 4833 Senior Design
Prerequisites: "C" or better in EET 2633 and (EET 3803 or MET 3803), and MET 4003.
Description: The course introduces students to the industrial design process in the area of mechatronics and robotics. The students will work in teams to engage in the design and development of industrial projects.
Credit hours: 3
Contact hours: Lab: 6 Contact: 6
Levels: Undergraduate
Schedule types: Lab
Department/School: Engineering Technology

MERO 4843 Senior Design II
Prerequisites: "C" or better in MERO 4833.
Description: This course is the second semester of the Senior Design Course. The students will be introduced to the industrial design process in the area of mechatronics and robotics.
Credit hours: 3
Contact hours: Lab: 6 Contact: 6
Levels: Undergraduate
Schedule types: Lab
Department/School: Engineering Technology

MERO 5000 Thesis Research
Prerequisites: Consent of instructor.
Description: Methods used in research and thesis writing. Same course as FSEP 5000. Offered for variable credit, 1-6 credit hours, maximum of 18 credit hours.
Credit hours: 1-6
Contact hours: Contact: 1-6 Other: 1-6
Levels: Graduate
Schedule types: Independent Study
Department/School: Engineering Technology

MERO 5060 Emerging Topics in Engineering Technology
Prerequisites: Consent of instructor.
Description: Advanced and emerging topics normally not included in existing MSET program. Repeat credit may be earned with different course subtitles assigned. Same course as FSEP 5060. Offered for fixed credit, 3 credit hours, maximum of 6 credit hours.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Engineering Technology

MERO 5070 Directed Studies
Prerequisites: Consent of instructor.
Description: Individual report topics in processes, equipment, experiments, literature search, theory, computer use or combinations or these. Offered for variable credit, 2-4 credit hours, maximum of 4 credit hours. Same as FSEP 5990.
Credit hours: 2-4
Contact hours: Contact: 2-4 Other: 2-4
Levels: Graduate
Schedule types: Independent Study
Department/School: Engineering Technology

MERO 5113 Mechatronic Systems I
Prerequisites: Consent of instructor.
Description: Applications of mechatronics, basic building blocks of mechatronics systems, electronic components, mechanical components, interface between electronic and mechanical components, and considerations of mechatronics system design.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Engineering Technology

MERO 5123 Mechatronic Systems II
Prerequisites: MERO 5113 or equivalent.
Description: Modeling of mechanical, electrical, and hydraulic components and robotic manipulators. Mechatronic control systems design, electro-hydraulic drives, electrical drives, robotic manipulator and intelligent control design.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Engineering Technology

MERO 5133 Mechatronic System Hardware and Software Integration
Prerequisites: MERO 5113.
Description: This course offers a comprehensive foundation for computer-based analysis of signals, digital and analog communication to support mechatronic application and troubleshooting. Various computing tools for mechatronic systems development such as MATLAB, LABVIEW, and ROS, will be introduced with a focus on software and hardware integration.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Engineering Technology

MERO 5213 Introduction to Robot Dynamics and Kinematics
Prerequisites: MERO 5113.
Description: This is an introductory course on robotics. The course introduces technology students with the modeling of robotics manulators. Dynamics and kinematics of industrial robots. Sensing and actuation systems used in the industry.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Engineering Technology

MERO 5303 Feedback Control Systems for Mechatronic Systems
Prerequisites: Graduate standing or instructor permission.
Description: This course introduces mechatronic system modeling, feedback control, time and frequency domain analysis.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Engineering Technology

MERO 5313 Linear Control Systems for Mechatronics
Prerequisites: MERO 5113.
Description: The course is an application specific course. Applications of feedback control in mechatronics, mathematical models of mechatronics systems and components, time-domain analysis, and stability, and state-variable models of feedback systems.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Engineering Technology

MERO 5323 Intelligent Control of Mechatronic Systems
Prerequisites: MERO 5123.
Description: The course introduces students with applications machine intelligence for control of mechatronic systems. Topics covered are neural network control, fuzzy logic control, and other evolutionary control approaches in mechatronics. The course will also introduce machine vision and image processing for mechatronic applications.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Engineering Technology

MERO 5333 Learning-Based Control for Mechatronics and Robotics
Prerequisites: Graduate standing or instructor permission.
Description: The goal of this course is to give the students an introduction to a variety of intelligent control techniques and their applications in mechatronics and robotics systems.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Engineering Technology

MERO 5413 Robotic Underwater Vehicles
Prerequisites: MERO 5213 or consent of instructor.
Description: Analyze the current design of a robotic underwater vehicle and contribute a substantial design improvement.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Engineering Technology

MERO 5423 Engineering Acoustics
Prerequisites: Graduate standing or consent of instructor.
Description: A first course in engineering acoustics dealing with the nature of sound. A mathematical basis for the analysis of sound is progressively developed beginning with first principles.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Engineering Technology

MERO 5433 Industrial Noise Control
Prerequisites: MERO 5423 or MAE 5083.
Description: Design and analysis of industrial noise creation and the methods of attenuation.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Engineering Technology

MERO 5513 Electrohydraulics
Prerequisites: Graduate standing, department permission required or consent of instructor.
Description: Proportional electrohydraulic control valves, servo valves, pressure transducers, position sensors, motion control of hydraulic cylinders, synchronization of two cylinders, and control of press circuits.
Credit hours: 3
Contact hours: Lecture: 2 Lab: 2 Contact: 4
Levels: Graduate
Schedule types: Lab, Lecture, Combined lecture and lab
Department/School: Engineering Technology

MERO 5523 Electropneumatics
Prerequisites: Graduate standing, department permission required or consent of instructor.
Description: Electronic components for pneumatic systems, sensor switches, ladder logic diagram, programmable logic controller, and sequence control.
Credit hours: 3
Contact hours: Lecture: 2 Lab: 2 Contact: 4
Levels: Graduate
Schedule types: Lab, Lecture, Combined lecture and lab
Department/School: Engineering Technology

MERO 5613 Smart Manufacturing for Mechatronics
Description: The course introduces the basic concepts, applications, and current advancements of SMART manufacturing in process industries. This course also shows overview of new technologies, such as Industry 4.0, Industrial Internet, manufacturing based on cyber-physical system (CPS), cloud computing, Internet of Things (IoT), big data analytics, artificial intelligence (AI), and digital twins, etc. Digital twin (DT) is introduced as a pragmatic way for the cyber-physical fusion. It helps to develop a smarter manufacturing system with higher efficiency and reliability.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Engineering Technology

MERO 5633 Multiphysics Computational Modeling and Simulation
Prerequisites: Graduate standing or consent of instructor.
Description: The course will introduce the basic concepts of computation through modeling and simulation that are increasingly being used by designers, architects, planners, and engineers to shorten design cycles, innovate new products, and evaluate designs and simulate the impacts of alternative approaches. Students will use COMSOL® Multiphysics, a commercially available finite-element modeling software, to explore a range of programming and modeling concepts while acquiring those skills.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Engineering Technology

MERO 5713 Advanced CAD for Electro-Mechanical Systems
Description: Advanced computer-aided design methodologies and processes for mechatronic system. Design methodologies on electronic, mechanical components, and whole system will be taught using state-of-the-art technologies and modules in CAD system.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Engineering Technology

MERO 5723 Mechanism Design with CAD
Prerequisites: Consent of instructor.
Description: Mechanism design of robotic and mechatronic components and systems. Kinematic and kinetic studies using analysis module in a CAD program.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Engineering Technology

MERO 5733 Advanced Vibration for Electro-Mechanical Systems
Prerequisites: Consent of instructor.
Description: Analysis, modeling and control of electro-mechanical systems vibrations with an emphasis on practical applications. Mechanical system design methods for noise and vibration mitigation.
Credit hours: 3
Contact hours: Lecture: 3 Contact: 3
Levels: Graduate
Schedule types: Lecture
Department/School: Engineering Technology

Undergraduate Programs

- Mechatronics and Robotics, BSET (p. 2389)

Faculty

Lingfeng Tao, PhD—**Assistant Professor and Program Coordinator**
Professors: Chulho Yang, PhD, PE
Associate Professors: Imad Abouzahr, PhD, PE; Aaron Alexander, PhD; Warren L. Lewis, MS; Hitesh Vora, PhD
Assistant Professors: Ellis Nuckolls, MS, PE; Yafeng Wang, PhD

Mechatronics and Robotics, BSET

Requirements for Students Matriculating in or before Academic Year 2024-2025. Learn more about University Academic Regulation 3.1 (p. 976).

Minimum average technical grade-point-average: 2.0
Total Hours: 121

Code	Title	Hours
General Education Requirements		
All General Education coursework requirements are satisfied upon completion of this degree plan		
English Composition		
See Academic Regulation 3.5 (p. 977)		
ENGL 1113	Composition I	3
or ENGL 1313	Critical Analysis and Writing I	
ENGL 3323	Technical Writing	3
American History & Government		
HIST 1103	Survey of American History	3
or HIST 1483	American History to 1865 (H)	
or HIST 1493	American History Since 1865 (DH)	
POLS 1113	American Government	3
Analytical & Quantitative Thought (A)		
MATH 2144	Calculus I (A)	4
MATH 2153	Calculus II (A)	3
Humanities (H)		
Courses designated (H)		6
Natural Sciences (N)		
Must include one Laboratory Science (L) course		
CHEM 1314	Chemistry I (LN)	4
or CHEM 1215	Chemical Principles I (LN)	
or CHEM 1414	General Chemistry for Engineers (LN)	
PHYS 2014	University Physics I (LN)	4
Social & Behavioral Sciences (S)		
SPCH 2713	Introduction to Speech Communication (S)	3
Additional General Education		
Any course with A, N, or S. Any Statistics (A) is recommended for students considering a graduate degree.		6
Diversity (D) & International Dimension (I)		
May be completed in any part of the degree plan		
Select at least one Diversity (D) course		
Select at least one International Dimension (I) course		
Hours Subtotal		**42**
College/Departmental Requirements		
UNIV 1111	First Year Seminar (or other approved first year seminar course) [1]	1
ENGR 2421	Engineering Data Acquisition Controls Lab	1
ENSC 2113	Statics	3
ENSC 2123	Elementary Dynamics	3
or MET 3003	Dynamics	
ENSC 2141	Strength of Materials Lab	1
ENSC 2143	Strength of Materials	3
ENSC 2411	Electrical Science Lab	1
ENSC 2613	Introduction to Electrical Science	3
EET 2303	Technical Programming	3
EET 2544	Pulse and Digital Techniques	4
EET 2633	Solid State Devices and Circuits I	3
MATH 3263	Linear Algebra and Differential Equations	3
or EET 3423	Applied Analysis for Technology	
MET 1123	Technical Drawing and Basic CAD	3
MET 2313	Fundamentals of Hydraulic Fluid Power	3
MET 4223	Geometric Dimensioning and Tolerancing	3
Hours Subtotal		**38**
Major Requirements		
EET 4314	Elements of Control	4
ENSC 3311	Material Science Lab	1
IEM 3503	Engineering Economic Analysis	3
EET 3253	Microprocessors I	3
MERO 3373	Programmable Logic Controller Fundamentals	3
MERO 4213	Industrial Robots	3
MERO 4833	Senior Design	3
MET 3343	Metallurgy and Polymers	3
MET 3803	Fundamentals of Mechatronics	3
MET 4003	Machine Elements	3
MERO-related specialty		9
Electives		
A total of 3 credit hours from the following: Accounting, Astronomy, Biology, Chemistry, Computer Science, Engineering, Engineering Technology, Entrepreneurship and Emerging Enterprise, Finance, Geology, Legal Studies in Business, Management, Marketing, Mathematics, Physics and Statistics. Calculus III is recommended for students considering a graduate degree.		3
Hours Subtotal		**41**
Total Hours		**121**

1 Minimum grade of "C".

Additional Requirements

- A grade of "C" or better is required in all courses with an analytical or natural science designation or engineering or engineering technology prefix.
- A grade of "C" or better is required for courses with the prefix EET/ MET/MERO, and any course in physics and mathematics that is required in subsequent courses.

Additional State/OSU Requirements

- At least: 60 hours at a four-year institution; 30 hours completed at OSU; 15 of the final 30 or 50% of the upper-division hours in the major field completed at OSU.
- Limit of: one-half of major course requirements as transfer work; one-fourth of hours earned by correspondence; 8 transfer correspondence hours.
- Students will be held responsible for degree requirements in effect at the time of matriculation and any changes that are made, so long as

these changes do not result in semester credit hours being added or do not delay graduation.

- Degrees that follow this plan must be completed by the end of Summer 2030.