The University Senate of Michigan Technological University

Proposal 30-26

Master of Science in Robotics Engineering

Basic Program Information

Primary Contact: Wayne Weaver, Chair, and Aurenice Oliveira, Associate Chair, Director of Graduate Studies, Department of Electrical and Computer Engineering
Program/Degree type: Master of Science
Program Title: Master of Science in Robotics Engineering
Planned Implementation Date: Fall 2026
Program location/modality: Face to Face
Target student population: New and Current Students (Robotics Engineering, Electrical Engineering, Computer Engineering, Mechanical Engineering, Computer Science, Applied Computing).

General description and characteristics of program[1]

The Department of Electrical and Computer Engineering within the College of Engineering (CoE) proposes the establishment of a Master of Science (MS) in Robotics Engineering. The MS program serves as a natural progression from the BSc program in Robotics Engineering, which was established in 2020 (see proposal 25-20). The MS degree builds on the BSc program to prepare graduates for technical leadership roles in the robotics industry and for advanced research in robotics.

The addition of this program fills a gap in Michigan Tech's program offerings that currently exists between electrical, computer, and robotics engineering, as well as mechanical engineering, computer science, data science, electrical engineering technology, and mechanical engineering technology offerings. Robotics engineering involves the application of these disciplines to the design and development of automated systems across diverse sectors, including manufacturing, healthcare, autonomous vehicles, agriculture, logistics, aerospace, and service industries. The Master of Science in Robotics Engineering will address the growing demand for advanced expertise in designing, developing, and deploying intelligent robotic systems across a variety of sectors. A 30-credit master's degree in Robotics Engineering prepares graduates for diverse opportunities across industries such as manufacturing, healthcare, agriculture,

[1] Portions of the wording in this proposal are drawn from existing program related documents at Michigan Technological University, including but not limited to the Robotics Engineering and Electrical Engineering Programs. In all cases these are used with permission from collaborators assisting in the transfer of the program to Michigan Tech.

aerospace, and defense. With the rapid growth of automation, there is an increasing demand for skilled professionals capable of designing, implementing, and maintaining advanced robotic systems.

Moreover, the master's program enrollment in the Department of Electrical and Computer Engineering has experienced significant growth of 23 students from Fall 2024 to Fall 2025, with a total enrollment of 92 students. Twelve out of 23 students are domestic students in the accelerated master's program. This growth is the largest growth of master's programs within the College of Engineering, clearly indicating the demand for our programs. Furthermore, the Master of Science in Robotics Engineering will provide a path for our undergraduate Robotics engineering population to an advanced degree. Enrollment in the BSc in Robotics Engineering program has grown steadily since its inception, increasing from 33 students in Fall 2021 to 70 in Fall 2022, 87 in Fall 2023, and 103 in Fall 2024. While providing pathways for students of other units, the program will be housed and administered by the ECE department. The interdisciplinary nature of the program will allow enrollment of students from Mechanical Engineering, Computer Science, Data Science, Mechanical Engineering Technology, and Electrical Engineering Technology.

The proposed program was discussed with faculty and administrators from all units for which it provides student pathways. It was reviewed and approved by the newly formed Faculty in Robotics Group, a Robotics Initiative that includes faculty from the Departments of Electrical and Computer Engineering, Applied Computing, Computer Science, and Mechanical and Aerospace Engineering. The discussion and approval occurred during a meeting held on November 13, 2025. About 20 faculty members attended the meeting, including the Graduate Program Director for the MS in Mechatronics. This proposal was also discussed with leadership of the College of Computing, Dr. Yu Cai and Dr. Dan Fuhrmann. In addition, the program learning goals were discussed with the Dean of Graduate School, Dr. Will Cantrell.

This program builds upon existing strengths in robotics systems, control systems, artificial intelligence, biomechanics, mechatronics, and human–robot interaction at Michigan Technological University. It aims to provide rigorous graduate-level education, integrating theory, design, research, and practical applications in robotics.

Students will have the option of a thesis or Report track (for those pursuing research or PhD preparation) or coursework/capstone track (for professional practice).

Rationale

The MS in Robotics Engineering, as one of the degree programs in the Department of Electrical and Computer Engineering is proposed for these reasons:

1. To appeal to student interest since currently enrolled undergraduates in Robotics Engineering would have a path for graduate studies in robotics.

2. To strengthen ties with the growing robotics industry as the use of robotics is increasing, driving the need for advanced programs in Robotics Engineering. Globally, robot installations are expected to grow [1].
3. To support faculty research through a graduate program in Robotics Engineering that will attract and retain robotics faculty, and to enable them to perform the most advanced research.
4. To allow enrollment from other programs as the interdisciplinary nature of the program will allow enrollment of students from Mechanical Engineering, Computer Science, Mechanical Engineering Technology, and Electrical Engineering Technology.
5. To maintain enrollment growth since MS growth of 23 students from Fall 2024 to Fall 2025, which accelerated Master counting for 12 out 23 students. The ECE department has the largest CoE master's degree enrollment together with Mechanical engineering, with a total of 92 students as of fall 2025.

The growth of the robotics industry is creating a demand in engineering talent to commercially exploit advances in robotics to design robotic systems. According to the International Federation of Robotics [1], in 2024, the operational stock of industrial robots was computed at 4,663,698 units (+9%). Since 2019, the operational stock of industrial robots has been increasing by 11% on average each year.

In the United States it was 6%. The US ranked 3rd on the list of countries with the highest number of industrial robot installations in 2024. We have a long way to go to catch up with China, which is at the top of the list with 54% of the total robot installations in 2024.[1]

In 2024, the average robot density in the manufacturing industry was 177 robots per 10,000 employees. Driven by the high volume of robot installations in recent years, Asia's average robot density grew by 12% from 2019 to 2024 and was 204 units per 10,000 employees in 2024. During the same period, the European robot density grew by 7% to 148 units. In the Americas, there were 131 robots per 10,000 employees (+6% since 2019). Despite the notable growth in robots' adoption, the share of companies that use robots is still rather small.

Additional efforts are needed to reap the benefits of robotic automation fully, including increasing knowledge, expertise and resources. The wide range of engineering capabilities needed also in peripherals, such as vision or process design, often prevents the adoption of robots. Thus, engineers with advanced skills to provide these capabilities are critical. While trends in Asia, Europe, and North America vary substantially, the aggregate global trajectory remains positive. Globally, robot installations are expected to grow by 6% to 575,000 units. By 2028, the 700,000-unit mark will be surpassed. There is no indication that the overall long-term growth trend will come to an end any time soon. [2]

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[2] *Executive Summary World Robotics 2025 Industrial Robots*, International Federation of Robotics, https://ifr.org/img/worldrobotics/Contents_WR_2025_Industrial_Robots.pdf/, [accessed October 6, 2025].

- **Market Demand:** Rapid growth in industries using robotics and automation (e.g., medical devices, autonomous vehicles, manufacturing 4.0) is increasing demand for engineers with specialized robotics expertise.

- **Institutional Fit:** Michigan Tech already has strong programs in control systems, AI, mechanical design, embedded systems, and machine vision. The MS Robotics Engineering program leverages these strengths and fills a gap between existing graduate offerings (e.g., MS in ECE, RE, CS, ME) by focusing specifically on robotics integration.

- **Recruitment & Retention:** Offering this MS will attract high-quality graduate students interested in robotics research and professional practice. It can enhance research funding, partnerships, and visibility of the institution. Moreover, this MS program is the natural path for Robotics Engineering students interested in the Accelerated Master's Program in Robotics Engineering.

Related programs: within MTU and at other institutions

Within MTU

Robotics Engineering encompasses some aspects of the disciplines of electrical engineering, mechanical engineering, and computer science. As such, parts of this program are related to the following programs: (1) MS in Electrical and Computer Engineering (2) MS in Mechatronics (3) MS in Mechanical Engineering, (4) MS in Computer Science. But none of these programs contain all of Robotics Engineering, and employers seek this specialized degree because of the training of its graduates.

Robotics Engineering vs. Mechatronics: Program Comparison

This program is related to Michigan Tech's MS in Mechatronics, housed in the Department of Applied Computing in the College of Computing. There are, however, notable differences in these two programs. The Mechatronics degree provides an understanding of the application of mechatronic systems in industrial or manufacturing settings. It is an application and hands-on-oriented program with a focus on industrial robot arms and manipulators. The MS in Robotics Engineering, on the other hand, focuses on autonomous robotic systems that can operate independently, perceive their environment, make decisions, and perform tasks without constant human control. Autonomous robotic systems use sensors and artificial intelligence to navigate, adapt, and achieve goals in dynamic environments, from self-driving cars and warehouse robots to drones and robotic surgery systems. Key aspects include real-time data processing, decision-making, and adaptation. The MS in Robotics Engineering addresses how we interface robots with other systems in a congruent manner, using the language of the associated engineering disciplines of mechanical engineering, computer engineering, and electrical engineering. Application areas include healthcare, transportation, manufacturing, logistics, and public safety.

The proposed MS program is more theoretical with a stronger emphasis on the underlying mathematics and advanced topics.. The MS in Robotics Engineering integrates electrical, mechanical, and computing systems to control intelligent systems. Students will be equipped with the skills to design systems at the intersection of these three disciplines by mastering areas such as artificial intelligence, robotics, real-time operating systems, microprocessors and embedded systems, human-robot interaction, rehabilitation robotics, cyber-physical systems, and cybersecurity, among others. Students will be able to build complete robotic platforms that respond to their environments by taking a wide range of courses in electrical engineering, computer science, and mechanical engineering. This proposed degree program has the potential to increase enrollments in each of the BSc programs that are integrated into the MS in Robotics Engineering: Robotics Engineering, Mechanical Engineering, and Computer Science. Students in Mechanical Engineering Technology and Electrical Engineering Technology would also be candidates for this program; however, additional preparation would be required.

Furthermore, the MS in Robotics Engineering curriculum intentionally excludes courses from Electrical Engineering Technology (EET) and Applied Computing that are foundational to the MS in Mechatronics. This distinction is maintained to preserve the unique identity and rigorous theoretical framework of the Robotics Engineering program. While the Mechatronics degree leverages these units to provide expertise in the practical implementation, maintenance, and operation of industrial automation, the MS in Robotics Engineering is rooted in the high-level design and algorithmic development of autonomous systems. By focusing on core engineering disciplines from the College of Engineering and Computer Science, this program ensures its graduates are prepared for research and development roles requiring deep mathematical proficiency in areas like sensor fusion, adaptive control, and artificial intelligence—competencies that are distinct from the applied, hands-on focus found in mechatronics-related technology coursework.

MS in Mechatronics

Currently housed in the Applied Computing division of the College of Computing, the Mechatronics degree is designed for practitioners. It offers an understanding of how to apply mechatronic systems specifically within industrial or manufacturing contexts.

- **Core Philosophy:** The program is application-oriented and hands-on.
- **Specific Domain:** There is a strong focus on industrial robot arms, manipulators, and the immediate application of automation technology to solve manufacturing challenges.

MS in Robotics Engineering

The proposed MS in Robotics Engineering takes a broader and more theoretical approach. It focuses on autonomous robotic systems capable of operating independently, perceiving their environment, making decisions, and performing tasks without constant human control.

- **Core Philosophy:** This program is theoretical with a strong emphasis on the underlying mathematics and advanced topics necessary for creating new systems rather than just applying existing ones.

- **Specific Domain:** It answers the question of how to interface robots with other systems congruently, using the combined languages of mechanical engineering, computer engineering, and electrical engineering.
- **Curriculum Depth:** Students will master areas such as:
    - Artificial Intelligence (AI) in robotics
    - Real-time operating systems and embedded systems
    - Human-robot interaction and rehabilitation robotics
    - Cyber-physical systems and cybersecurity

The following table visualizes the primary contrasts between the two degrees:

Feature	MS in Mechatronics	MS in Robotics Engineering (Proposed)
Primary Focus	*Application of systems in industrial and manufacturing settings.*	*Autonomous systems, perception, and independent decision-making.*
Orientation	*Hands-on & Applied: Focuses on implementation and maintenance.*	*Theoretical & R&D: Stronger emphasis on underlying mathematics and advanced algorithms.*
Key Technologies	*Industrial robot arms, manipulators, and automated manufacturing cells.*	*AI, sensors, real-time operating systems (RTOS), and cyber-physical systems.*
System Intelligence	*Automated execution of pre-programmed tasks.*	*Adaptive behavior, navigation, and learning in dynamic environments.*
Interdisciplinary Basis	*Applied Computing (housed in the College of Computing).*	*Integration of Electrical, Mechanical, and Computer Engineering.*
Target Applications	*Industrial automation, manufacturing lines.*	*Self-driving cars, drones, robotic surgery, healthcare, and public safety.*

At other institutions

There are three Master of Science in Robotics Engineering degree programs in Michigan. The program at the University of Michigan – Ann Arbor, which is an interdisciplinary MS via Michigan Robotics. It requires 30 credits, including directed study. Focus areas included sensing, reasoning, and acting. This program is also geared towards autonomous robotics systems and therefore follows a structure similar to the proposed program. The robotics program classifies most of its courses as belonging to one of three core subdisciplines:

- Sensing - Includes computer vision, mapping, signal processing.

- Reasoning - Includes planning, multi-agent coordination, machine learning, artificial intelligence.
- Acting - Includes control, kinematics, dynamics, mechanical, bio-mechanical systems design, manipulation, real-time systems.

Wayne State University also offers an MS in Robotics with both thesis and non-thesis tracks, including three concentrations: Industrial Automation; Intelligent Control; Smart Mobility. Wayne State University's Master of Science in robotics program offers a flexible curriculum designed to match students' career goals. The Industrial Automation concentration is housed in the department of Engineering Technology with focuses on industrial arms and manipulators. The Intelligent Control Concentration is housed in the department of Electrical and Computer Engineering. This concentration covers Industrial robot modeling and simulation, controls, and smart sensors technology. The third concentration is housed in the Computer Science department, focusing on design and enhancing modern mobility solutions via cyber-physical systems, artificial intelligence, and machine learning.

The University of Michigan – Dearborn also offers a 30 credit MS in Robotics Engineering, which is mainly designed to accommodate part-time students. It consists of three core courses to introduce students to subjects like math for electrical and computer engineering, robotic systems, control of robots, and mobile robots. Additional nine credits are chosen from specializations chosen by students. The specializations are in the areas of:

- Sensing and Processing
- Systems and Control
- Machine Learning and Reasoning
- Autonomous Vehicles

More choices are available in cognate courses, which are six credits of graduate-level courses in an engineering discipline other than robotics engineering. Some options include:

- Automotive engineering
- Engineering management
- Industrial and manufacturing systems engineering
- Mechanical engineering
- Computer and information science

Why a fourth Robotics Engineering master's program in Michigan?

Michigan has a strong automotive, manufacturing, and technology industry base. The increasing adoption of robotics and automation drives demand for highly trained robotics engineers. Our program will contribute to meet industry workforce needs. Additionally, the new program will focus on areas not emphasized in the current programs, such as advanced AI integration, rehabilitation robotics, advanced perception systems, and human-robot interaction. All the three existing programs in the state of Michigan are in Michigan Lower Peninsula, a new program in a different region of the state will improve access for students to advanced education. Furthermore, establishing another program will strengthen our institution's strategic position, attract research funding, or enhance state-level competitiveness in robotics education.

In the United States

Surprisingly, there are only a few accredited Robotics Engineering degree programs in the United States. Outside of Michigan, there is a Master's Program at Worcester Polytechnic Institute (WPI), a well-known and reputable program launched in Fall 2009. The foundation of robotics course work is supplemented by forward-thinking engineering course options in project management or entrepreneurship and innovation. The program has options in the areas of robotic manipulation, voice recognition, biomechanics and robots, wearable robots, robotic musical instruments, among others. The WPI Master's in Robotics Engineering curriculum consists of 36 credits, with curriculum breakdown as described below:

- Robotics Core (15 credits):
  - Robotics Foundations (6 credits)
  - Computer Science (3 credits)
  - Electrical and Computer Engineering (3 credits)
  - Mechanical Engineering (3 credits)
- Engineering Context (6 credits):
  - Management (3 credits)
  - Systems Engineering (3 credits)
- Capstone/Thesis (6-9 credits):
  - 6-credit capstone design project or practicum
  - 9-credit thesis option
- Electives (6-9 credits):
  - Upper-level undergraduate and graduate courses selected to complete the 36 credit hours

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Projected Enrollment

Projected enrollment is 10-20 students in Year 1, growing to 20-30 by Year 4. Enrollment in the BSc in Robotics Engineering program has grown steadily since its inception, increasing from 33 students in Fall 2021 to 70 in Fall 2022, 87 in Fall 2023, and 103 in Fall 2024. Similar growth is expected at the Master level with enrollment from domestic and international students.

Specialized Accreditation Requirements

Not Applicable.

Professional Licensure Requirements

Not Applicable.

Curriculum Details

Learning Goals

- **Learning Goal 1:** Students will apply fundamental principles of robotics engineering to the design, analysis, and implementation of robotic systems that address real-world engineering challenges. Achievement of the learning goal and outcomes will be assessed using multiple direct measures, including:
    - Coursework assessments, such as homework assignments, projects, laboratories, and exams in required core courses.
    - Project-based evaluations, where students demonstrate system-level design, integration, and analysis skills.

  Indirect assessment methods (e.g., student feedback, exit surveys) may be used to supplement direct assessment and inform continuous improvement.

- **Learning Goal 2:** Students will apply advanced knowledge in their technical specialty to analyze, evaluate, and solve complex engineering problems using appropriate methodologies and tools, while adhering to the highest standards of professional and ethical practice. Achievement of this learning goal will be demonstrated through substantial coursework, such as advanced projects, case studies, design experiences, or comprehensive examinations that require integration and application of disciplinary knowledge.

- **Learning Goal 3:** Students will communicate complex technical ideas effectively in both written and oral forms, producing professional-quality publications and delivering clear, well-organized presentations to diverse audiences. This learning goal will be demonstrated by successful completion of required coursework as well as through research presentations (local, regional, and/or national), progress reports submitted to the graduate advisor, committee, and graduate program director (including list of abstracts, presentations, and publications), and through written and oral presentations of the master's thesis and master's report.

Assessment Plan

The ECE graduate program committee will monitor and evaluate the enrollment and student performance of the new program on an annual basis. Learning goals are tied to milestones in the Master program. Learning goal 1 corresponds to the successful completion of coursework. Learning goal 2 corresponds to thesis/report defense (master's with thesis/report) and coursework projects. Learning goal 3 corresponds to thesis/report defense, written thesis, oral technical presentations, and publications. Performance indicators and rubrics have been developed and are currently used by our programs.

Curriculum Design

The curriculum structure of the proposed MS program requires 30 credits of graduate work. The Graduate Academic Advisor and the departmental faculty will help the students tailor programs to fit their interests and needs. All course plans must be approved by the graduate program director. The credit requirements for the MS program plan are summarized in the table below.

	Coursework only	Report	Thesis
Total required credits	30	30	30
Core Required Courses Credits[1,2]	15-18	15	15
Elective Credits[2,3]	12	6-13	2-9
Co-op (5000-lvl) Credits	0-3	0-3	0-3
Project/research credits[4, 5]	0	2-6	6-10

[1] Course credits exclude research/project courses (e.g., EE 599X), other directed study or project courses, and ENT courses. A maximum of 3 credits of EE 5805 can be included in the coursework requirements. EE 5805 (1-3cr) may be taken once with pre-approval from Graduate Program Director (GPD) by coursework MS students. Coursework credits do not include Advanced Responsible Conduct for Research Training (RCR).

[2] All courses must be at 4000-level or above. 3000-level courses are not counted towards degree requirements. A maximum of 12 credits is allowed of 4000-level courses for coursework and report options, while a maximum of 9 credits is allowed for thesis option.

[3] Courses outside of the Department should be approved by the advisor and Graduate Program Director. Usually, courses that are offered in Physics, Mathematics, Mechanical Engineering, Biomedical Engineering, Materials Science and Engineering, and Computer Science will be approved. Students must seek approval from the Graduate Program Director before registering courses from other disciplines.

[4] EE 5990 for students in the thesis option and EE 5991 for students in the report option. EE 5990/5991 cannot be taken before completing a minimum of one semester in the program.

[5] Project/research credits may include credits needed to meet the Advanced RCR requirement. All MS students with a report or thesis option must take Advanced RCR training. Advanced RCR must be taken within the first two semesters.

To complete the master's with thesis or report degree, students must complete the following milestones:

- Complete all coursework and research credits (see credit requirements above)
- Take advanced RCR Graduate course (1cr)
- Prepare and Submit Approved Thesis or Report

- Pass Final Oral Defense

Total Credits: 30 credits minimum

Detailed Sample Curriculum Design:

Required Courses: Coursework option requires 15-18 credits, while thesis and report options require 15 credits, selected from any of the courses listed below. For organizational purposes, courses are grouped by focus area; however, students are not required to take courses listed within a particular group.

- **Introduction to Robotics Systems**
  EE 4235: Sensing and Processing in Robotics Applications: 3cr
  EE 4375: Autonomous Vehicle Design: 3cr
  ME 4707: Autonomous Systems: 3cr
  EE 5531: Introduction to Robotics: 3cr

- **Advanced Control & Motion Planning**
  EE 5xxx: Advanced Robotics: 3cr
  EE 5715/ ME 5715: Linear Systems Theory and Design: 3cr
  EE 6702: Nonlinear Systems and Control: 3cr
  EE 5542: Algorithms and Optimizations: 3cr
  EE 5812 / ME 5812: Automotive Control Systems: 3cr
  EE 5xxx: Swarming Robotics: 3cr

- **Perception & Computer Vision for Robotics**
  EE 5532: Sensing and Processing for Robotics: 3cr
  EE 5522: Digital Image Processing: 3cr
  EE 4252: Digital Signal Processing and its Applications: 3cr
  EE 4253: Real Time Signal Processing: 3cr
  EE 5xxx: Advanced Perception Systems: 3cr
  HF 4880: Usability Assessment: 3cr
  HF 4015: Cognitive Task Analysis: 3cr
  PSY 4160: Sensation and Perception: 3cr

- **AI/Machine Learning for Robotics**
  EE 4615 / EE 5615: AI Engineering Applications: 3cr
  EE 5xxx: Machine Learning for Robotics: 3cr
  CS 5861: Artificial Intelligence Theory and Applications: 3 cr
  CS 5821: Computational Intelligence – Theory and Applications: 3cr
  EE 5841 / CS 5841: Machine Learning: 3cr
  ME 5190: Machine Learning for Engineering Applications: 3cr

Electives: Coursework option requires 12 credits, while thesis (2-9cr) and report options require 6-13 credits of any course listed below. For organizational purposes, courses are grouped by focus area; however, students are not required to take courses listed within a particular group.

- **Rehabilitation Robotics**
  EE 5xxx: Rehabilitation Robotics: 3cr

- **Human–Robot Interaction & Safety**
  CS 5761: Human Robot Interaction: 3cr

- **Soft Robotics / Bio-inspired Robotics**
  EE 5533: Neuromorphic Robotic Systems: 3cr

- **Simultaneous Localization and Mapping (SLAM)**
  EE 5xxx: Probabilistic Graphical Models

- **Secure Communications for Robots**
  EE 4272: Computer Networks: 3cr
  EE 5726: Wireless Sensor Networks: 3cr
  EE 4250: Modern Communication Systems: 3cr
  EE 4723: Network Security: 3cr

- **Cybersecurity for Robotics**
  EE 5xxx: Cyber-physical system cybersecurity: 3cr
  CS 4471/5471: Computer Security: 3cr
  CS 5740: Development of Trusted Software: 3cr
  CS 5472: Advanced Topics in Computer Security: 3cr

- **Embedded Systems for Automation**
  EE 4737: Embedded system Interfacing: 3cr
  ME 4705/5705: Robotics and Mechatronics: 3cr
  EE/ME 5750: Model-based Embedded Control System Design: 3cr
  EE/ME 5811: Automotive Systems: 3cr
  EE 4219: Introduction to Electric Machines and Drives: 3cr

Co-Op: 0-3 credits of Co-op credits at 5000-level is allowed.

Research: 0 credits for coursework option, 2-6 credits for report option and 6-10 credits for thesis option.

Course Pre-requisites

Intro to Robotics Systems	**Pre-req**	**Semester offering**
EE 4235	EE 2180 and ENG 1101	Spring
EE 4375	None	Fall/Spring
ME 4707	ME 3750 or ME 4775 or EE 3160	Fall/Spring
EE 5531	None	Fall/Spring
Adv Control & Motion Plan		
EE 5xxx: Advanced Robotics	EE 3261	Fall/Spring
EE 5715/ME 5715	EE 3261 or ME 3750	Fall
EE 6702	EE 5715 or ME 5715	Spring
EE 5542	EE 5300	Spring

EE 5812/ME 5812	EE 3261or ME 4775	Spring
Perception & Computer Vision		
EE 5532	EE 5522	Spring
EE 5522	None	Fall/Spring
EE 4252	EE 3160	Fall
EE 4253	EE 4252	Spring
HF 4880	None	Spring, odd years
HF 4015	PSY2000 and UN1015 and UN1025	Fall, even years
PSY 4160	PSY 2000 or HF 2000	Spring, odd years
AI/Machine Learning		
EE 4615	EE 3180	Spring
EE 5615	EE 3180	Spring
(New) EE 5xxx: Machine Learning for Robotics	EE 4235 or EE 5522	Fall
CS 5811	CS 4811	Fall
CS 5821	None	On demand
EE 5841/ME 5841	None	Spring
ME 5190	None	Spring
Electives		
(New) EE 5990: Rehabilitation Robotics	None	Fall
CS 5761	None	Fall
EE 5533	None	Fall/Spring
EE 4272	CS 3411	Fall/Spring/Summer
EE 5726	EE4272	On demand
EE 4250	EE3180 and EE 3260 and EE3131	Spring/Summer
EE 4723	EE 4272 or CS 4461	Spring
(New) EE 5xxx: Cyber-physical system cybersecurity	None	Fall
EE 5455/ME 5300		
CS 4471	None	On demand
CS 5471	None	Fall/Spring
CS 5472	CS 3411 or CS 4411	Fall/Spring
ME 6320	CS 4471 or CS 5471	Spring
EE 4737	ME 5310 or EE 5310	Fall
ME 4705	CS 1111 and (EE 3171 or EE3173)	Spring/Summer
ME 5705	ME 3750 or EE 3160	Fall/Spring
EE 5750/ME 5750	ME 3750	Fall/Spring
EE 5811/ME 5811	EE 4700 or EE 4775 or EE 3261 or EE4261	Fall
EE 4219	None	Fall
CS 5740	(EE 212 or EE 3010) and EE3120 CS 4471	Spring Spring

New Courses Description

The courses listed below are either currently under development or have already been developed and are scheduled to be offered in the upcoming academic year. For example, *Machine Learning for Robotics* will be offered in Fall 2026 under course number EE5900 (CRN 84631). All of the courses listed below are planned to be included in the course binder review process for the 2026–2027 academic year.

Table 3-New Course Descriptions

Course Title	cr	Description
EE5xxx Machine Learning for Robotics	3	This course introduces machine learning methods for perception in robotics. Topics include image processing, convolutional neural networks, 3D perception, LiDAR and multi-modal fusion. Fall/Spring semesters. **Prerequisite**: EE 4235 or EE 5522 (or equivalent)
EE5xxx Cyber-Physical Systems Cybersecurity	3	Provides an advanced exploration of cybersecurity principles, vulnerabilities, and defense mechanisms in cyber-physical systems (CPS) that integrate computational intelligence with physical processes. Emphasis is placed on understanding how attacks on cyber components can impact physical operations and system safety in domains such as robotics, autonomous vehicles, smart grids, healthcare devices, and industrial automation Fall/Spring semesters. **Prerequisite**: Graduate students
EE5xxx Rehabilitation Robotics	3	Introduces the principles, technologies, and applications of robotics in rehabilitation and assistive systems. Students will explore how robotic devices can aid physical therapy, motor recovery, and functional assistance for individuals with neurological or physical impairments. Topics include human biomechanics and motor control, sensors and actuators for human–robot interaction, control strategies for assistive devices, wearable exoskeletons, prosthetics, and neurorehabilitation systems. Emphasis is placed on system integration, user-centered design, safety, and clinical considerations in the deployment of rehabilitation robots. Fall/Spring semesters. **Prerequisite**: EE 3261 (or ME 4775 or equivalent)

Course Title	cr	Description
EE5xxx Advanced Robotics	3	Introduces Rigid body models of robots, motion planning methods including sampling based, trajectory optimizations, state estimation algorithms including linear observers, Kalman filters, feedback control methods including PD, Impedance Control, optimization-based controllers, Differential Dynamic Programming, Lyapunov, and underactuation. Fall/Spring semesters **Prerequisite**: EE 3261 (or ME 4775 or equivalent)
EE5xxx Probabilistic Graphical Models	3	This course provides a unified probabilistic framework for perception, mapping, and localization in robotic systems. Students will learn to represent uncertainty, dependency, and structure using probabilistic graphical models, including Bayesian networks and factor graphs, and apply these models to state estimation, sensor fusion, and SLAM (Simultaneous Localization and Mapping). Fall/Spring semesters **Prerequisite**: EE 3180 (or EE5500)
EE5xxx Swarming Robotics	3	This course explores the principles of using simple robots to work together in a decentralized system, inspired by biological swarms like ants and bees. Course content includes decentralized control, coordination strategies, and emergent behavior. Students will learn to design, simulate, and test collective behaviors like formation control and task allocation, often using tools like Python and ROS 2. Fall/Spring semesters **Prerequisite**: EE 3261 (or ME 4775 or similar course)
EE5xxx Advanced Perception Systems	3	This course addresses the performance of perception systems at both the component and system levels. A primary focus is placed on assessing system robustness in degraded environments, particularly inclement weather. While all sensors relevant to autonomous vehicles are discussed, students will explore advanced techniques for filtering, processing, and evaluating data with an emphasis on radar, lidar, and camera systems (both visible and infrared). The course heavily utilizes unique field data collected in and around Michigan Tech. Fall/Spring semesters **Prerequisite**: None listed. Instructor approval.

Model Schedule for accelerated MS program

Table 1- Schedule model for accelerated Master of Science in Robotics Engineering

Semester	Course	Credits	Pre-reqs
UG	EE 4252: Digital Signal Processing and its Applications (fall)	3	EE 3160

Semester	Course	Credits	Pre-reqs
	EE 4253: Real Time Signal Processing (sp)	3	EE 4252
	EE 4615: AI Engineering Applications (sp)	3	EE 3180
	Totals	9	
1 - Fall	EE 4235: Sensing and Processing in Robotics applications	3	EE 2180 and (ENG 1101)
	EE 5531: Introduction to Robotics	3	
	CS 5761: Human Robot Interaction	3	
	CS 5821: Computational Intelligence	3	
	Totals	12	
2 - Spring	EE 5xxx: Advanced Robotics	3	EE 3261
	EE 5xxx: Cyber-physical systems cybersecurity	3	
	EE 5xxx: Machine Learning for Robotics	3	EE 4235 or EE 5522
	Total	9	
	Coursework Total	30	

Table 2-Schedule model for coursework option Master of Science in Robotics Engineering (ME Student)

Semester	Course	Credits	Pre-reqs
1 - Fall	ME 4705: Robotics and Mechatronics	3	ME 3750
	ME 4707: Autonomous Systems	3	ME 3750
	ME 5715: Linear Systems Theory and Design	3	ME 3750 or EE 3261
	EE 5531: Introduction to Robotics	3	
	Totals	12	
2 - Spring	ME 5812: Automotive Control Systems	3	ME 3750 or EE 3261
	ME 5190: Machine learning for Engineering Applications	3	
	EE 5xxx: Cyber-Physical Systems Cybersecurity	3	
	Totals	9	
3 - Fall	ME 5750: Model-based embedded control system design	3	
	EE 5xxx: Advanced Robotics	3	ME 3750 or EE 3261

Semester	Course	Credits	Pre-reqs
	EE 5xxx: Swarming Robotics	3	ME 3750 or EE 3261
	Total	9	

Curriculum Plan for Stackable Graduate Certificates:

This proposed master's program is designed with a curriculum that can be met by stacking up to three of the following graduate certificates, which both MAE and ECE students can take. Students in the CS, EET, and MET programs would be able to obtain certificates but additional courses would be required to fulfill required prerequisites.

NEW Graduate Certificate in Robotics Engineering (I) - 9 credits
This is a new graduate certificate to be offered in conjunction with the MS in Robotics engineering.

Graduate Certificate in Automotive Systems and Controls (II) - 15 credits
This graduate certificate is currently offered by both the Electrical and Computer Engineering Department as well as the Mechanical and Aerospace Engineering Department.

Graduate Certificate in Control Systems (III) – 9 credits
This graduate certificate is currently offered by both the Electrical and Computer Engineering Department as well as the Mechanical and Aerospace Engineering Department.

With the allowed double counting of courses between graduate certificates, these three could be completed in 30 credits.

Faculty Qualifications

The curriculum vitae of the faculty members are available on the ECE faculty listing.

Graduate Faculty serving this program will be the same as the existing MS and PhD degrees in the department of Electrical and Computer Engineering.

Program-specific policies, regulations, and rules

- The following program requirements are stricter than the current Graduate School policies:
    - No 3000-level coursework allowed
    - Thesis students may take a maximum of 9-credits at the 4000-level

Otherwise, the program will follow regular University and Graduate School policies.

Resources Needed

Library and other learning resources needed

No additional library or learning resources are required.

Suitability of existing space, facilities, and equipment

The ECE Department at Michigan Technological University is well equipped with modern research laboratories. Since the department already offers a Master degree in Electrical and Computer Engineering, no additional equipment is required to implement this proposal.

Program Costs

Minor additional costs for lab equipment and software licenses will be absorbed by the department.

108.1.2: Criteria for Financial Evaluation Proposed Academic Programs

Relation to University Strategic Plan

Michigan Technological University's stated vision and mission are as follows:

> **Vision**
> Michigan Tech is a globally recognized technological university that educates students, advances knowledge, and innovates to improve the quality of life and to promote mutual respect and equity for all people within the state, the nation, and the global community.
>
> **Mission**
> Create solutions for society's challenges by delivering action-based undergraduate and graduate education, discovering new knowledge through research, and launching new technologies through innovation.

Continuing to provide an advanced degree engineering program to "advance knowledge" and "innovates to improve the quality of life," particularly as robotics systems can have a significant positive impact in areas such as health, transportation, and safety.

Relation of program to the university's educational and research goals.

The new Master program supports Michigan Tech's education and research goals within the university strategic plan. Specifically, "*Continually assess, review, and improve programs and develop new offerings in emerging disciplinary and interdisciplinary areas"*, *"Develop and enhance pathways to completion of undergraduate and graduate programs*", and *"Advance interdisciplinary research to address problems of social significance*."

Consistency with the university's resource allocation criteria.

The proposed program intended to attract new graduate students to the university based on existing instruction and research resources.

Impact on University Enrollment

- **Projected number of students in the program**: Projected enrollment is stable at the initial phase, but we expect growth in the future.
- **Source of new students; in particular, will the students be drawn from existing programs, or will they be students who would otherwise not have come to MTU?**: Both. The graduate student body in ECE is presently majority international students. We anticipate this will be at least steady, however, making the program attractive to a bigger cross section of people with non-traditional science and engineering backgrounds will likely grow both the US citizen and international enrollment.
- **What is the likely correlation between demand for the new program and existing enrollment patterns at MTU?** This program emphasizes preparing students to meet the demands of interdisciplinary expertise in the job market. This will likely attract students from non-ECE backgrounds into the ECE department and thus diversify the existing enrollment patterns at the departmental level.
- **Current enrollment in the unit:** Current numbers of master's in electrical and computer engineering students is 92, which is one of the largest at Michigan Tech only lower by 1 as compared to MAE enrollment (93 students).

Impact on Resources in Home Department

- **Faculty lines:** This program will be supported by existing faculty lines.
- **Faculty and student labs:** Existing research labs are adequate to support this program.
- **Advising:** This will be supported by the existing Graduate Academic Advisor.
- **Assessment:** The ECE graduate program committee will monitor and evaluate the enrollment and student performance of the new program on an annual basis.

Impact on Resources in Other Units Within the University

- **Other academic (e.g., Gen Ed) units regarding faculty, labs and assessment.** We do not expect any significant impact on other units although some of the existing classes may occasionally see an increase of enrollment by one or two students.
- **Information Technology, the Library, central administration and career planning with respect to the impact on the need for computing services, library resources, advising, record keeping, development of employer relations etc.** There should be no significant impact on other units.

Assessment of the ability to obtain the necessary resources assuming requested funds are obtained

Not applicable as we do not need additional resources.

Past Proposal Outcomes

The ECE department has not initiated any new Master programs since the combined Master in Electrical and Computer Engineering was approved in 2020 (see proposal 48-20).

Departmental Budget Contribution

- What is the department's total general fund budget?
    - $ AY25-26: $3,798,464
- How much tuition does the department generate?
    - $9,173,397 for tuition generated by credit hours taught by ECE in 2022-23 (Fall 2022, Spring 2023, Summer 2023)
    - $17,969,740 for tuition generated by the number of credit hours taken by ECE enrolled students in 2022-23 (Fall 2022, Spring 2023, Summer 2023)

How do the benefits from this program compare to other alternatives that are currently under consideration or development?

The proposed MS Robotics in Engineering degree will offer the following benefits:

1. The course sequence will be customized to align with each student’s specific interests and academic background, ensuring a coherent and relevant pathway through the program.

2. The proposed M.Sc. in Robotics Engineering is designed to attract students from a wide range of undergraduate disciplines, including electrical and computer engineering, robotics engineering, mechanical engineering, mechanical engineering technology, electrical engineering technology, computer science, and related fields.
3. This new master's program will establish a clear pathway for robotics engineering students to pursue advanced graduate studies and research in robotics and its associated technologies.