

The University Senate of Michigan Technological University

Proposal 33-22

(Voting Units: Academic)

Establishment of a New Graduate Certificate in Automation and Controls in Mechatronic Systems

Submitted by: Department of Applied Computing

1. Proposal Date:

January 17, 2022

2. Proposing Contacts and Department

Contact:

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Committee Members:

Dr. Aleksandr Sergeev, Department of Applied Computing, College of Computing.

Dr. John Irwin, Department of Manufacturing and Mechanical Engineering Technology, College of
Engineering.

Kevin Johnson, Department of Manufacturing and Mechanical Engineering Technology, College of
Engineering.

3. Sponsor Department Approvals

Approved by the department and college.

4. General Description and Characteristics of Program

4.1 General Description of Certificate

The Department of Applied Computing in the College of Computing and Department of Manufacturing and Mechanical Engineering Technology in the College of Engineering join the efforts to introduce three

graduate, stackable certificates leading to Master of Science in Mechatronics. These certificates are: “Industrial Robotics”, “Automation and Controls in Mechatronic Systems”, and “Fluid Power in Mechatronic Systems”. All three certificates include the core courses for MS in Mechatronics.

The certificate in “Automation and Controls in Mechatronic Systems” concentrates on industrial automation and control systems. Students will learn about advanced concepts in programmable logic control including sensors and actuators. Sensor calibration and pneumatic power regulation are taught alongside the programming of pneumatic and electrical actuators. Sensor types discussed include ultrasonic, optical, magnetic and electrostatic field devices. In addition to programming controllers, students will study feedback control systems prevalent in industrial settings. Control circuits, stability criteria, digitization of control signals and non-linear control concepts are covered.

4.2 Catalog Description

The Certificate in Automation and Controls in Mechatronic Systems is designed to develop skills and competencies in advanced programmable logic controllers, industrial sensors/actuators, human machine interfacing, feedback control electrical circuits, non-linear digital control concepts, and feedback control systems. The curriculum integrates application of these skills in real-world problems and implementation of application specific solutions.

5. Rationale for Certificate

Note: The data collected for the Master of Science degree in Mechatronics and its analysis can be directly related to the Graduate Certificate Automation and Controls in Mechatronic Systems. Students pursuing undergraduate or graduate studies in different fields will be attracted by the opportunity to receive an additional breadth of knowledge and credentials in the field of Automation and Controls without necessarily committing to a standalone degree.

Graduate certificates in Automation and Controls in Mechatronic Systems or its close derivatives are more prevalent in the United States as compared to stand-alone MS degrees in Mechatronics. For example, the military college of South Carolina is offering a 12-credit graduate certificate in Mechatronics Engineering with concentration in control systems. Rochester Institute of Technology’s Mechatronics Engineering Certificate program is designed for practicing mechanical and electrical engineers who aspire to become strong contributors to multidisciplinary design and product development teams working in the area of mechatronics. The 9-credit program consists of two online courses in electrical and mechanical engineering, plus an on-campus integrated laboratory applications course in Mechatronics. The University of Utah’s Department of Mechanical Engineering offers a Certificate of Mechatronics open to all matriculated, upper-division College of Engineering students or any student who has a bachelor’s degree from a recognized engineering program or an allied science. To obtain the certificate the student must complete 22 credit hours of mechatronics course work, plus a mechatronics project. University of Maryland offers a graduate certificate in Mechatronics for eligible students with a B.S. in either Mechanical or Aerospace Engineering. The certificate focuses on advanced controls, mechatronics system design, and digital electronics. The list of available graduate certificates in Mechatronics can continue

being complemented by some purely online programs. Most of the existing certificates are designed around advanced controls, digital electronics and mechatronics systems with little or no emphasis in automation and industrial robotics. The proposed graduate certificate in Automation and Controls in Mechatronic Systems at Michigan Tech is designed to address this by focusing on automation and controls.

6. Related Programs:

There are a variety of certification programs in Automation and Controls in Mechatronics Systems at undergraduate and graduate levels. The proposed Michigan Tech certificate “Automation and Controls in Mechatronic Systems” stands out by its specific focus on Allen Bradley ControlLogix and SLC500 programmable controllers.

Within Michigan, the University of Michigan-Dearborn (UMD) offers a similar program (<https://umdearborn.edu/cecs/graduate-programs/certificates/control-systems>) for a 12-credit certificate.

Other similar programs are offered at:

- Missouri S&T (12 credit – Control Systems)
<https://dce.mst.edu/credit/certificates/controlsystems/>
- Stanford (12 credits - Guidance and Control Graduate Certificate) :
<https://scpd.stanford.edu/public/category/courseCategoryCertificateProfile.do?method=load&certificateId=1211168>
- University of Florida (9 credit – Control Systems)
<https://mae.ufl.edu/sites/default/files/custom/Brochure%20-%20Control%20Sys.pdf>
- Rensselaer Polytechnic Institute, 12-credits,
http://catalog.rpi.edu/preview_program.php?catoid=8&poid=1713&returnto=185
- Villanova, 12-credits, Interdisciplinary
<https://www1.villanova.edu/villanova/engineering/grad/certificates/ndc.html>

Internationally:

- Dalhousie University – Nova Scotia (12 credit – Process Instrumentation and Control)
<https://www.dal.ca/faculty/cce/programs/process-instrumentation-and-control/process-instrumentation-and-control-certificate-program.html>

7. Projected Enrollments

Based on the popularity of the courses included in this certificate and the fact that they are part of the MS degree in Mechatronics, we have estimated the following enrollment:

Academic Year	Enrollment
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2022-2023	5
2023-2024	10
2024-2025	15
2025-2026	15

8. Scheduling Plans

No change in the regular scheduling of the existing courses is anticipated. The Department of Applied Computing will deliver the courses in our regular scheduling plans. Initially, the courses will be delivered on-campus, with the goal of offering later in a blended format. The blended version will consist of the theoretical content being offered in the online format, followed by intense training in the laboratories.

9. Curriculum Design

Required Coursework: 11 credits

EET 5373 Advanced Programmable Logic Controllers (4cr)

EET 5311 Advanced Circuits and Controls (4cr)

MET 5801 Controls of Dynamic Systems (3cr)

Course description:

EET5373 Advanced PLC (4cr)

- Using Allen Bradley ControlLogix and SLC500 programmable controllers, the 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.

EET 5311 Advanced Circuits and Controls (4cr)

- This course starts with the modeling and analysis of circuits in the time domain. The solution of a circuit is simplified by using Laplace transform. The circuits are further studied in the frequency domain by using Bode plots. The sinusoidal components of a signal are studied by using Fourier technique. Discrete-time systems will also be discussed, and linear control techniques will be addressed.

MET 5801 Controls of Dynamic Systems (3cr)

- 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.

10. Model Schedule Demonstrating Completion Time

The certificate can be completed in two academic semesters, during summer Track A or combination of both.

Fall Semester or Summer Track A

EET 5311 Advanced Circuits and Controls (4cr)

Spring Semester or Summer Track A

EET 5373 Advanced PLC (4cr)

MET 5801 Controls of Dynamic Systems (3cr)

11. Library and other Learning Resources

No library or other learning resources are required at this time.

12. Faculty Resumes

Key faculty members for this graduate program are listed below:

Graduate Program Director in Mechatronics:

Dr. Sergeyev, <https://www.mtu.edu/technology/about/faculty/sergeyev/index.html>

Dr. Rawashdeh, <http://www.mtu.edu/technology/about/faculty/>

Dr. Hazaveh, <http://www.mtu.edu/technology/about/faculty/>

13. Equipment

No additional equipment will be required.

14. Program Costs

Initial costs for offering the certificate will not incur additional costs, but as enrollment grows additional instructional resources will be needed.

15. Space

There are no new space requirements.

16. Policies, Regulations, and Rules

Not applicable

17. Accreditation Requirements

No specialized accreditation is required for this program.

18. Planned Implementation Date

Fall 2022

19. Assessment

Upon successful completion of this certificate, students will be able to :

1. Analyze electrical control circuits
2. Model, analyze, and control dynamic systems
3. Configure PLCs (programmable logic controllers) for application in industrial automation.