

**The University Senate of Michigan Technological University**  
**Proposal 48-21**  
(Voting Units: Academic)

**Establishment of a New Graduate Certificate in Signal and Image Processing**

**Submitted by: Department of Electrical and Computer Engineering**

**1. Proposal Date:**

February 25, 2021

**2. Proposing Contacts and Department:**

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**3. Sponsor Department Approvals**

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**4. General Description and Characteristics of Program:**

The Department of Electrical and Computer Engineering proposes to create a nine-credit Graduate Certificate in Signal and Image Processing. This certificate will provide an intermediate certification of competency short of a full MSECE degree. Students have found certificates to be attractive ways to summarize expertise to employers and have pursued them vigorously. It is clear that students and employers value these certifications as statements of competency in a field and working professionals value them as less of a commitment than a Master's degree. We anticipate that there will be a number of non-degree-seeking students who will enroll for certifications to enhance their educations and careers. We further conjecture that these certificates will be attractive to on-line, at least initially non-degree seeking students seeking to broaden their education for professional development.

**4.1 General Description of Certificate**

This proposal offers students a path to obtaining a Graduate Certificate in Signal and Image Processing as part of an MS degree program or as non-degree-seeking students. The certificate requires students to take one required class, and then

choose two courses from a list of four.

#### **4.2 Catalog Description**

The Graduate Certificate in Signal and Image Processing is designed to develop advanced skills in the areas of signal processing and image processing including their use in engineering applications.

#### **5. Rationale for Certificate:**

MTU already has ten graduate certificate programs:  
<https://www.mtu.edu/gradschool/programs/certificates/>

Anecdotal evidence, including discussions with constituent employers in External Advisory Committee meetings, suggests that students and employers value graduate certificate programs as a way to achieve and document competency in specific areas. In fact, it may be that certificates are easier for prospective employers to understand as they represent a specific arc of coursework and competency that may in some cases be hard to glean from a quick look at a transcript. We believe that this clear statement will in the long run improve recruiting for both the residence and on-line graduate programs.

#### **6. Related Programs**

##### *Relation to Internal Programs*

Michigan Tech currently offers an MS degree in Electrical and Computer Engineering (MSECE). The Electrical and Computer Engineering department also offers a fifteen-credit Graduate Certificate in Advanced Electric Power Engineering. In conjunction with the Mechanical Engineering – Engineering Mechanics department, ECE also offers fifteen-credit Graduate Certificates in Automotive Systems and Controls, and Hybrid Electric Drive Vehicle and Engineering. This certificate will merge seamlessly with those certificates and with existing degree requirements.

The proposed nine-credit certificate in Signal and Image Processing focuses on the technologies used in digital and analog signal analyses, and digital image processing, technologies used in many fields of interest from medical imaging to autonomous vehicle technology.

This proposed certificate would also benefit those who are also pursuing a certificate in Data Science Foundations. The Data Science Foundations is focused on data analytics and algorithms for pattern recognition or artificial intelligence, while the proposed Signal and Image Processing certificate focuses on engineering applications and on techniques for the manipulation of data to improve signal or image fidelity.

### *Relation to External Programs*

The proposed certificate is similar to the graduate certificates (although most others are fifteen-credits) offered by:

Stanford University:

<https://online.stanford.edu/courses/ee264-digital-signal-processing>

Purdue University:

<https://engineering.purdue.edu/online/programs/certificate-programs/digital-signal-processing>

New Mexico State University:

<https://ece.nmsu.edu/graduate/distance-education/graduate-certificate-in-digital-signal-processing/>

and UMass-Dartmouth

<https://www.umassd.edu/programs/digital-signal-processing-graduate-cert/>

among others, but none in Michigan, Wisconsin, or Minnesota. This list should suffice to show that Michigan Tech will be in good company if this proposal is approved, while also being a unique online program for regional working professionals.

### **7. Projected Enrollment**

The projected enrollment in the proposed certificate program would likely initially be small, drawing students from the MSECE and the PhD programs in Electrical Engineering and Computer Engineering. However, as the program develops we expect approximately 20 degree seeking students to enroll in the program. As the number of stackable certificates at the university increases, the number of these students will continue and earn a Master's degree. We also expect a number of students entering the program who are interested in the certificate only and not necessarily seeking an MS degree.

ECE is not presently running at capacity for our graduate program, and can accommodate additional students. All of the courses in this proposed certificate are already offered as a part of the MSECE. The table shows expected enrollment in the certificate program. The Fall 2019, Spring 2020 and Fall 2020 enrollments shown in the table are for one of the courses in this certificate program (EE5300), and are provided for context with respect to students in the MSEE program who might also be interested in pursuing the certificate.

Semester	On-campus Enrollment	On-line Enrollment
	Past Enrollment (EE5300)	

Fall 2019	11	3
Spr 2020	3	3
Fall 2020	6	6
	Projected Enrollment (Certificate)	
Fall 2021	5	5
Fall 2022	8	8
Fall 2023	8	10

## 8. Scheduling Plans

We propose to roll this out in Fall semester, 2021, merging it seamlessly with our regular course offerings. Courses will be available on-campus initially, and on-line as certified on-line instructors are able to develop the materials.

## 9. Curriculum Design

Implementation of this certificate does not change the curriculum structure of the MSEE program. The courses proposed in this certificate are:

EE5500 Probability and Stochastic Processes (3 cr.)

and any two of:

EE5300 Mathematical and Computational Processes for Engineering (3 cr.)

EE5521 Detection and Estimation Theory (3 cr.)

EE5522 Digital Image Processing (3 cr.)

EE5532 Sensors and Processing for Robotics (3 cr.)

### Course Descriptions

EE5500 Probability and Stochastic Processes (3 cr., Fall, Spring)

Theory of probability, random variables, and stochastic processes, with applications in electrical and computer engineering. Probability measure and probability spaces. Random variables, distributions, expectations. Random vectors and sequences. Stochastic processes, including Gaussian and Poisson processes. Stochastic processes in linear systems. Markov chains and related topics.

EE5300 Mathematical and Computational Processes for Engineering (3 cr., Fall, Spring)

Overview of problem-solving tools and techniques in engineering, considered from both the analytical and computational point of view. Systems of linear equations, eigenvalue and eigenvector computations, boundary value and initial value problems, Fourier analysis, large-scale systems, optimization. Mathematical modeling and computer programming.

EE5521 Detection and Estimation Theory (3 cr., Spring)

Detecting and estimating signals in the presence of noise. Optimal receiver design. Applications in communications, signal processing, and radar.

EE5522 Digital Image Processing (3 cr., Fall, Spring)

Fundamentals of image processing are covered including image representation,

geometric transformations, binary image processing, compression, space and frequency domain processing. Computer programming in MATLAB and Python is required.

EE5532 Sensors and Processing for Robotics (3 cr., Spring)

Sensing modes, signal and image processing for industrial robotic automation processes. Emphasis placed on widely used sensors, including cameras and 3-D sensors for process control and computer vision for autonomous navigation.

#### **10. Model Schedule Demonstrating Completion Time**

The certificate is designed to be completed in 1-3 semesters. Students may enter in the Fall or Spring. One-semester or two-semester example paths include:

##### **One-Semester**

Fall Semester (9 cr.)

EE5300 Math. and Computational Processes for Engineering (3 cr.)

EE5500 Probability and Stochastic Processes (3 cr.)

EE5522 Digital Image Processing (3 cr.)

##### **Two-Semesters**

Fall Semester (6 cr.)

EE5500 Probability and Stochastic Processes (3 cr.)

EE5522 Digital Image Processing (3 cr.)

Spring Semester (3 cr.)

EE5532 Sensors and Processing for Robotics (3 cr.)

#### **11. Library and other Learning Resources**

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

#### **12. Faculty Resumes**

The curriculum vitae of the faculty members are given at:

<https://www.mtu.edu/ece/department/faculty/>

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

The University has implemented special certification requirements for faculty teaching on-line courses. This certification is completed by the appropriate faculty in advance of running an on-line course. In the near term, courses are currently delivered by the following faculty members:

Dr. Jeffrey Burl, Associate Professor of Electrical and Computer Engineering

<https://www.mtu.edu/ece/department/faculty/burl/>

Dr. Michael Roggemann, Professor of Electrical and Computer Engineering

<https://www.mtu.edu/ece/department/faculty/roggemann/>

Dr. Timothy Schulz, University Professor, Electrical and Computer Engineering

<https://www.mtu.edu/ece/department/faculty/schulz/>

**13. Equipment**

No additional equipment is required to implement this proposal.

**14. Program Costs**

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

**15. Space**

No additional space is required to accommodate the new certificate program.

**16. Policies, Regulations, and Rules**

None besides curricular requirements outlined above.

**17. Accreditation Requirements**

Michigan Tech is accredited by the [Higher Learning Commission](#) (HLC). The proposed certificate will meet HLC criteria 3 and 4. The proposed certificate will not seek additional or discipline specific accreditation.

**18. Planned Implementation Date**

Fall 2021

**19. Assessment**

The Graduate Learning Objectives (GLOs) for Certificate in Signal and Image Processing are:

At the time of completion, students will have:

GLO1. Demonstrated proper utilization of signal and image processing techniques.

Students receiving this certificate will have demonstrated the ability to solve open-ended problems in statistical signal and/or image processing from fundamental principles, and be able to apply their solution to real world problems.

**Approval Process**

Departmental Graduate Committee: June 9, 2020

Department: June 23, 2020

College of Engineering: Oct. 21, 2020

Provost's Office and Deans' Council

Graduate School

Approved by the Senate:  
Approved by the President: