Michigan Tech

Office Memo

Office of the Provost and
Senior Vice President for Academic Affairs

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TO: Richard Koubek, President

FROM: Jacqueline E. Huntoon, Provost & Senior Vice President for Academic Affairs

Jacqueline E Huntoon

DATE: March 26, 2021

SUBJECT: Senate Proposal 48-21

Attached is Senate proposal 48-21, “Establishment of a New Graduate Certificate in Signal and Image Processing,” and a memo stating the Senate passed this proposal at their March 24, 2021 meeting. I have reviewed this memo and recommend approving the proposal.

I concur X do not concur_____ with this recommendation.

Richard Koubek, President

3/29/2021

Date

Michigan Tech

University Senate

DATE:	March 25, 2021
TO:	Richard Koubek, President
FROM:	Samuel Sweitz University Senate President
SUBJECT:	Proposal 48-21
COPIES:	Jacqueline E. Huntoon, Provost & Senior VP for Academic Affairs

At its meeting on March 24, 2021, the University Senate approved Proposal 48-21, "Establishment of a New Graduate Certificate in Signal and Image Processing". Feel free to contact me if you have any questions.

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:**

   Mike Roggemann, Graduate Committee Chair, Electrical and Computer Engineering (mroggema@mtu.edu)
   Glen Archer, Interim Chair, Electrical and Computer Engineering (gearcher@mtu.edu)
   John Pakkala, Graduate Academic Advisor, Department of Electrical and Computer Engineering (jepakkal@mtu.edu)
   Leonard Bohmann, Associate Dean, College of Engineering (ljbohman@mtu.edu)

3. **Sponsor Department Approvals**
   At the end of the document

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 MSECE 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.

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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: