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 47-21

Attached is Senate proposal 47-21, “Establishment of a New Graduate Certificate in Electronics Materials and 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 47-21
COPIES:	Jacqueline E. Huntoon, Provost & Senior VP for Academic Affairs

At its meeting on March 24, 2021, the University Senate approved Proposal 47-21, "Establishment of a New Graduate Certificate in Electronics Materials and Processing". Feel free to contact me if you have any questions.

The University Senate of Michigan Technological University
Proposal 47-21
(Voting Units: Academic)

Establishment of a New Graduate Certificate in Electronics Materials and 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 Electronics Materials and 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 Electronics Materials and Processing as a part of their MS degree program, or as non-degree-seeking students. The certificate requires students to take three

courses from a list of approved courses.

4.2 Catalog Description

The Graduate Certificate in Electronics Materials and Processing is designed to develop advanced skills in the analysis and development of electronic and electro-mechanical materials and their processing for use in computer engineering or sensor design 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. 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, including the fully online MSECE degree program in Signal Processing and Communications.

The proposed nine-credit certificate in Electronics Materials and Processing is not closely related to any other graduate certificate program at Michigan Tech, although it contains several courses that are dual-listed with the Material Science and Engineering department. This certificate would be of value to professionals in electrical engineering, micro-system technology, and computer engineering.

Relation to External Programs

The proposed certificate is similar to the graduate certificate offered by:

University of Florida, 9-credits, Certificate in Microsystem Technology, Electrical and Computer Engineering

https://www.ece.ufl.edu/academics/certificates/mtc/

Boston University, 9-credits, Certificate in Micro-electro-mechanical Systems, Mechanical Engineering
https://www.bu.edu/academics/eng/programs/graduate-certificate-programs/

Georgia Institute of Technology, 12-credits, Certificate in Micro-electro-mechanical Systems, Electrical and Computer Engineering
https://www.ece.gatech.edu/sites/default/files/documents/academics/mems_certificate.pdf

This list shows that Michigan Tech will be in good company if this proposal is approved.

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 15 certificate-seeking students, mainly from ECE, but also from MEEM or MSE to enroll in the program. As the number of stackable certificates at the university increases, a 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 2020 enrollments shown in the table are for graduate level students in EE5430. Those numbers are provided for context with respect to students in the MSECE program who might also be interested in pursuing the certificate. Undergraduate enrollment in the introductory MEMS course tends to be approximately 15 students from ECE and a few from MSE.

Semester	On-campus Enrollment	On-line Enrollment
	Past Enrollment (EE5430)	
Fall 2020	3	0
	Projected Enrollment (Certificate)	
Fall 2021	5	0
Fall 2022	8	2
Fall 2023	12	3
Fall 2024	15	5

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:

Nine credits from the following list, with a maximum of three credits at the 4000-level:
EE4271 VLSI Design (3) cr
EE4240 OR MSE4240 Introduction to MEMS (3) cr
EE5430 OR MSE5430 Electronic Materials (3) cr
EE5460 OR MSE5460 Solid-state Devices (3) cr
EE5470 OR MSE5470 Semiconductor Fabrication (3) cr
EE5471 Semiconductor Fabrication Lab (2) cr
EE5480 OR MSE5480 Advanced MEMS (3) cr
EE5780 Advanced VLSI Design (3) cr

Course Descriptions

EE4240/MSE 4240 Introduction to MEMS (3 cr., Fall)
Fundamentals of micromachining and microfabrication techniques, including planar thin-film process technologies, photolithographic techniques, deposition and etching techniques, and the other technologies that are central to MEMS fabrication.

EE4271 VLSI Design (3 cr., Fall)
Design of VLSI circuits using CAD tools. Analysis of physical factors affecting performance.

EE5430/MSE5430 Electronic Materials (3 cr., Fall)
A study of the physical principles, operational characteristics, models, and basic applications of selected solid-state devices.

EE5460/MSE5460 Solid-state Devices (3 cr., Spring)
A study of the physical principles, operational characteristics and models and basic applications of solid state devices such as p-n junctions, metal-semiconductor junctions and transistors.

EE5470/MSE5470 Semiconductor Fabrication (3 cr., Fall)
Graduate level introduction to the science and engineering of semiconductor device fabrication.

EE5471 Microfabrication Lab (2 cr., Fall)
A hands-on laboratory experience in which the students fabricate devices with micro-and nano-scale dimensions. Lecture component covers safety training, background on microfabrication processes and systems, and facility tours to observe additional systems.

EE5480/MSE5480 Advanced MEMS (3 cr., Spring)
This course will cover advanced topics dealing with MEIXIS technologies, transduction mechanisms, and micro-fabricated sensors and actuators and is a continuation of EE4240/MY4240

EE5780 Advanced VLSI Design (3 cr., Spring)
Nanoscale chip design presents issues for IC designs and new market areas for design automation. This course provides a comprehensive introduction on layout design. Advanced algorithms and optimization techniques are presented to give students the skills needed for nanometer VLSI design.

10. Model Schedule Demonstrating Completion Time

The certificate is designed to be completed in 2-3 semesters. Students may enter in the Fall or Spring. There are many possible ways of fulfilling the certificate requirements. One possible schedule for a student starting in Fall and taking two semesters is shown below.

Fall Semester

EE/MSE 4240 Introduction to MEMS (3 cr.)
EE/MSE 5470 Semiconductor Fabrication (3 cr.)

Spring Semester

EE/MSE 5480 Advanced MEMS (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 in 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:

Paul Bergstrom, Professor of Electrical and Computer Engineering
https://www.mtu.edu/ece/department/faculty/bergstrom/

Elena Semouchkina, Professor of Electrical and Computer Engineering, Affiliated Professor of Physics
https://www.mtu.edu/ece/department/faculty/semouchkina/

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 Outcomes (GLOs) for Certificate in Electronics Materials and Processing are:

At the time of graduation, students will have:

GLO1. Demonstrated knowledge of microelectromechanical systems and electronics materials.

Students receiving this certificate will have demonstrated the ability to solve open-ended problems in electronic materials and 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
Graduate School
Provost's Office and Deans' Council
Approved by the Senate:
Approved by the President: