

The University Senate of Michigan Technological University
Proposal 46-21
(Voting Units: Academic)

**Establishment of a New Graduate Certificate in Network and
Communication Systems**

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 Network and Communication Systems. This certificate will provide an intermediate certification of competency short of a full Master of Science degree in Electrical and Computer Engineering. 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. Coursework completed as a part of this certificate may be "stacked" with other certificates as work completed toward the MS degree.

4.1 General Description of Certificate

This proposal offers students a path toward earning a Graduate Certificate in Network and Communication Systems as either part of their 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 Network and Communication Systems is designed to develop advanced skills in computer networking analysis, design of computer communication systems, and the use of networks and communications systems 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. 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 Network and Communication Systems is similar to the fifteen-credit certificate in Safety and Security of Autonomous Cyber-Physical Systems, but is only nine credits. It is also more general or theoretical in nature and not necessarily focused on automotive applications or on security concerns of networks. This certificate would be of value to professionals in many different industrial sectors, including automotive, but also manufacturing, power generation and distribution, and the various autonomous systems and multi-level control function systems under development.

Relation to External Programs

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

Iowa State University, 12-credits, Certificate in Computer Networking, Computer Engineering
<https://engineeringonline.iastate.edu/graduate-certificates/computer-networking-graduate-certificate-online/>

University of Illinois, 12-credits, Certificate in Networks and Distributed Systems, Computer Science
<https://cs.illinois.edu/academics/graduate/non-degree-options>

Illinois Institute of Technology, 9-credits, Networking and Communications, Computer Science
<http://bulletin.iit.edu/graduate/colleges/science/computer-science/networking-communications-certificate/#programrequirements>

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 25 certificate seeking students, mainly from ECE, but also from MEEM or CS 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 ECE and MEEM students in EE5365. Those numbers are provided for context with respect to students in the MSECE program who might also be interested in pursuing the certificate.

Semester	On-campus Enrollment	On-line Enrollment
	Past Enrollment (EE5365)	
Fall 2020	21	0
	Projected Enrollment (Certificate)	
Fall 2021	12	0
Fall 2022	12	5
Fall 2023	12	7
Fall 2024	15	10

8. Scheduling Plans

We propose to roll this out in Fall semester, 2021, merging it seamlessly with our regular course and degree 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:

EE4250 Modern Communication Theory (3 cr.)

EE4272 Computer Networks (3 cr.)

EE5365 In-Vehicle Communications (3 cr.)

EE5525 Wireless Communications (3 cr.)

EE5527 Digital Communications (3 cr.)

EE5726 Wireless Sensor Networks (3 cr.)

Course Descriptions

EE4250 Modern Communication Theory (3 cr., Fall, Spring)

Introduces the mathematical theory of communication science. Topics include baseband and digital signaling, bandpass signaling, AM and FM systems, bandpass digital systems, and case studies of communication systems.

EE4272 Computer Networks (3 cr., Fall, Spring)

Computer network architectures and protocols; design and implementation of datalink, network, and transport layer functions. Introduction to the Internet protocol suite (TCP, UDP, IP), domain name service and protocols, file sharing protocols, wireless networks, and network security.

EE5365 In-Vehicle Communications (3 cr., Fall)

Focuses on in-vehicle system domains and their requirements, and in-vehicle communication bus Controller Area Network (CAN) and its related physical layers standards. It also covers other buses such as LIN, FlexRay, MOST, Ethernet, as well as introduction to V2V and V2I.

EE5525 Wireless Communications (3 cr., Fall)

Principles of wireless communications systems. Projects may include cell phones, computer networks, paging systems, satellite communications, radio, television and telemetry.

EE5527 Digital Communications (3 cr., Spring)

This course focuses on the basic principles that underlie the analysis and design of digital communication systems. Topics covered include: characterization of communication signals and systems, modulation schemes, optimum receiver design and performance analysis in AWGN and band-limited channels, concepts

of information theory and channel coding, carrier and symbol synchronization, and ISI channel equalization.

EE5726 Wireless Sensor Networks (3 cr., Spring)

Introduces the concepts of wireless sensor networks. Topics include sensor network coverage and sensor deployment, time synchronization and sensor node localization, network protocols, data storage, and collaborative signal processing. Introduce sensor network programming network reliability and tolerance.

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. A two-semester example plan is:

Fall Semester (take 6 cr.)

EE4250 Modern Communication Theory (3 cr.)

EE4272 Computer Networks (3 cr.)

EE5365 In-Vehicle Communications (3 cr.)

EE5525 Wireless Communications (3 cr.)

Spring Semester (take 3 cr.)

EE4250 Modern Communication Theory (3 cr.)

EE4272 Computer Networks (3 cr.)

EE5527 Digital Communications (3 cr.)

EE5726 Wireless Sensor Networks (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:

Christopher Cischke, Senior Lecturer, Electrical and Computer Engineering

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

Jason Hiebel, Instructor, Computer Science

<https://www.mtu.edu/cs/department/people/faculty/hiebel/>

Aurenice Oliveira, Associate Professor of Electrical and Computer Engineering
<https://www.mtu.edu/ece/department/faculty/oliveira/>

Zhaohui Wang, Associate Professor, Electrical and Computer Engineering
<https://www.mtu.edu/ece/department/faculty/wang/>

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 Outcomes (GLOs) for Certificate in Network and Communication Systems are:

At the time of graduation, students will have:

GLO1. Demonstrated knowledge of computer networking and communications systems.

Students receiving this certificate will have demonstrated the ability to solve open-ended problems in network and communications systems 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: