SPECIAL REPORT

OF THE

GRADUATE COUNCIL

concerning

CREATION OF A CERTIFICATE PROGRAM:
EMBEDDED SYSTEMS
(#4437)

Presented at the
776th Regular Meeting of the Faculty Senate
March 8, 2018

COUNCIL MEMBERSHIP

GRADUATE COUNCIL


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The Graduate Council recommends approval of this proposal.

Briefly describe the certificate.

The Embedded Systems certificate is meant to provide a coherent foundation for graduate students interested in learning how computing components can be embedded in many of the systems we use every day. This certificate covers issues related to the design of small computing devices, the security of the devices, and the interconnection of the associated components.

The Electrical and Computer Engineering (ECE) Department would like to offer the graduate certificate consisting of five courses from its graduate curriculum. To receive the certificate, students would take the following required and elective courses:
Required courses

- ECE688F: Graduate Project (1st semester)
- ECE688P: Graduate Project (2nd semester)

Elective courses (students choose 3 out of 5 courses)

- ECE510: Foundations of Computer Engineering
- ECE568: Computer Architecture
- ECE636: Reconfigurable Computing
- ECE622: Embedded Systems: Design, Modeling, and Verification
- ECE658: VLSI Design

To receive the Embedded Systems certificate, students must develop and complete a project in embedded systems as part of the ECE688F/P sequence. All courses listed are three credits.

Current ECE Masters of Science (MS) students and non-matriculating students may apply for the certificate program. Non-matriculating students should have sufficient technical background, as determined by the ECE Graduate Program Director, to join the certificate program. This certificate will be transitional. All credits received as part of the certificate can be applied to an MS degree in ECE. Acceptance into the certificate program does not automatically qualify a student for the ECE MS program, although the student may attempt to join such a program at any time. If a student joins the ECE MS program after completing the certificate, all 15 credits can be applied to the ECE MS degree. Completion of the certificate does not imply admission to the University in a specific academic program. All courses associated with the certificate will be taught frequently. Students will be able to complete the certificate within a reasonable time period.

*Provide a brief overview of the process for developing this certificate.*

The proposal has been developed in consultation with the ECE Department Head and several other ECE faculty members. The proposal has been presented to the ECE Instructional Development Committee (IDC).

Purpose and Goals

*Describe the certificate's purpose and the particular knowledge and skills that will be acquired by participating students.*

By completing the courses associated with this certificate, students will become familiar with the state-of-the-art in the design, testing, and use of embedded systems. Powerful computing devices are increasingly dedicated to serve as the brains of everyday systems such as televisions, kitchen appliances, and transportation systems. Understanding the real-time operation of these systems is key to their design, development, and deployment. New England has an abundance of industry dedicated to the development of military and commercial embedded systems. Companies such as Raytheon and United Technologies will benefit from increased student knowledge in these key areas. A graduate project will provide hands-on experience to students to develop skills they will need in the field.
UMass Amherst does not currently have a similar graduate certificate offering in this technical area.

Resources

*If this proposal requires no additional resources, say so and briefly explain why. If this proposal requires additional resources, explain how they will be paid for. For proposals involving instruction, indicate how many new enrollments are expected and whether the courses have room to accommodate them.*

All seven courses associated with this certificate are already offered by the ECE department. Formal course proposals have been submitted for ECE510 and ECE622. It is expected that the enrollment in each course will remain roughly the same for on-campus students. If the courses are offered via Continuing and Professional Education (CPE), an increase of 10 to 15 students per class could be expected. The income from these students would defer additional expenses associated with the program. The courses are also currently offered as part of the UMass Field Degree (Shorelight) MS in ECE. The availability of a certificate that uses the courses will not affect enrollment since the courses are already needed for the MS degree.

Curriculum

Please describe the curriculum for this certificate, listing all required courses and possible electives, any prerequisites or GPA requirements, the recommended order or coursework and any other pertinent information. You may attach additional materials related to the curriculum at the end of this section.

To receive the certificate, students would take the following required and elective courses:

**Required courses**

- ECE688F: Graduate Project (1st semester)
- ECE688P: Graduate Project (2nd semester)

**Elective courses (students choose 3 out of 5 courses)**

- ECE510: Foundations of Computer Engineering
- ECE568: Computer Architecture
- ECE636: Reconfigurable Computing
- ECE622: Embedded Systems: Design, Modeling, and Verification
- ECE658: VLSI Design

To receive the Embedded Systems certificate, students must develop and complete a project in embedded systems as part of the ECE688F/P sequence. In ECE688F and ECE688P students work in small teams of two or three students. Each team produces one system in their project. However, each student is responsible for an aspect or a component of the overall system. Thus, each student’s contribution and the quality of that contribution will be assessed separately.
All courses listed are three credits.

ECE568 requires prior student knowledge in computer architecture. Other courses do not contain prerequisites beyond undergraduate ECE knowledge. The elective courses can be taken in any order although it is recommended that if a student chooses to take ECE510, this course should be taken first. ECE688F precedes ECE688P. Students may enroll in the certificate courses if they have been accepted into the Embedded Systems certificate program at the discretion of the ECE Graduate Program Director. Per UMass regulations, students must achieve a 3.0 GPA in the certificate courses to receive a certificate.

**Explain how these courses represent a coherent course of study.**

The courses provide a solid basis of state-of-the-art knowledge in embedded systems. ECE510 provides appropriate background in advanced computer engineering fundamentals for students so that students may have a solid foundation for the remaining four certificate courses. ECE568 provides a review of contemporary computer architecture. ECE622 examines the modeling and verification of embedded systems. ECE658 introduces the fundamentals of digital circuit design and layout on silicon chips. ECE636 describes the state of the art in using field-programmable devices for computation. Finally, ECE688F/P provide the students an opportunity to work in a small group to complete a hands-on project related to embedded systems. The students also learn technical presentation and writing skills as part of the project courses.

**Describe how there is a clear educational objective that can be achieved in an efficient and well-defined manner.**

The courses provide a broad spectrum of background in internet of things. Upon completion of the certificate, students will have a clear understanding of the important issues in internet of things and will be qualified to seek employment in this area. Each course covers a different aspect of internet of things. ECE510 is provided as an elective option for students that feel that they need additional background in computer engineering when starting the certificate program.

**Explain how the course sequence offers a clear objective at the appropriate educational level.**

ECE510 provides foundations for students who feel that they need additional computer engineering background. The ECE688F/P sequence offers an opportunity for students to work on an involved project in a team setting. The other courses can be taken at any time during the program. The collection of these courses offers the student a strong foundation in embedded systems.

**Describe the perceived need for this certificate.**

By completing the courses associated with this certificate, students will become familiar with the state-of-the-art in the design, testing, and use of embedded systems. Powerful computing devices are increasingly dedicated to serve as the brains of everyday systems such as televisions, kitchen appliances, and transportation systems. Understanding the real-time operation of these systems...
is key to their design, development, and deployment. New England has an abundance of industry dedicated to development of military and commercial embedded systems. Companies such as Raytheon and United Technologies will benefit from increased student knowledge in these key areas. A graduate project will provide hands-on experience to students to develop skills they will need in the field.

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If the courses that comprise the certificate have been or currently are being offered, describe their schedule of availability. If the certificate is comprised of new courses, describe their planned availability.

ECE568, ECE688F, ECE658, and ECE688P are currently offered every year. ECE622 has been offered every year for the past several years as a seminar course, ECE697MB. ECE636 is offered about once every 18 months. ECE510 is being offered for the first time in Fall 2017 as a seminar course (ECE697CE). It is expected that all courses associated with the new certificate will be offered every one to two years to allow students to complete the certificate in a timely fashion.

If the certificate requires or includes courses from outside the sponsoring department, provide evidence of agreement(s) with the unit(s) offering those courses. You may attach any memoranda of understanding below.

All courses will be offered by the ECE department

If applicable, please attach any memoranda of understanding from other departments or colleges below.

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If the requirements for this certificate overlap with those of another certificate or a degree program, describe that overlap. (Note that if a student who has completed a certificate seeks clearance for a degree program that overlaps with that certificate program, the Registrar will note on the transcript that the certificate has been superseded by the degree.)

Students that complete the certificate will be able to use the course credits to complete a Masters of Science (MS) degree in ECE if they are accepted into the MS program. Three other ECE graduate certificate proposals (Computer Networking, Computer Systems Security, and Internet of Things) also include ECE688F/P and ECE510. To complete an Embedded Systems certificate, students will need to complete a project specifically in the Embedded Systems area in ECE688F/P.

If a student receives an Embedded Systems certificate, the student will not be eligible to receive one of the following certificates (Internet of Things, Computer Systems Security, and Computer Networking).
What type of student is allowed to participate in this certificate program? (E.g., matriculated UMass students, non-matriculated CPE students, Five College students, graduate students, students in a specific degree program, etc.)

The following types of students are eligible for the certificate program: matriculated UMass ECE graduate students, non-matriculated UMass graduate students (e.g. CPE), and UMass Field Degree (Shorelight) ECE students.

What role will this certificate play in relation to other departments or degree programs on campus?
Certificates vary widely across campus and may represent a subset of an existing degree program, a multidisciplinary program, or an entirely free-standing area of focus.

Students who complete the certificate program can use the credits towards an ECE MS degree. Students in an ECE MS program may also complete a certificate if they are accepted into the certificate program.

Is this a transitional certificate program?
(Transitional certificate programs are comprised of core courses from specific degree programs and may act as stepping stones into those programs. If a student who has completed a transitional certificate matriculates to the University and completes the degree program associated with that certificate, the transcript will note that the certificate has been superseded by the degree.)

Yes
Comments: The credits can be used towards an ECE MS degree.

If applicable, please attach any additional material relating to the certificate (such as requirement checksheets for students, etc.) below.