The University Senate of Michigan Technological University

Proposal 31-26

“PhD in Electrical and Computer Engineering”

Basic Program Information

Primary Contacts: Wayne Weaver, Chair, and Aurenice Oliveira, Associate Chair, Director of Graduate Studies, Department of Electrical and Computer Engineering
Program/Degree type: PhD
Program Title: PhD in Electrical and Computer Engineering
Planned Implementation Date: Fall 2026
Program location/modality: Face to Face and Online
Target student population: New and Current Students

General description and characteristics of program

The Department of Electrical and Computer Engineering (ECE) proposes to create a new PhD Degree in Electrical and Computer Engineering (PhD-ECE) with the intent to shelve the two existing degrees, the PhD in Electrical Engineering (PhD-EE) and the PhD in Computer Engineering (PhD-CpE). If this proposal is approved, current students have the option to complete the major title they were accepted into or change to the new title. The proposed program will meet the needs of engineers seeking training in all areas of electrical and computer engineering supported by the ECE Department while making the graduation requirements both simpler to understand and more flexible, making the program easier to administer. The new degree will allow students to determine a flexible mix of coursework in electrical and computer engineering, engineering from related fields, physical sciences, and computer science to meet their educational and career goals, while fulfilling a demanding set of Graduate School and departmental requirements. The proposed program will use the resources already available in the ECE Department and in the University - no new resources are proposed here. The PhD-ECE is expected to continue to attract domestic and international students to pursue graduate study in interdisciplinary areas of Electrical and Computer Engineering including electrical energy systems, robotics, signal and image processing, communications, embedded systems, electro-magnetics, optics and photonics.

The proposal below outlines a program which is flexible enough to allow students to emphasize their interests within the architecture of a single degree program. This proposal preserves the ECE Department’s longstanding emphasis on the strong connection between hardware, software, and the physical world.

Rationale

The PhD-CpE program is much smaller than the PhD-EE program. When the PhD-CpE program was established, the degree requirements were set to be distinct from the PhD-EE requirements as–at that time–these were essentially two separate fields. Since then, large areas of Electrical Engineering and Computer Engineering have converged, and these two fields are often interdisciplinary.

At our graduate program review in October 2020, the external reviewers raised these issues and pointed out that many universities have combined their Graduate Degrees in this manner. Historically, the ECE field has at times been “stove piped” in the sense that narrow specialization was the norm for most graduate students. While it is still the case that some students will seek narrow specialization, a great deal of exciting research in ECE is interdisciplinary. Because of this, the Master's Program’s in EE and CpE were combined in 2020 (see proposals 48-20, 49-20, and 50-20).

Continuing this trend, the ECE Department proposes to also do this for our PhD program. One of our goals in restructuring the PhD Program is to better serve both constituencies, while making sure graduates have the depth and breadth in their education to have successful careers. The proposed PhD-ECE degree will offer the following advantages:

- There are no required core courses; each program can be tailored to meet the needs and interests of each student while still providing the necessary level of rigor associated with PhD degrees.
- The proposed PhD-ECE degree program will attract students from diverse undergraduate backgrounds, including but not limited to Electrical Engineering, Computer Engineering, Physics, and Mechanical Engineering.

Related programs: within MTU and at other institutions

Within MTU

Michigan Tech currently offers PhD degrees in Electrical Engineering and in Computer Engineering. If this proposal is approved, we will shelve the existing degrees and offer only the PhD-ECE. It is our intent to make the PhD-ECE program flexible, and interdisciplinary, while maintaining rigor.

At other institutions

A few examples of prestigious universities which now offer PhD-ECE degrees include

- Georgia Institute of Technology
- Purdue University
- University of Illinois - Urbana Champaign

There are many others, but this list should suffice to show that Michigan Tech will be in good company if this proposal is approved. All these universities emphasize new emerging areas of

interdisciplinary study. Our program will initially cover areas supported by our faculty which includes:

- Robotics, AI, and autonomous navigation
- Quantum optics, quantum computing, nanoelectronic devices, electronic manufacturing
- Power generation and distribution, power system protection, and renewable energy, microgrids, power operations, and power grid cybersecurity
- Sensing and processing, embedded systems, and networking

Projected Enrollment

The projected enrollment in the proposed PhD-ECE program would likely initially be unchanged from the sum of the number of PhD-EE (EEE) and PhD-CpE (ECP) students in the department (current numbers of PhD-EE and PhD-CpE students are 33 and 5, respectively.). However, making the program more flexible by reducing the required coursework credits for students post-master degree, introducing the online modality, and expanding the acceptance of people from a broader set of disciplines will very likely expand enrollment. Additionally, we expect the number of PhD students in ECE to grow, in line with the 100 PhDs initiative.

Specialized Accreditation Requirements

Not applicable

Professional Licensure Requirements

Not applicable

Curriculum Details

Learning Goals

- **Learning Goal 1:** Students will demonstrate mastery of the advanced concepts, theories, and applications in electrical and computer engineering, integrating this knowledge to solve complex technical problems. This learning goal will be demonstrated by passing the required coursework and the written and oral comprehensive examinations.

- **Learning Goal 2:** Students will conduct independent, original research in their technical specialty, applying advanced research methodologies and adhering to the highest standards of responsible and ethical research practice. This learning goal will be demonstrated through making original and substantial contributions to the discipline.

- **Learning Goal 3:** Students will communicate complex technical ideas effectively in both written and oral forms, producing professional-quality publications and delivering clear, well-organized presentations to diverse audiences. This goal will be demonstrated through research presentations (local, regional, and/or national), progress reports submitted to the graduate advisor, committee, and graduate program director (including a list of abstracts, presentations, and publications), and through written and oral presentations of the dissertation.

Assessment Plan

The ECE graduate program committee will monitor and evaluate the enrollment and student performance of the new program on an annual basis. Learning goals are tied to milestones in the PhD program. Learning goal 1 corresponds to the successful completion of coursework. Learning goal 2 corresponds to passing the qualifying exam, research dissertation proposal, proposal defense, and dissertation defense. Learning goal 3 corresponds to dissertation proposal, dissertation proposal defense, dissertation defense, dissertation, oral technical presentations, and publications. Performance indicators and rubrics have been developed and are currently used by our programs.

Curriculum Design

There are no required courses in this program. However, the Graduate Program Director and the departmental faculty advisor will help the students tailor programs to fit their interests and needs. The credit requirements for the PhD-ECE plan are summarized in the table below.

	Entering without MS	Entering with MS[4]
Total required credits	60	30
Total non-research course credits[1]	Minimum of 30	9-12
EE 5000-, and 6000-level credits[2]	Minimum of 21	Minimum of 9
Other approved course credits[3]	Maximum of 9	Maximum of 3
Allowed 4000-level course credits	Maximum of 9	Maximum of 0
Co-op credits at 5000-level	Maximum of 3	Maximum of 0
Project/research credits[5]	Minimum of 21	18-21

[1] Course credits exclude research/project courses (e.g., EE 599X and EE 699X), other directed study or project courses, and ENT courses. No credits of EE 5805 can be included in the coursework requirements for the PhD program. Coursework credits do not include Responsible Conduct for Research Training (RCR).

[2] Transferring in Graduate Credits: For PhD entering with MS no transfer credits are allowed.

[3] For entering without MS option: other courses must be at 4000-level or above. A maximum of 9 credits is allowed of 4000-level courses and a maximum of 3 credits of Co-op credits at 5000-level is allowed. For entering with MS option: only courses 5000-level or above are allowed. Courses outside of the Department should be approved by the research advisor as well as Graduate Program Director. Usually, courses offered in Physics, Mathematics, Mechanical Engineering, Biomedical Engineering, Materials Science and Engineering, Computer Science, and Applied Computing can be approved.

[4] Online PhD modality is only allowed after a master's degree in electrical and computer engineering or similar disciplines approved by the Graduate Program Director during admission. All the other rules apply for both on-campus and online PhD students.

[5]Project/research credits may include credits needed to meet the Advanced RCR requirement. All PhD students must take advanced-RCR training. Advanced-RCR must be taken within the first three semesters.

To complete the PhD-ECE degree, students must complete the following milestones:

- Complete all coursework and research credits (see credit requirements above)
- Complete an Advanced RCR training in the first 3 semesters (approved training list is kept by the Graduate School)
- Pass Qualifying Examination
- Pass Research Proposal Examination
- Prepare and Submit Approved Dissertation
- Pass Final Oral Defense

Model Schedule

Semester	Course	Credits
1 - Fall	EE 5200 - Advanced Methods in Power Systems	3
	EE 5230 – Power System Operations	3
	EE 6990 – Doctoral Research	3
	Milestone: • Take advanced RCR Graduate course	
	Totals	9
2 - Spring	EE 5223 - Power System Protection	3

Semester	Course	Credits
	EE 6990 – Doctoral Research	6
	Total	9
3 - Fall	EE 6990 – Doctoral Research	-
	Milestone: • Pass Qualifying Examination	
	Total	-
4 - Spring	EE 6990 - Doctoral Research	-
	Milestone: • Complete all coursework and research credits	
	Total	-
5 - Fall 6 - Spring	EE 6990 - Doctoral Research	-
	Milestone: • Pass Research Proposal Examination	
7 - Fall 8 - Spring	EE 6990 - Doctoral Research	-
	Milestone: • Prepare and Submit Approved Dissertation • Pass Final Oral Defense	

Table 1- Schedule model for PhD-ECE with MS (over 3-4 years)

Courses currently offered online

Semester	Course	Credits
Fall	EE 4173 – Comp Sys Engineering and Perform	3
	EE 4221 – Power System Analysis 1	3
	EE 4227 – Power Electronics	3
	EE 4295 – Intro Propulsion Sys for HEV	3
	EE 5200 – Advanced Methods in Powe Sys	3

Semester	Course	Credits
	EE 5227 – Advanced Power Electronics	3
	EE 5251 – Distribution Engineering II	3
	EE 5290 – Adv Power Systems Protection	3
	EE 5455 – Cybersecurity Industrial Control Systems	3
	EE 5500 – Prob and Stoch Processes	3
	EE 5811 – Automotive Systems	3
	Totals	33
Spring	EE 4219 – Intro to Elec Mach and Drives	3
	EE 4222 – Power System Analysis 2	3
	EE 5220 – Transient Analysis Methods	3
	EE 5223 – Power System Protection	3
	EE 5224 – Power System Protection Lab	1
	EE 5231 – Energy Control Center App	3
	EE 5295 – Adv Propulsion System for HEV	3
	EE 5315 – Cyber Security Auto Sys I	3
	EE 5812 – Automotive Control Systems	3
	EE 6702 – Nonlinear Sys Analysis and Control	3
	Total	28
Summer	EE 4250 – Modern Communication Systems	3
	EE 4272 – Computer Networks	3
	EE 5777– Open-Source 3-D Printing	3
	EE 5250 – Distribution Engineering	3
	EE 5841 – Machine Learning	3
	Total	15

New Course Descriptions

Since the department already offers graduate degrees in Electrical Engineering and in Computer Engineering, no new courses are necessary.

Faculty Qualifications

The curriculum vitae of the faculty members are available on the ECE Faculty Listing.

Graduate Faculty serving this program will be the same as for the existing MS and PhD 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.

Program-specific policies, regulations, and rules

None besides curricular requirements outlined above.

Resources Needed

Library and other learning resources needed

No additional library or learning resources are required.

Suitability of existing space, facilities, and equipment

The ECE Department at Michigan Technological University is well equipped with modern research laboratories. Since the department already offers PhD degrees in Electrical Engineering and in Computer Engineering, no additional equipment is required to implement this proposal.

Program Costs

Degree name changes in printed materials, if applicable, will be phased in over time and the minor costs will be absorbed by the department.

108.1.2: Criteria for Financial Evaluation Proposed Academic Programs

Relation to University Strategic Plan

Relation of program to the university's educational and research goals.

The new PhD program supports Michigan Tech's education and research goals within the university strategic plan. Specifically, "*Continually assess, review, and improve programs and*

develop new offerings in emerging disciplinary and interdisciplinary areas”, *“Develop and enhance pathways to completion of undergraduate and graduate programs*”, and *“Advance interdisciplinary research to address problems of social significance*.”

Consistency with the university's resource allocation criteria.

The proposed program intended to attract new graduate students to the university based on existing instruction and research resources.

Impact on University Enrollment

- **Projected number of students in the program**: Projected enrollment is stable at the initial phase, but we expect growth in the future.
- **Source of new students; in particular, will the students be drawn from existing programs, or will they be students who would otherwise not have come to MTU?**: Both. The graduate student body in ECE is presently majority international students. We anticipate this will be at least steady, however, making the program attractive to a bigger cross section of people with non-traditional science and engineering backgrounds will likely grow both the US citizen and international enrollment. We anticipate that adding online modality to the PhD program will increase enrollment from domestic students, especially from industry professionals.
- **What is the likely correlation between demand for the new program and existing enrollment patterns at MTU?** This program emphasizes preparing students to meet the demands of interdisciplinary expertise in the job market. This will likely attract students from non-ECE backgrounds into the ECE department and thus diversify the existing enrollment patterns at the departmental level. With the decrease in enrollment in international students, the addition of online modality will increase the demand for this program.
- **Current enrollment in the unit:** Current numbers of PhD-EE and PhD-CpE students are 33 and 5, respectively.

Impact on Resources in Home Department

- **Faculty lines:** This program will be supported by existing faculty lines.
- **Faculty and student labs:** Existing research labs are adequate to support this program.
- **Advising:** This will be supported by the existing Graduate Academic Advisor.
- **Assessment:** The ECE graduate program committee will monitor and evaluate the enrollment and student performance of the new program on an annual basis.

Impact on Resources in Other Units Within the University

- **Other academic (e.g., Gen Ed) units with regard to faculty, labs and assessment.** We do not expect any significant impact to other units although some of the existing classes may occasionally see an increase of enrollment by one or two students.
- **Information Technology, the Library, central administration and career planning with respect to the impact on the need for computing services, library resources, advising, record keeping, development of employer relations etc.** There should be no significant impact on other units.

Assessment of the ability to obtain the necessary resources assuming requested funds are obtained

Not applicable as we do not need additional resources.

Past Proposal Outcomes

The ECE department has not initiated any new PhD programs since the PhD-CpE was approved in 2009.

Departmental Budget Contribution

- What is the department's total general fund budget?
    - AY25-26: $3,798,464
- How much tuition does the department generate?
    - $9,173,397 for tuition generated by credit hours taught by ECE in 2022-23 (Fall 2022, Spring 2023, Summer 2023)
    - $17,969,740 for tuition generated by the number of credit hours taken by ECE enrolled students in 2022-23 (Fall 2022, Spring 2023, Summer 2023)

How do the benefits from this program compare to other alternatives that are currently under consideration or development?

The proposed PhD-ECE degree will offer the following benefits:

1. The course sequence will be tailored to meet the needs of students, depending on their individual area of interest.
2. The proposed PhD-ECE degree program will attract students from diverse undergraduate and masters' backgrounds, including but not limited to electrical and computer engineering, other engineering disciplines, and physics.

3. A single PhD-ECE program will be less time consuming to administer than two single programs.