

# ELECTRICAL ENGINEERING, PHD

The Doctor of Philosophy, the highest degree offered by the University, is conferred in recognition of marked scholarship in a broad field of knowledge as well as distinguished critical or creative achievement within a special area of the general field (the special area being the subject of the doctoral dissertation). The Doctor of Philosophy (PhD) program in Electrical Engineering provides a program of coursework and in-depth scholarly research in an area of Electrical Engineering.

The PhD degree requires a minimum of 54 credits beyond the baccalaureate, including a dissertation. The student must also satisfy a residence requirement.

Many of the courses leading toward graduate degrees in CEAS are offered in the late afternoon or evening. So, students can complete much of their coursework on a part-time basis.

## Admission Requirements

### Application Deadlines

Application deadlines vary by program, please review the application deadline chart (<http://uwm.edu/graduateschool/program-deadlines/>) for specific programs. Other important dates and deadlines can be found by using the One Stop calendars (<https://uwm.edu/onestop/dates-and-deadlines/>).

### Admission

The program follows the College's **existing Ph.D. admission requirements**, which are:

- Bachelor's or Master's degree in electrical engineering.
- If you have BS or MS degrees outside of electrical engineering, you may be admitted with no more than two course deficiencies.
- Minimum GPA of 3.0 in the highest degree granted based on a 4.0 scale.
- A brief statement describing your professional goals (i.e., Statement of Purpose, SoP) and two letters of reference.
- The Graduate Record Examination (GRE) is required for all international and domestic applicants.
- International students require proof of English language proficiency.

## Credits and Courses

The electrical engineering doctoral program will be comprised of 54 graduate credits beyond the Bachelor's degree with minimum credit distribution as follows:

Code	Title	Credits
<b>Electrical Engineering Topics</b>		<b>21</b>
<b>Approved Minor Area (within or outside of Electrical Engineering)</b>		<b>6</b>
<b>Approved Electives</b>		<b>9</b>
<b>CEAS Graduate Seminars</b>		
EAS 701	Effective Academic Writing	1
EAS 702	Preparing Future Engineering Faculty & Professionals	2
<b>Doctoral Thesis</b>		<b>15</b>

ELECENG 998	Doctoral Thesis
<b>Total Credits</b>	<b>54</b>

A minimum of 27 credits (including thesis) must be completed in the Ph.D. program at UWM, and a minimum of 21 credits, excluding dissertation, must be at the 700 level or higher.

Courses are chosen by the student in consultation with their advisors.

The minor must be taken using courses outside of Electrical Engineering (and excluding cross-listed courses) in other CEAS programs, or in the physical sciences, management sciences, or mathematics. However, in some cases there may be a subdomain of Electrical Engineering that is clearly separate yet necessary and complementary to their major area courses. In this case, the student may create a Program of Study that specifies a set of minor courses taken from within Electrical Engineering. These minor courses must be approved by the advisor \*prior\* to taking any of them.

A maximum of 24 credits may be considered for transfer from prior graduate work, including a Master's degree earned at UWM or elsewhere provided the course work taken falls within the appropriate areas and has earned a grade of "B" or better. Students entering the program without an applicable Master's degree are limited to a maximum transfer of 9 credits for courses taken elsewhere.

Independent study courses (699 and 999) may be included in the minimum course credit requirements provided approval by the CEAS Graduate Studies Office has been obtained prior to registration in such courses. Typically no more than six credits of independent study are allowed in the PhD program. Guidelines on acceptable independent study courses are available in the CEAS Graduate Studies Office.

Code	Title	Credits
<b>Graduate Course List</b>		
ELECENG 410G	Digital Signal Processing	3
ELECENG 420G	Random Signals and Systems	3
ELECENG 421G	Communication Systems	3
ELECENG 430G	Energy Modeling	3
ELECENG 436G	Introduction to Medical Instrumentation	3
ELECENG 437G	Introduction to Biomedical Imaging	3
ELECENG 439G	Introduction to Biomedical Optics	3
ELECENG 451G	Introduction to VLSI Design	3
ELECENG 457G	Digital Logic Laboratory	3
ELECENG 458G	Computer Architecture	3
ELECENG 461G	Microwave Engineering	3
ELECENG 464G	Fundamentals of Photonics	3
ELECENG 465G	Broadband Optical Networks	3
ELECENG 471G	Electric Power Systems	3
ELECENG 474G	Introduction to Control Systems	4
ELECENG 481G	Electronic Materials	3
ELECENG 490G	Topics in Electrical Engineering:	1-3
ELECENG 541G	Integrated Circuits and Systems	3
ELECENG 565G	Optical Communication	3
ELECENG 572G	Power Electronics	3
ELECENG 574G	Intermediate Control Systems	3
ELECENG 575G	Analysis of Electric Machines and Motor Drives	3

ELECENG 699G	Independent Study	1-3
ELECENG 700	CEAS Graduate Seminar	1-3
ELECENG 701	Advanced Linear System Analysis	3
ELECENG 710	Artificial Intelligence	3
ELECENG 711	Introduction to Machine Learning	3
ELECENG 712	Image Processing	3
ELECENG 716	Tomography: Imaging and Image Reconstruction	3
ELECENG 717	Tomography: Image Quality and Artifact Correction	3
ELECENG 718	Nonlinear Control Systems	3
ELECENG 721	Digital Communications	3
ELECENG 733	Sensors and Systems	3
ELECENG 737	Medical Imaging Signals and Systems	3
ELECENG 741	Electromagnetic Fields and Waves	3
ELECENG 742	Electromagnetic Wave Theory	3
ELECENG 755	Information and Coding Theory	3
ELECENG 758	Advanced Computer Architecture	3
ELECENG 760	Computer Systems Performance Evaluation	3
ELECENG 762	Fault-Tolerant Computing	3
ELECENG 765	Introduction to Fourier Optics and Optical Signal Processing	3
ELECENG 766	Introduction to Nonlinear Optics	3
ELECENG 781	Advanced Synchronous Machinery	3
ELECENG 810	Foundations for Advanced Machine Learning and Signal Processing	3
ELECENG 816	Optimal Control Theory	3
ELECENG 819	Adaptive Control Theory	3
ELECENG 872	Computer Analysis of Electric Power Systems	3
ELECENG 880	Bioengineering Seminar	1
ELECENG 888	Candidate for Degree	0
ELECENG 890	Special Topics:	3
ELECENG 990	Masters Thesis	1-9
ELECENG 998	Doctoral Thesis	1-12
ELECENG 999	Advanced Independent Study	1-3

## Additional Requirements

### Major Professor as Advisor

The Graduate School requires that the student must have a major professor to advise, supervise, and approve the program of study before registering for courses. The department will assign the incoming student to an initial Program Advisor at the time of admission. Prior to the completion of 12 credits (9 credits for part-time students), the student must select a major professor who will be the student's thesis advisor. The student, in consultation with the major professor, develops a proposed program of studies which is submitted to the Graduate Program Representative for approval. For subsequent changes, the student must file a revised program of study for approval.

### Foreign Language

There is no foreign language requirement for the degree.

## Residence

The program residence requirement is satisfied either by completing 8 or more graduate credits in each of two consecutive semesters, inclusive of summer sessions, or by completing 6 or more graduate credits in each of three consecutive semesters, exclusive of summer sessions.

## Qualifying Examination

Each student in the program must take and pass a Qualifying Examination to demonstrate that the student is qualified for doctoral-level work. The Qualifying Examination is a written exam and is structured in two parts: Part 1 and Part 2. The examination is offered twice a year during the regular academic year. The content of the examination reflects the major areas of Electrical Engineering.

Students entering with only a bachelor's degree or with a master's degree in an area unrelated to their major area may take the Qualifying Examination for the first time after earning 12 credits of graduate work at UWM and must successfully pass the exam before earning 30 credits of graduate work at UWM.

Students admitted after completing an appropriate master's degree must take this examination no later than the semester immediately after 18 credits of graduate work have been earned at UWM.

A student may take the Qualifying Examination twice. On the first attempt, the student must attempt both Part 1 and Part 2 of the examination.

- If the student passes both parts, then the student has passed the entire examination and will be permitted to proceed toward the Doctor of Philosophy degree.
- If the student fails both parts, then the student must take the entire exam again at its next offering.
- If a student passes only one of the two parts, then the student must take the examination again at its next offering, but may choose to take only the part of the examination that was not passed on the first attempt.
- If a passing grade is not obtained on the second attempt of the Qualifying Examination, the student will not be permitted to proceed toward the Doctor of Philosophy degree.

A student who fails the qualifying exam twice is subject to dismissal from the PhD in Electrical Engineering program. A student may appeal the failure and dismissal within 30 days of being notified of the failure. If the student does not appeal or the appeal is not granted, the College will recommend to the Graduate School that the student be dismissed. A student who is dismissed from the PhD in Electrical Engineering program because of failing the qualifying exam may not be enrolled in the PhD in Electrical Engineering program for a complete calendar year. This does not preclude the student from being enrolled in any other degree program offered by the University. A student who wishes to re-enroll in the program after a calendar year has passed must apply as any other student would, including payment of fees. A student readmitted after having failed the qualifying exam twice must take the qualifying exam in the first semester of matriculation and this will count as the student's first attempt at the exam. The student may appeal this requirement prior to the first scheduled day of classes. If the student fails the qualifying exam on this first attempt, the student is permitted the customary second attempt as described above. All appeals must be in writing and directed to the CEAS Associate Dean for Academic Affairs.

## Doctoral Program Committee

The Doctoral Program Committee is proposed by the major professor in consultation with the student and the department. The Committee must include at least five graduate faculty (three from major area, one from minor area, and one from any area, including the major and minor areas). The last member may be a person from outside the University (such as another university, a research laboratory, or a relevant industrial partner), provided that person meets Graduate School requirements. The Committee may have more than five members, provided that the majority of the Committee members are from the student's major field. The Major Professor is generally a faculty member from the EECS Department who has Graduate Faculty status.

## Doctoral Preliminary Examination

A student is admitted to candidacy only after successful completion of the doctoral preliminary examination conducted by the Doctoral Program Committee. This examination, which normally is oral, must be taken before the completion of 48 credits of graduate work toward the Doctor of Philosophy degree in Electrical Engineering and should be taken within the first five years in the program. Prior to the examination, the student must present a proposal for a doctoral dissertation project. The examination may cover both graduate course material and items related to the proposed dissertation project.

## Dissertation and Dissertator Status

The student must carry out a creative effort in the major area under the supervision of the major professor and report the results in an acceptable dissertation. The effort of the student and the major professor to produce the dissertation is reflected in the PhD in Electrical Engineering program requirement that the student complete at least 18 credits of doctoral thesis. After the student has successfully completed all degree requirements except the dissertation, the student may apply for Dissertator Status.

Achieving Dissertator Status requires successful completion of the Doctoral Preliminary Examination and prior approval of the student's advisor and the Doctoral Program Committee of a dissertation proposal that outlines the scope of the project, the research method, and the goals to be achieved. Any proposal that may involve a financial commitment by the University also must be approved by the Office of the Dean. After having achieved Dissertator Status, the student must continue to register for 3 credits of doctoral thesis per semester during the academic year until the dissertation is completed.

## Dissertation Defense

The final examination, which is oral, consists of a defense of the dissertation project. The doctoral defense examination may only be taken after all coursework and other requirements have been completed. The student must have Dissertator Status at the time of the defense.

## Time Limit

All degree requirements must be completed within ten years from the date of initial enrollment in the doctoral program.