

ELECTRICAL ENGINEERING, MS

Banner Code: VS-MS-ELEN

Academic Advising

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Electrical Engineering is the discipline that drives our increasingly-connected society. Electrical engineers design systems, devices, and algorithms that contribute innovative solutions across a broad spectrum of applications. The Electrical Engineering program offers the following concentrations: bioengineering, communications and networking, control and robotics, electronics, signal processing, and space-based systems. The graduates of our program develop reliable, secure, and high-speed communication networks and systems; apply modern signal processing algorithms to extract information from images, audio, video, sonar, and radio signals; apply control theory and robotics foundations to applications such as autonomous vehicles, humanoid robots, and multi-agent systems; design nanoscale devices for the highly integrated circuits that drive the Internet of Things, health-monitoring devices, smartphones, tablets, and modern-day computer systems; develop prosthetic devices, brain-machine interfaces, and systems to ameliorate neurological disorders. Students in this program will develop theoretical foundations, analytical capabilities, and practical hands-on skills in their chosen field of specialization. They will also develop the oral and written communication skills necessary to articulate their ideas and succeed as entrepreneurs, practicing engineers, or technical managers in high-tech companies.

Admissions & Policies

Admissions Requirements

To be considered for admission to the degree, applicants should have a baccalaureate degree in electrical engineering, computer engineering, or a closely-related discipline from an accredited program, and have earned a GPA of B or better during the last 60 credits. Other requirements are as follows:

- Two letters of recommendation, preferably from academic references or references in industry or government who hold advanced degrees and are familiar with the applicant's professional accomplishments
- Resume and detailed statement of career goals and aspirations
- For students who have not earned a bachelor's degree from a U.S. university, satisfactory performance on the GRE
- For applicants who have not earned an academic degree in an English-speaking country (as defined in the GMU Catalog), a satisfactory score on any of the English proficiency examinations accepted by Mason, namely, TOEFL, IELTS, or PTE. Satisfactory scores are specific to Volgenau School of Engineering and are listed

here (<https://catalog.gmu.edu/admissions/international-students/#text>).

Students with BS or MS degrees in ECE-related disciplines (for example, bioengineering, computer science, cyber security engineering, mathematics, mechanical engineering, or physics) are encouraged to apply for admission. Domestic students may be admitted provisionally and required to satisfy provisional requirements before taking advanced coursework. Such students may also be advised to take some courses from the undergraduate electrical engineering curriculum, according to their intended specialization and specific backgrounds.

Policies

Student Advising

Students can select a concentration from those available in the MS degree program at the time of application to the program or later during their studies. In the former case, students are assigned an academic advisor from the selected concentration at the time of the admission, in the latter case, students can petition for a change of an academic advisor to match their concentration choice.

Plan of Study

Before completing 6 credit hours of coursework, each student must submit to the department a plan of study that has been approved by the academic advisor. This plan should be kept up to date by regular consultation with the academic advisor. A final, signed version of the plan must be turned in when the student submits a graduation application.

Requirements

Degree Requirements

Total credits: 30

Students must complete a minimum of 30 graduate credits beyond the bachelor's degree. The plan of study for the degree must fulfill the following requirements:

Core Course Requirement

Code	Title	Credits
Required Courses		
Select 15 credits from the following:		15
ECE 511	Computer Architecture	
ECE 521	Linear Systems and Control	
ECE 526	Neural Engineering	
ECE 528	Introduction to Random Processes in Electrical and Computer Engineering	
ECE 535	Digital Signal Processing	
ECE 542	Computer Network Architectures and Protocols	
ECE 580	Small Spacecraft Engineering	
ECE 584	Semiconductor Device Fundamentals	
ECE 586	Digital Integrated Circuits	
ECE 587	Design of Analog Integrated Circuits	
ECE 621	Systems Identification	

ECE 630	Statistical Communication Theory	
ECE 799	Master's Thesis ¹	
Total Credits		15

¹ See Thesis/Scholarly Paper option.

Concentration Requirement

Accomplished by choosing one of the concentrations, and then meeting course requirements for this concentration with the grade B or better in each course. For each concentration, related ECE 590 Selected Topics in Engineering courses can be used in addition to all explicitly listed 500-level courses, and related ECE 699 Advanced Topics in Electrical and Computer Engineering courses in addition to all explicitly listed 600 level or above courses, subject to approval by the student's academic advisor. With assistance from their advisors, students may petition the graduate program coordinator to approve a specialization area of their own design, not fulfilling the requirements of any concentration.

Available Concentrations

- Concentration in Bioengineering (BIOE)
- Concentration in Communications and Networking (CONE)
- Concentration in Control and Robotics (CORO)
- Concentration in Electronics (ELE)
- Concentration in Signal Processing (SIGP)
- Concentration in Space-Based Systems (SBSY)

Concentration in Bioengineering (BIOE)

Code	Title	Credits
Required Courses		
ECE 526	Neural Engineering	3
ECE 538	Medical Imaging	3
Total Credits		6

Code	Title	Credits
Electives		
Select at least three courses from the following, including two courses at the 600 level or above:		9

BENG 501	Bioengineering Research Methods	
BENG 636	Advanced Biomedical Signal Processing	
BENG 738	Advanced Medical Image Processing	
ECE 521	Linear Systems and Control	
ECE 528	Introduction to Random Processes in Electrical and Computer Engineering	
ECE 530	Sensor Engineering	
ECE 535	Digital Signal Processing	
ECE 537	Introduction to Digital Image Processing (DIP)	
ECE 542	Computer Network Architectures and Protocols	
ECE 620	Optimal Control Theory	
ECE 621	Systems Identification	
ECE 622	Kalman Filtering with Applications	
ECE 734	Detection and Estimation Theory	
ECE 738	Advanced Digital Signal Processing	
ECE 754	Optimum Array Processing I	
Total Credits		9

Concentration in Communications and Networking (CONE)

Code	Title	Credits
Required Courses		
ECE 528	Introduction to Random Processes in Electrical and Computer Engineering	3
ECE 542	Computer Network Architectures and Protocols	3
Total Credits		6

Code	Title	Credits
Electives		
Select at least three courses from the following, including two courses at the 600 level or above:		9
ECE 508	Internet of Things	
ECE 531	Introduction to Wireless Communications and Networks	
ECE 567	Optical Fiber Communications	
ECE 630	Statistical Communication Theory	
ECE 631	Software-Defined Radio	
ECE 633	Error Control Coding	
ECE 639	Satellite Communications	
ECE 642	Design and Analysis of Computer Communication Networks	
ECE 643	Network Switching and Routing	
ECE 646	Applied Cryptography	
ECE 728	Random Processes in Electrical and Computer Engineering	
ECE 731	Digital Communications	
ECE 732	Mobile Communication Systems	
ECE 734	Detection and Estimation Theory	
ECE 741	Wireless Networks	
ECE 742	High-Speed Networks	
ECE 751	Information Theory	
Total Credits		9

Concentration in Control and Robotics (CORO)

Code	Title	Credits
Required Courses		
ECE 521	Linear Systems and Control	3
ECE 528	Introduction to Random Processes in Electrical and Computer Engineering	3
Total Credits		6

Code	Title	Credits
Electives		
Select at least three courses from the following list: ¹		9
ECE 612	Real-Time Embedded Systems	
ECE 619	Nonlinear Systems and Control	
ECE 620	Optimal Control Theory	
ECE 621	Systems Identification	
ECE 622	Kalman Filtering with Applications	
ECE 627	Adaptive Control	
ECE 635	Adaptive Signal Processing	

ECE 673	Discrete Event Systems	
Total Credits		9

¹ At least two courses must be different than ECE 612, ECE 635, and ECE 673.

Concentration in Electronics (ELE)

Code	Title	Credits
Required Courses		
ECE 584	Semiconductor Device Fundamentals	3
ECE 586	Digital Integrated Circuits	3
Total Credits		6

Code	Title	Credits
Electives		
Select at least three courses from the following, including two courses at the 600 level or above:		9
ECE 513	Applied Electromagnetic Theory	
ECE 565	Introduction to Optical Electronics	
ECE 587	Design of Analog Integrated Circuits	
ECE 681	VLSI Design for ASICs	
ECE 684	MOS Device Electronics	
ECE 685	Nanoelectronics	
ECE 686	Sensor Device Technology	
ECE 780	Radio Frequency Electronics	
Total Credits		9

Concentration in Signal Processing (SIGP)

Code	Title	Credits
Required Courses		
ECE 528	Introduction to Random Processes in Electrical and Computer Engineering	3
ECE 535	Digital Signal Processing	3
Total Credits		6

Code	Title	Credits
Electives		
Select at least three courses from the following, including two courses at the 600 level or above:		9
ECE 521	Linear Systems and Control	
ECE 527	Learning From Data	
ECE 530	Sensor Engineering	
ECE 537	Introduction to Digital Image Processing (DIP)	
ECE 538	Medical Imaging	
ECE 545	Digital System Design with VHDL	
ECE 621	Systems Identification	
ECE 622	Kalman Filtering with Applications	
ECE 630	Statistical Communication Theory	
ECE 631	Software-Defined Radio	
ECE 633	Error Control Coding	
ECE 635	Adaptive Signal Processing	
ECE 728	Random Processes in Electrical and Computer Engineering	
ECE 731	Digital Communications	

ECE 732	Mobile Communication Systems	
ECE 734	Detection and Estimation Theory	
ECE 738	Advanced Digital Signal Processing	
ECE 740	Digital Signal Processing Hardware Architectures	
ECE 751	Information Theory	
ECE 754	Optimum Array Processing I	
Total Credits		9

Concentration in Space-Based Systems (SBSY)

Code	Title	Credits
Required Courses		
ECE 511	Computer Architecture	3
ECE 580	Small Spacecraft Engineering	3
Total Credits		6

Code	Title	Credits
Electives		
Select at least three courses from the following, including two courses at the 600 level or above:		9
ECE 510	Real-Time Concepts	
ECE 513	Applied Electromagnetic Theory	
ECE 521	Linear Systems and Control	
ECE 528	Introduction to Random Processes in Electrical and Computer Engineering	
ECE 530	Sensor Engineering	
ECE 535	Digital Signal Processing	
ECE 545	Digital System Design with VHDL	
ECE 550	System Engineering Design	
ECE 612	Real-Time Embedded Systems	
ECE 615	Software/Hardware Codesign	
ECE 620	Optimal Control Theory	
ECE 622	Kalman Filtering with Applications	
ECE 627	Adaptive Control	
ECE 630	Statistical Communication Theory	
ECE 631	Software-Defined Radio	
ECE 635	Adaptive Signal Processing	
ECE 639	Satellite Communications	
ECE 754	Optimum Array Processing I	
SYST 682	Space Systems Engineering	
Total Credits		9

Upper-Level Course Requirement

A minimum of 9 credit hours of ECE courses at the 600 level or above, other than ECE 698, ECE 798, and ECE 799 (including, but not limited to, the selected concentration elective), with the grade B or better in each course.

ECE Course Requirement

A maximum of 6 credits of non-ECE courses may be used to fulfill degree requirements, subject to prior approval by the student's academic advisor, in the form of a plan of study signed by the advisor and submitted to the ECE Office.

Electives

Electives can be chosen from among all ECE (<http://catalog.gmu.edu/courses/ece/>) graduate courses, as well as related graduate courses with other designations. The students are encouraged to discuss their choice of electives with their academic advisor prior to the registration.

GPA Requirements

A maximum of 6 credits of courses with grades of C or B- may be applied toward the degree. The student must present a GPA of at least 3.00 for all courses submitted for the degree.

Seminar Requirement

Graduate students are expected to participate actively in the exchange of knowledge and ideas in their discipline. Towards this objective, all degree candidates must attend a minimum of 6 graduate seminars approved for the degree program. Approved seminars are publicized on the departmental website.

To demonstrate completion of the seminar requirement, students must register for ECE 795 Engineering Seminar in their final semester. The department office will verify that the seminar requirement has been met and submit a grade of S (satisfactory) upon completion of the requirement. Students who have not met the seminar requirement in their final semester must continue to register for ECE 795 in subsequent semesters until the requirement is met.

Thesis/Scholarly Paper Option

To complete the program, students may select one of the following options:

Thesis Option

Students who select this option must complete:

Code	Title	Credits
ECE 799	Master's Thesis	6
Coursework		24
Total Credits		30

The thesis is particularly recommended for those students who wish to develop and document their research skills or contemplate subsequent enrollment in a PhD program. The thesis involves a research effort, which is conducted under the guidance of a faculty advisor. Choosing the thesis option requires approval of a full-time faculty member willing to serve as a thesis advisor. The topic and scope of the thesis must be approved by the thesis advisor. In some cases, permission may be granted to complete a portion of the work at the student's place of employment. The final written thesis and oral defense are approved by the student's advisory committee.

This committee consists of at least three full-time faculty members, including two from the student's concentration, and one from outside the concentration. Thesis students may not register for ECE 798 Research Project. Students must register for at least 3 credits of ECE 799 Master's Thesis for their first thesis semester. Following their first thesis semester, they must register for at least 1 credit of ECE 799 Master's Thesis each fall and spring semester until graduation.

Scholarly Paper Option

Students who select to complete their degree program with a scholarly paper must:

Code	Title	Credits
Complete 30 credits of coursework		30
ECE 797	Scholarly Paper	0
Enroll in a 600-level or above course requiring a research project		
Write a Scholarly Paper project report and present findings as part of the course requirements		
Total Credits		30

An acceptable scholarly paper must be technically sound, adhere to accepted formatting standards for technical reports, and contain a significant literature review evidenced by a comprehensive list of cited references.

A list of courses requiring projects that can be used to satisfy the scholarly paper requirement will be published on the department website. Scholarly papers must be individual written project reports – not group projects. To qualify as a scholarly paper an oral presentation of the project is required. A passing grade for the project, reflecting both the written report and the oral presentation, satisfies the scholarly paper requirement.

A successful scholarly paper will be recorded by awarding a satisfactory (S) grade for ECE 797 Scholarly Paper. Students are eligible to attempt the scholarly paper and register for ECE 797 Scholarly Paper after completion of 18 hours of coursework. Students choosing the scholarly paper option are not eligible for graduation until they have received a final, passing grade for ECE 797 Scholarly Paper.

Accelerated Master's

Computer Engineering, BS/Electrical Engineering, Accelerated MS

Overview

The university offers highly-qualified students in the Computer Engineering, BS (<http://catalog.gmu.edu/colleges-schools/engineering/electrical-computer/computer-engineering-bs/>) the option of obtaining an accelerated Electrical Engineering, MS.

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees (<http://catalog.gmu.edu/policies/academic/graduate-policies/#ap-6-7>). For policies governing all graduate degrees, see AP.6 Graduate Policies (<http://catalog.gmu.edu/policies/academic/graduate-policies/>).

Admission Requirements

Students in the Computer Engineering, BS (<http://catalog.gmu.edu/colleges-schools/engineering/electrical-computer/computer-engineering-bs/>) program may apply to this option if they have earned 75 undergraduate credits with an overall GPA of 3.00. Criteria for admission are identical to criteria for admission to the Electrical Engineering, MS program.

Accelerated Option Requirements

Students must complete all credits that satisfy the requirements for the BS and MS programs, with 6 credits overlap.

Students take 6 credits of 500-level courses as part of their technical electives or substitutes for required courses as part of their 126-

credit undergraduate program. The specific courses that may be taken and applied to the accelerated program will be specified by the ECE Department.

Students may take additional graduate-level courses as part of their BS technical electives with advisor approval. These additional graduate-level courses will not count toward the MS degree.

Degree Conferral

Students must apply the semester before they expect to complete the BS requirements to have the BS degree conferred. In addition, at the beginning of the student's final undergraduate semester, students must complete a Bachelor's/Accelerated Master's Transition form that is submitted to the Office of the University Registrar and the VSE Graduate Admissions Office. At the completion of MS requirements, a master's degree is conferred.

Electrical Engineering, BS/Electrical Engineering, Accelerated MS

Overview

Highly-qualified students in the Electrical Engineering, BS (<http://catalog.gmu.edu/colleges-schools/engineering/electrical-computer/electrical-engineering-bs/>) have the option of obtaining an accelerated Electrical Engineering, MS.

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees (<http://catalog.gmu.edu/policies/academic/graduate-policies/#ap-6-7>). For policies governing all graduate degrees, see AP.6 Graduate Policies (<http://catalog.gmu.edu/policies/academic/graduate-policies/#text>).

Admission Requirements

Students in the Electrical Engineering, BS (<http://catalog.gmu.edu/colleges-schools/engineering/electrical-computer/electrical-engineering-bs/>) program may apply to this option if they have earned 75 undergraduate credits with an overall GPA of 3.00. Criteria for admission are identical to criteria for admission to the Electrical Engineering, MS program.

Accelerated Option Requirements

Students must complete all credits that satisfy the requirements for the BS and MS programs, with 6 credits overlap.

Students take 6 credits of 500-level courses as part of their technical electives or substitutes for required courses as part of their 121-credit undergraduate program. The specific courses that may be taken and applied to the accelerated program will be specified by the ECE Department.

Students may take additional graduate-level courses as part of their BS technical electives with advisor approval. These additional graduate-level courses will not count toward the MS degree.

Degree Conferral

Students must apply the semester before they expect to complete the BS requirements to have the BS degree conferred. In addition, at the beginning of the student's final undergraduate semester, students must complete a Bachelor's/Accelerated Master's Transition form that is submitted to the Office of the University Registrar and the VSE Graduate

Admissions Office. At the completion of MS requirements, a master's degree is conferred.

Mechanical Engineering, BS/Electrical Engineering, Accelerated MS

Overview

The university offers highly-qualified students in the Mechanical Engineering, BS (<http://catalog.gmu.edu/colleges-schools/engineering/mechanical/mechanical-engineering-bs/>) the option of obtaining an accelerated Electrical Engineering, MS.

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees (<http://catalog.gmu.edu/policies/academic/graduate-policies/#ap-6-7>). For policies governing all graduate degrees, see AP.6 Graduate Policies (<http://catalog.gmu.edu/policies/academic/graduate-policies/#text>).

Admission Requirements

Students in the Mechanical Engineering, BS (<http://catalog.gmu.edu/colleges-schools/engineering/mechanical/mechanical-engineering-bs/>) program may apply for this option if they have earned 90 undergraduate credits, with an overall GPA of at least 3.25, and passed MATH 203 Linear Algebra and STAT 346 Probability for Engineers, or their equivalents, with the grade C or better. Criteria for admission are identical to criteria for admission to the Electrical Engineering, MS program.

Accelerated Option Requirements

Students must complete all credits that satisfy the requirements for the BS and MS programs, with 6 credits overlapping.

Students take 6 credits of 500-level ECE (<http://catalog.gmu.edu/courses/ece/>) or SYST (<http://catalog.gmu.edu/courses/syst/>) courses as part of their technical electives or substitutes for required courses in the Mechanical Engineering, BS (<http://catalog.gmu.edu/colleges-schools/engineering/mechanical/mechanical-engineering-bs/>) program.

Specifically, students are encouraged to take two of the following courses:

Code	Title	Credits
ECE 521	Linear Systems and Control	3
ECE 526	Neural Engineering	3
ECE 527	Learning From Data	3
ECE 528	Introduction to Random Processes in Electrical and Computer Engineering	3
ECE 580	Small Spacecraft Engineering	3
SYST 521	Network Analysis	3

Degree Conferral

Students must apply the semester before they expect to complete the BS requirements to have the BS degree conferred. In addition, at the beginning of the student's final undergraduate semester, students must complete a Bachelor's/Accelerated Master's Transition form that is submitted to the Office of the University Registrar and the VSE Graduate Admissions Office. At the completion of MS requirements, a master's degree is conferred.