

COMPUTER ENGINEERING, MS

Banner Code: VS-MS-CPE

Academic Advising

MSN 1G5
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Computer Engineering involves knowledge of hardware and software development. The students learn how to design new generations of computers, as well as embedded computing systems, such as those found in smartphones, cars, appliances, computer networks, smart factories, and the internet-of-things. The program covers the entire digital integrated circuit design process targeting Field Programmable Gate Arrays (FPGAs) and Application Specific Integrated Circuits (ASICs), using various optimization criteria, such as speed, cost, power, energy, reliability, and security. It also encompasses the complete software development process targeting microcontrollers, microprocessors, multi-cores, and Graphics Processing Units (GPUs). It teaches students how to efficiently partition the system into software and hardware components, and develop high-performance interfaces between these two parts. Project-oriented courses and labs expose students to modern computer-aided design tools for hardware and software design. The students master the art of writing comprehensive technical reports and giving successful oral presentations. The computer engineering program offers the following concentrations: computer architecture and embedded systems, computer networks, digital signal processing, digital system design, hardware security and cryptographic engineering, internet of things and network security, and space-based systems.

Admissions & Policies

Admissions

Requirements

To be considered for admission to the degree, applicants should have a baccalaureate degree in computer engineering, electrical 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 here (<http://catalog.gmu.edu/admissions/international-students/#text>)), 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, 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 or computer engineering curriculum, according to their intended concentration 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 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
Select 15 credits from the following:		15
ECE 505	Hardware Security	
ECE 508	Internet of Things	
ECE 511	Computer Architecture	
ECE 516	Mobile Systems and Applications	
ECE 527	Learning From Data	
ECE 528	Introduction to Random Processes in Electrical and Computer Engineering	
ECE 531	Introduction to Wireless Communications and Networks	
ECE 535	Digital Signal Processing	
ECE 542	Computer Network Architectures and Protocols	
ECE 545	Digital System Design with VHDL	
ECE 611	Advanced Computer Architecture	

ECE 646	Applied Cryptography	
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 can be used 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 Computer Architecture and Embedded Systems (CAES)
- Concentration in Computer Networks (CNWK)
- Concentration in Digital Signal Processing (DISP)
- Concentration in Digital System Design (DSYD)
- Concentration in Hardware Security and Cryptographic Engineering (HSCE)
- Concentration in Internet of Things and Network Security (INNS)
- Concentration in Space-Based Systems (SBSY)

Concentration in Computer Architecture and Embedded Systems (CAES)

Code	Title	Credits
Required Courses		
ECE 511	Computer Architecture	3
ECE 516	Mobile Systems and Applications	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
CS 571	Operating Systems	
CS 583	Analysis of Algorithms	
ECE 508	Internet of Things	
ECE 510	Real-Time Concepts	
ECE 545	Digital System Design with VHDL	
ECE 611	Advanced Computer Architecture	
ECE 612	Real-Time Embedded Systems	
ECE 615	Software/Hardware Codesign	
ECE 616	Advanced Mobile Systems and Applications	
Total Credits		9

Concentration in Computer Networks (CNWK)

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 633	Error Control Coding	
ECE 642	Design and Analysis of Computer Communication Networks	
ECE 643	Network Switching and Routing	
ECE 646	Applied Cryptography	
ECE 741	Wireless Networks	
ECE 742	High-Speed Networks	
ECE 746	Advanced Applied Cryptography	

Total Credits 9

Concentration in Digital Signal Processing (DISP)

Code	Title	Credits
Required Courses		
ECE 535	Digital Signal Processing	3
ECE 545	Digital System Design with VHDL	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 527	Learning From Data	
ECE 528	Introduction to Random Processes in Electrical and Computer Engineering	
ECE 530	Sensor Engineering	
ECE 531	Introduction to Wireless Communications and Networks	
ECE 537	Introduction to Digital Image Processing (DIP)	
ECE 615	Software/Hardware Codesign	
ECE 631	Software-Defined Radio	
ECE 633	Error Control Coding	
ECE 635	Adaptive Signal Processing	
ECE 645	Computer Arithmetic	
ECE 738	Advanced Digital Signal Processing	
ECE 740	Digital Signal Processing Hardware Architectures	

Total Credits 9

Concentration in Digital System Design (DSYD)

Code	Title	Credits
Required Courses		
ECE 511	Computer Architecture	3
ECE 545	Digital System Design with VHDL	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 505	Hardware Security	
ECE 527	Learning From Data	
ECE 586	Digital Integrated Circuits	
ECE 615	Software/Hardware Codesign	
ECE 645	Computer Arithmetic	
ECE 681	VLSI Design for ASICs	
ECE 682	VLSI Test Concepts	
ECE 740	Digital Signal Processing Hardware Architectures	
Total Credits		9

Concentration in Hardware Security and Cryptographic Engineering (HSCE)

Code	Title	Credits
Required Courses		
ECE 505	Hardware Security	3
ECE 545	Digital System Design with VHDL	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 511	Computer Architecture	
ECE 527	Learning From Data	
ECE 542	Computer Network Architectures and Protocols	
ECE 586	Digital Integrated Circuits	
ECE 615	Software/Hardware Codesign	
ECE 633	Error Control Coding	
ECE 645	Computer Arithmetic	
ECE 646	Applied Cryptography	
ECE 681	VLSI Design for ASICs	
ECE 746	Advanced Applied Cryptography	
ECE 747	Cryptographic Engineering	
Total Credits		9

Concentration in Internet of Things & Network Security (INNS)

Code	Title	Credits
Required Courses		
ECE 508	Internet of Things	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 510	Real-Time Concepts	
ECE 511	Computer Architecture	
ECE 530	Sensor Engineering	
ECE 611	Advanced Computer Architecture	
ECE 612	Real-Time Embedded Systems	
ECE 633	Error Control Coding	
ECE 642	Design and Analysis of Computer Communication Networks	
ECE 646	Applied Cryptography	
ECE 746	Advanced Applied Cryptography	
ECE 747	Cryptographic Engineering	
SWE 619	Object-Oriented Software Specification and Construction	
SWE 681	Secure Software Design and Programming	
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 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 611	Advanced Computer Architecture	
ECE 612	Real-Time Embedded Systems	
ECE 615	Software/Hardware Codesign	
ECE 631	Software-Defined Radio	
ECE 635	Adaptive Signal Processing	
ECE 646	Applied Cryptography	
SYST 682	Space Systems Engineering	
ECE 740	Digital Signal Processing Hardware Architectures	
ECE 747	Cryptographic Engineering	
Total Credits		9

Upper-Level Course Requirement

A minimum of 9 credit hours of ECE (<http://catalog.gmu.edu/courses/ece/>) or CS (<http://catalog.gmu.edu/courses/cs/>) courses at the 600 level or above, other than ECE 799 (including, but not limited to, the selected concentration electives), with the grade B or better in each course. No more than 3 credit hours of either ECE 698 or ECE 798 may be used to fulfill this requirement.

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. Additional 6 credit hours of CFRS (<http://catalog.gmu.edu/courses/cfrs/>), CS (<http://catalog.gmu.edu/courses/cs/>), ISA (<http://catalog.gmu.edu/courses/isa/>), or SWE (<http://catalog.gmu.edu/courses/swe/>) courses may be used to fulfill degree requirements, subject to the same approval process.

Electives

Electives can be chosen from among all 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 degree conferral.

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 webpage.

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 Engineering Seminar 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 affiliated with the MS in Computer Engineering Program, one of whom must be from the ECE Department. 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/Computer 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 Computer 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 Computer 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.

Computer Science, BS/Computer Engineering, Accelerated MS Overview

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

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees. For policies governing all graduate degrees, see AP.6 Graduate Policies.

Admission Requirements

Students in the Computer Science, BS program may apply for this option if they have earned 75 undergraduate credits with an overall GPA of at least 3.00. Criteria for admission are identical to criteria for admission to the Computer 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 CS (<http://catalog.gmu.edu/courses/cs/>) courses as part of their technical electives or substitutes for required courses in

the Computer Science, BS (<http://catalog.gmu.edu/colleges-schools/engineering/computer-science/computer-science-bs/>) program.

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

Code	Title	Credits
CS 571	Operating Systems ¹	3
ECE 508	Internet of Things	3
ECE 511	Computer Architecture	3
ECE 516	Mobile Systems and Applications	3
ECE 527	Learning From Data	3
ECE 542	Computer Network Architectures and Protocols	3

¹ CS 471 and CS 571 should not be simultaneously used to fulfill the requirements of the Computer Science, BS (<http://catalog.gmu.edu/colleges-schools/engineering/computer-science/computer-science-bs/>) program.

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.

Cyber Security Engineering, BS/Computer Engineering, Accelerated MS Overview

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

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

Admission Requirements

Students in the Cyber Security Engineering, BS (<http://catalog.gmu.edu/colleges-schools/engineering/cyber-security-engineering/cyber-security-engineering-bs/>) program may apply for this option if they have earned 75 undergraduate credits with an overall GPA of at least 3.00. Criteria for admission are identical to criteria for admission to the Computer 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 CS (<http://catalog.gmu.edu/courses/cs/>) courses as part of their technical electives or substitutes for required courses in the Cyber Security Engineering, BS (<http://catalog.gmu.edu/colleges->

schools/engineering/cyber-security-engineering/cyber-security-engineering-bs/) program.

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

Code	Title	Credits
CS 571	Operating Systems	3
ECE 505	Hardware Security	3
ECE 508	Internet of Things	3
ECE 511	Computer Architecture	3
ECE 542	Computer Network Architectures and Protocols	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 (<https://registrar.gmu.edu/forms/>) 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/Computer 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 Computer 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 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 Computer 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.