ELECTRICAL & COMPUTER ENGINEERING - PROFESSIONAL MASTER OF SCIENCE (MSEE)

The professional Master of Science degree in electrical & computer engineering is a professional degree composed of advanced courses relevant to working engineers.

The department offers many professional degree tracks, each of which result in a professional Master of Science degree in electrical engineering (MSEE).

Program Tracks

Embedded Systems Engineering (ESE) Track

The Embedded Systems Engineering (http://www.colorado.edu/ecee/graduate-program/degrees/embedded-systems/) (ESE) track provides comprehensive coverage of essential embedded technologies, current tools and trends. It is structured to provide students with a broad, versatile skill set and is coupled with industry input for continuous curriculum updates.

Through flexible core course options and electives, students enrolled in the ESE program pursue a 30-credit-hour MSEE degree. Many courses offer distance learning options through CU Boulder Distance Education.

High-Speed Digital Engineering (HSDE) Track

The High-Speed Digital Engineering (https://www.colorado.edu/ecee/academics/graduate-programs/professional-masters/high-speed-digital-engineering/)(HSDE) track is an innovative practical degree plan that prepares students for a career in industry with the specialized knowledge required to be a successful high-speed design engineering team member and to be able to solve complex signal integrity, power integrity and electromagnetic compatibility design problems quickly and efficiently. Simulation and measurement tools used in industry are leveraged to develop and enhance high-speed digital engineering design intuition at the same time fundamental principles are studied through best practices from industry in design, measurement, simulation and analysis. The program facilitates lifelong learning capabilities and is continuously updated with industry input.

Through five core courses and five elective options, students enrolled in this program pursue a ten course, 30-credit-hour degree. Most courses emphasize practical, hands-on experience, understanding and solving real world problems faced by the electronics industry today. Students with a background in electrical engineering fundamentals will be well-prepared for this program. It is intended for students and engineers with a bachelor's degree in electrical engineering or equivalent, including a background in basic electromagnetics. Students with other relevant engineering or scientific backgrounds may still be admitted to the program with a personalized study program to address foundational knowledge gaps.

Next-Generation Power and Energy Systems (PPS) Track

The Next-Generation Power and Energy Systems (https://www.colorado.edu/ecee/graduate-program/degrees-programs/next-generation-power-and-energy-systems/) (PPS) track offers five core courses and numerous electives for the 30-credit hour program to prepare students with the specialized knowledge required to practice grid integration of renewable energy into integrated energy systems, taught by instructors from CU Boulder's faculty and National Renewable Energy Laboratory (NREL) research programs

Through flexible core course options and electives, students enrolled in the PPS program pursue a 30-credit-hour MSEE degree. Many courses also offer distance learning options.

Power Electronics (PPE) Track

Power Electronics (http://www.colorado.edu/ecee/graduate-program/degrees/power-electronics-certificate/) is a key enabling technology in essentially all electronic systems and is increasingly important in the grid interface of renewable energy sources and in efficient electrical loads. The necessity for power electronics technology in these rapidly expanding areas creates an increasing need for design engineers equipped with knowledge and skills to actively participate in multidisciplinary teams.

Through flexible core course options and electives, students enrolled in this program pursue a 30-credit-hour MSEE degree. The program is intended for students and engineers with a BS degree in electrical engineering or the equivalent. Entering students must have adequate knowledge of circuits and electronics, as taught in undergraduate courses intended for EE majors.

Quantum Engineering (QE) Track

Inspired by the promise of more powerful computers and better sensors the global rise in funding for quantum technology has skyrocketed. This can be evidenced by the investment in several large companies (Google, IBM, Intel and Amazon). The quantum engineering track provides a unique overview of one of the fastest-growing technological fields and will help to prepare students for the quantum workforce of today and tomorrow.

The QE track provides students with a working knowledge of the principles of quantum mechanics and how they can be implemented in technological areas such as quantum computing, communications and sensing. Through core course options and electives, students enrolled in this program pursue a 30-credit-hour professional MSEE degree. The program is intended for students and engineers with a BS degree in STEM with solid knowledge in calculus, linear algebra and probability.

Distance Education Option

Students can take individual courses toward a master's degree or graduate certificate through distance education (online). For more information, connect with the individual graduate program directly.

Requirements

Admission

A minimum undergraduate GPA of 3.00 is required for application to the master's program. Students who are interested in the PhD degree and have strong academics (including 3.50 or higher GPA) should apply directly to the PhD program (https://catalog.colorado.edu/graduate/

colleges-schools/engineering-applied-science/programs-study/electrical-engineering/electrical-engineering-doctor-philosophy-phd/).

Course Requirements

The following course requirements are subject to change; for the most current information, visit the ECEE department's Professional Master's Program webpage (https://www.colorado.edu/ecee/academics/graduate-programs/professional-masters/).

Students must complete a total of 30 course credit hours with a grade of C or better and a cumulative GPA of at least 3.00. At least 24 credit hours must be completed at the 5000-level or above, and at least 18 of those credits must be in sufficiently technical ECEN 5000+ level courses.

Time Limit

All degree requirements must be completed within four years of the date of commencing coursework. Most students complete the degree in one-and-a-half to two years.

Program Tracks

Embedded Systems Engineering (ESE) Track

Code	Title	Credit Hours
A minimum of 5 ESE core courses (15 credit hours) and 2 ESE elective courses (6 credit hours) from the ESE course list are required.		
ESE Core Courses		
Choose five of the following:		15
ECEN 5613	Embedded System Design	
ECEN 5623	Real-Time Embedded Systems	
ECEN 5803	Mastering Embedded Systems Architecture	
ECEN 5813	Principles of Embedded Software	
ECEN 5823	Internet of Things Embedded Firmware	
ECEN 5833	Low Power Embedded Design Techniques	
ECEN 5853	Embedding Sensors and Motors	
ECEN 5863	Programmable Logic Embedded System Design	
ESE Program Electives		
Choose two of the following (or additional ESE core courses):		6
ECEN 5133	Fundamentals of Computer Security	
ECEN 5224	High Speed Digital Design	
ECEN 5593	Advanced Computer Architecture	
ECEN 5713	Advanced Embedded Software Development	
ECEN 5763	Embedded Computer Vision	
ECEN 5730	Practical Printed Circuit Board Design and Manufacture	
ECEN 5773	Developing the Industrial Internet of Things	
ECEN 5783	Embedded Interface Design	
ECEN 5313	Concurrent Programming	
ECEN 5139	Computer-Aided Verification [1]	
Open 5000 Level Electives		**9**
Choose three 5000-level electives from the ESE core, ESE electives, other ECEE courses, or courses in other departments, with approval of academic advisor.		
Total Credit Hours		**30**

[1] Can also optionally take ECEN 5525 Compiler Construction and/or ECEN 5033 Special Topics: Datacenter Scale Computing, when available.

For more information, visit the department's Embedded Systems Engineering (http://www.colorado.edu/ecee/graduate-program/degrees/embedded-systems/) webpage. (At that page, please click on the "Courses (https://www.colorado.edu/ecee/academics/graduate-programs/professional-masters/embedded-systems/embedded-systems-iot-courses/)" button to see particular semesters of course availability).

High-Speed Digital Engineering (HSDE) Track

This program track consists of 10 courses totaling 30 credits. Five of the courses (15 credits) must be the core courses of the curriculum. A minimum of two additional courses (6 credits) must be chosen from the HSDE PMP elective courses list. The remaining three courses (9 credits) may be chosen from the HSDE PMP elective courses list OR from the courses that fulfill general ECEE Master's degree requirements.

A grade of C or better is required for each course applied towards the HSDE PMP track for degree-seeking students.

For HSDE courses taken non-degreed, and subsequently wanting to transfer maximally 9 credit hours toward a degree, the minimal grade in each course must be a solid B or better.

Code	Title	Credit Hours
HSDE Core Courses		
All five required:		
ECEN 5224	High Speed Digital Design (spring)	3
ECEN 5514	Principles of Electromagnetics for High-Speed Digital Engineering (spring)	3
ECEN 5524	Principles of Computational Electromagnetics for Signal and Power Integrity (spring)	3
ECEN 5534	Signal Integrity Measurements for High Speed Digital Engineering (fall)	3
ECEN 5730	Practical Printed Circuit Board Design and Manufacture (fall, spring)	3
HSDE Program Electives		
Choose two:		6
ECEN 5013	Special Topics (Advanced PCB Design for high-speed serial links (fall))	
ECEN 5414	Essential Principles of Signal Integrity (spring)	
ECEN 5424	High Speed Channel Design for Signal Integrity (spring 2024)	
ECEN 5434	S-Parameters for Signal Integrity in High Speed Digital Engineering (fall)	
ECEN 5444	Electromagnetic Compatibility (EMC) for High-Speed Digital Engineering (fall)	
ECEN 5544	EM Signal Modeling for HSDE using Ansys HFSS and Q3D (spring)	

ECEN 5554	Designing PCB Memory Systems using Keysight ADS (fall)	
Choose three more from the above HSDE electives list, or from other STEM electives		*9*
Total Credit Hours		**30**

- For more information, visit the department's High-Speed Digital Engineering (https://www.colorado.edu/ecee/academics/graduate-programs/professional-masters/high-speed-digital-engineering/)webpage.

Next-Generation Power and Energy Systems (PPS) Track

Code	Title	Credit Hours
Core Courses		
ECEN 5797	Introduction to Power Electronics	3
ECEN 5407	Renewable Energy and the Future Power Grid (Renewable Energy and the Future Power Grid)	3
ECEN 5417	Power System Analysis (Power Systems Analysis)	3
ECEN 5427	Power System Planning & Operations (Power System Operations & Planning)	3
ECEN 5437	Distribution System Analysis (Distribution System Analysis)	3
Elective Courses		
At least 3 credit hours of ECEN courses at the 5000 level or above.		3
AREN 5010	Energy System Modeling and Control	
AREN 5570	Building Electrical Systems Design 1 (Building Electrical Systems)	
AREN 5060		
AREN 5830	Architectural Engineering Special Topic (Grid-Connected Systems)	
ECEN 5007	Special Topics (Electrified Transportation)	
ECEN 5007	Special Topics (Power System Protection)	
ECEN 5007	Special Topics (High Voltage AC and DC Transmission)	
ECEN 5447	Power System Dynamics with Renewable Energy	
ECEN 5457	Energy Systems Optimization	
ECEN 5467	Data Analytics and Data-Driven Decision Making for Modern Power and Energy Systems	
ECEN 5517	Power Electronics and Photovoltaic Power Systems Laboratory	
ECEN 5807	Modeling and Control of Power Electronic Systems	
ENVM 5005	The Business of Renewable and Sustainable Energy	
ENVM 5006	Sustainable Energy Policy	

Power Electronics (PPE) Track

This curriculum is built around a core of three theory courses and two laboratory courses that provide practical laboratory and design experience of specific relevance to the practice of power electronics.

Code	Title	Credit Hours
Required Theory Courses		
ECEN 5797	Introduction to Power Electronics (fall)	3
ECEN 5807	Modeling and Control of Power Electronic Systems (alternate spring)	3
ECEN 5817	Resonant and Soft-Switching Techniques in Power Electronics (alternate spring)	3
Required Laboratory Courses		
The degree also requires completion of the following laboratory course in power electronics.		
ECEN 5527	Power Electronics Design Laboratory (fall)	3
ECEN 5517	Power Electronics and Photovoltaic Power Systems Laboratory (spring)	3
Electives		
Select at least one of the following power electronics electives:		3
Digital Control for Power Electronics		
ECEN 5857	Digital Control for Power Electronics (fall)	
Electric Vehicles		
ECEN 5607	Power Electronics for Electrified Transportation (alternate fall)	
ECEN 5737	Adjustable-Speed AC Drives (alternate spring)	
Power Management Integrated Circuits		
ECEN 5827	Analog IC Design (alternate fall)	
Grid Integration of Renewables (variable semesters)		
ECEN 5407	Renewable Energy and the Future Power Grid	
ECEN 5417	Power System Analysis	
ECEN 5427	Power System Planning & Operations	
ECEN 5437	Distribution System Analysis	
ECEN 5447	Power System Dynamics with Renewable Energy	
ECEN 5457	Energy Systems Optimization	
ECEN 5467	Data Analytics and Data-Driven Decision Making for Modern Power and Energy Systems	
Technical Electives		
Choose up to three technical electives with advisor approval.		9
Open Elective		
Choose an additional elective course with advisor approval.		3
Total Credit Hours		**30**

For more information, visit the department's Power Electronics (http://www.colorado.edu/ecee/graduate-program/degrees/power-electronics-certificate/) webpage.

Quantum Engineering Track

Quantum engineering has a wide variety of hardware platforms to choose from and quantum engineers need a broad range of skills that are more traditional EE topics. To address this diversity and help quantum

engineers make informed choices, the program offers a wide range of options, allowing students to tailor their education to their interests and to the specific demands of the quantum industry.

1-Both of the two **core courses** below are required.

2-Two **quantum electives** are also required (of the four listed below, with the offerings changing semester to semester).

3-Additionally, students may request specific 5000-level (graduate) courses be counted on a case-by-case basis.

Code	Title	Credit Hours
Required Core courses		
ECEN 5915	Foundations of Quantum Engineering	
ECEN 5925	Foundations of Quantum Hardware	
Required Quantum Elective Courses		
PHYS 7570	Quantum Information and Computing Must have UG Quantum pre-reqs	
Quantum Metrology & Sensing. (Currently ECEN 5005 Special Topics: Optical & Quantum Metrology) Must have Quantum pre-reqs		
CSCI 7000 Special Topics: Intro Quantum Comp Arch/Sys		
CSCS 7000 Special Topics: Quantum Complexity and Beyond		
Other Electives		
Electromagnetics / RF Electives		
ECEN 5114	Electromagnetic Theory	
ECEN 5154	Computational Electromagnetics	
ECEN 5634	Microwave and RF Laboratory	
ECEN 5104	Passive Microwave Circuits	
ECEN 5014	Special Topics (Active Microwave Circuits)	
Optics Electives		
ECEN 5156	Physical Optics	3
ECEN 5696	Fourier Optics	3
ECEN 5645	Introduction to Optical Electronics	3
ECEN 5126	Computational Optical Imaging	3
ECEN 6006	Special Topics (Crystal & Nonlinear Optics)	3
Embedded Systems Engineering Electives		
ECEN 5623	Real-Time Embedded Systems	3
ECEN 5803	Mastering Embedded Systems Architecture	3
ECEN 5593	Advanced Computer Architecture	3
ECEN 5783	Embedded Interface Design	3
ECEN 5863	Programmable Logic Embedded System Design	3
Theory Electives		
ECEN 5712	Machine Learning for Engineers	3
PHYS 5250	Introduction to Quantum Mechanics 1	3
PHYS 5260	Introduction to Quantum Mechanics 2	3
ECEN 5345	Introduction to Solid State Physics	3
PHYS 7560	Quantum Optics	3

By petition, other STEM (Science, Technology, Engineering, Math) courses will be considered if not explicitly listed.

Learning Outcomes

By the completion of the program, students will be able to:

- Demonstrate the necessary understanding and skillsets with specific kinds of software and hardware in order to perform at a relatively strong level in industry jobs, both for optional industry internships and in post-graduation employment.
- Practice the necessary technical and interpersonal skills to gain meaningful employment within their chosen field of study through university relations with local and national companies and laboratories in addition to career events.
- Demonstrate a deeper, specialized set of technical skills through successful completion of additional, concentrated coursework in a chosen specialty within the field of study.
- Demonstrate the experimental and/or analytical skills essential to a career in their chosen field of study.