ELECTRICAL ENGINEERING - PROFESSIONAL MASTER OF SCIENCE (MSEE)

The professional Master of Science degree in electrical 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.

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.

Photonics (PHO) Track

While 20th-century technology was defined by the growth of electronics, the 21st century belongs to photonics (https://www.colorado.edu/ecee/graduate-program/degrees/photonics/). LEDs will light households powered by photovoltaic panels and filled with displays and cameras communicating by optical fiber to distant owners wearing virtual reality glasses. Laser 3D printing will transform manufacturing. New microscopes and telescopes will peer into the depths of living cells and distant galaxies. Photonics graduates will command skills in design, fabrication and laboratory practice to place them at the forefront of these industries and many more not yet invented.

Photonics is the electrical engineering sub-discipline concerned with the generation, modulation, radiative or guided transmission, sensing and detection of optical-frequency signals. Application areas include optical telecommunications, medical instrumentation, photovoltaic power generation, quantum information processing, optical instruments and environmental sensing. While some of these industries are mature, photonics continues to rapidly grow into new industries such as LED lighting and on-chip silicon photonics for multi-core CPUs.

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 photonics, as taught in undergraduate courses intended for EE majors.

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.

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.

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 department's Embedded Systems Engineering (http://www.colorado.edu/ecee/graduate-program/degrees/embedded-systems/), Power Electronics (http://www.colorado.edu/ecee/graduate-program/degrees/power-electronics-certificate/), Photonics (https://www.colorado.edu/ecee/graduate-program/degrees/photonics/) or Next-Generation Power and Energy Systems (https://www.colorado.edu/ecee/graduate-program/degrees-programs/next-generation-power-and-energy-systems/) webpages.

Students must complete a total of 30 credit hours (including both course and thesis 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

Artificial Intelligence and Communication Engineering (AICE) Track

Students need 10 courses, 30 credit hours to graduate. A grade of B- or better is required for each course applied towards the AICE program.

Code	Title	Credit Hours
Required Courses		
ECEN 5612	Random Processes for Engineers	3
ECEN 5712	Machine Learning for Engineers	3
ECEN 5692	Principles of Digital Communication	3
Electives		**15**
Choose at least 5 of the following:		
ECEN 5002	Special Topics	
Deep Learning		
ECEN 5022	Special Topics (Topics in Artificial Intelligence)	
Topics in Artificial Intelligence		
ECEN 5632	Theory and Application of Digital Filtering	
ECEN 5322	Data and Network Science	
ECEN 5012	Special Topics	
Modern Signal Processing		
ECEN 5752	Communication Laboratory	
ECEN 5622	Information Theory and Coding	
ECEN 5682	Theory and Practice of Error Control Codes	
CSCI 5254	Convex Optimization and Its Applications	
Open 5000-level Electives		**6**
Choose two 5000-level electives, at least one of which is technical, from the AICE electives, other ECEE courses or courses in other departments with the approval of an academic advisor. Recommended electives include courses in computer science and applied math, such as APPM 5570 Statistical Methods.		
Total Credit Hours		**30**

For more information, visit the department's Artificial Intelligence and Information/Communication Engineering (https://www.colorado.edu/ecee/academics/graduate-programs/professional-masters/artificial-intelligence-communication-engineering/) webpage.

Embedded Systems Engineering (ESE) Track (non-thesis)

Code	Title	Credit Hours
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 5013	Special Topics (Advanced Printed Circuit Board Design for Signal Integrity)	
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 Machine Vision and Intelligent Automation	
ECEN 5730	Practical Printed Circuit Board Design and Manufacture	
ECEN 5773	Developing the Industrial Internet of Things	
ECEN 5783	Embedded Interface Design	
Open 5000 Level Electives		
Choose three 5000-level electives from the ESE core, ESE electives, other ECEE courses, or courses in other departments, with approval of academic advisor.		9
Total Credit Hours		**30**

For more information, visit the department's Embedded Systems Engineering (http://www.colorado.edu/ecee/graduate-program/degrees/embedded-systems/) webpage.

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	Practical Signal Integrity Measurements (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.		
AREN 5010	Energy System Modeling and Control	
AREN 5570	Building Electrical Systems Design 1 (Building Electrical Systems)	
AREN 5060	Distributed Electricity Generation	
AREN 5830	Architectural Engineering Special Topic (Grid-Connected Systems)	
ECEN 5007	Special Topics (Power System Protection)	
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	3
ECEN 5807	Modeling and Control of Power Electronic Systems	3
ECEN 5817	Resonant and Soft-Switching Techniques in Power Electronics	3
Required Laboratory Courses		
ECEN 5517	Power Electronics and Photovoltaic Power Systems Laboratory	3
Choose one 5000-level project laboratory in power electronics (offered every fall).		3
Electives		
Select one of the following power electronics electives:		3
ECEN 5007	Special Topics (Power Electronics for Electric Drivetrain Vehicles)	
ECEN 5737	Adjustable-Speed AC Drives (spring)	

ECEN 5827	Analog IC Design (fall)	
Grid Integration of Renewables		
ECEN 5XX7	Control of Power Electronics in AC Systems and Micrograms	
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 three technical electives with advisor approval. Recommended electives include courses in control systems, RF/microwaves and engineering management.		9
Open Elective		
Choose an additional elective course.		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.

Photonics (PHO) Track

Code	Title	Credit Hours
PHO core courses		
Offered in Fall:		
ECEN 5156	Physical Optics	3
ECEN 5696	Fourier Optics	3
ECEN 5345	Introduction to Solid State Physics	3
ECEN 5915	Foundations of Quantum Engineering	3
Offered in Spring:		
ECEN 5616	Optoelectric System Design	3
ECEN 5606	Optics Laboratory	3
ECEN 5626	Active Optical Devices	3
ECEN 5355	Principles of Electronic Devices 1	3
PHO elective courses		
Offered in variable semesters		
ECEN 5005	Special Topics (Photovoltaic Devices)	3
ECEN 5015	Special Topics (Nanophotonics)	3
ECEN 5016	Special Topics (Quantum Mechanics)	3
ECEN 5026	Special Topics (Computational Imaging)	3
ECEN 6006	Special Topics (Numerical Methods in Photonics)	3

For more information, visit the department's Photonics (https://www.colorado.edu/ecee/graduate-program/degrees/photonics/) webpage.