ELECTRICAL & COMPUTER ENGINEERING - MASTER OF SCIENCE (MS) ONLINE

The online Master of Science in Electrical & Computer Engineering (MSEE), hosted on the internationally acclaimed Coursera (https://www.coursera.org/degrees/msee-boulder/) platform, offers stackable graduate-level courses, graduate certificates and a fully accredited master's degree in electrical engineering. The Master of Science in Electrical & Computer Engineering on Coursera students earn the same credentials as our on-campus students. There are no designations on official CU transcripts, degrees or certificates that this is an online program.

Focus Areas

Embedded Systems

Embedded system engineering is used in industries such as aerospace and defense, energy, industrial automation, health care, networking and communication, security, transportation and more. Embedded systems also drive the Internet of Things (IoT), enabling countless human-to-machine and machine-to-machine applications including home automation, security and more.

The embedded systems engineering curriculum covers essential embedded technologies, synthesizes foundational principles and directly applies them to current tools and trends. It is structured to provide you with a broad, versatile and highly competitive skill set. We emphasize practical, project-based learning across hardware and embedded software design that addresses numerous end markets, as well as multiple semiconductor technologies including sensors, controllers, programmable devices and development tools.

Power Electronics

Power electronics 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.

The power electronics curriculum addresses this demand for skilled power electronics design engineers, covering switching power supplies, DC-DC converters, inverters, power factor correction converters and LED lighting drivers. The power electronics curriculum emphasizes fundamentals and application in the power electronics field. This domain competency applies to end markets such as power management, portable power, computer systems, medical applications, spacecraft power systems, the automotive industry, renewable energy and the utilities.

Photonics & Optics

While 20th-century technology was defined by the growth of electronics, the 21st century belongs to 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.

The photonics curriculum provides a firm theoretical foundation on the generation, modulation, radiative or guided transmission, sensing, and detection of optical signals. It also covers optical telecommunications, medical instrumentation, photovoltaic power generation, information processing, optical instruments and environmental sensing. While some of these industries are mature, photonics continues to grow into new industries such as LED lighting and on-chip silicon photonics for multi-core CPUs.

Program Policies

This CU Boulder on Coursera program does not align with standard campus policies. Please refer to the Online Programs (https://catalog.colorado.edu/online/) section of the catalog for more information.

Up to 9 credits offered by the MS in Computer Science (https://catalog.colorado.edu/graduate/colleges-schools/engineering-applied-science/programs-study/computer-science/computer-science-master-science-ms-online/) and/or MS in Data Science (https://catalog.colorado.edu/graduate/colleges-schools/interdisciplinary-programs/data-science-master-science-ms-online/) and/or ME in Engineering Management (https://catalog.colorado.edu/graduate/colleges-schools/engineering-applied-science/programs-study/engineering-management/engineering-management-master-engineering-me-online/) on Coursera programs in which a student earns a grade of solid B or higher (B-minus is too low) may be applied toward the MS in Electrical Engineering degree's required 30 credits. Courses must be graduate level and meet all applicable academic standards and may not be double counted toward two credentials of the same level. Only courses offered through CU Boulder's for-credit programs on Coursera may be used.

Admission Requirements

The MSEE program utilizes performance-based admissions for enrollment. There is no traditional application for admission to the degree. Students do not need to take the GRE or submit letters of recommendation or proof of language proficiency. Neither a prior degree nor university transcripts are required for admission. Because this is a purely online program, students do not need to complete a background check to enroll.

A student desiring admission to the MSEE program must complete four required protocols:

1. Take one pathway specialization for credit with at least a grade of C in each course.
2. Achieve a computed pathway specialization grade-point average (GPA) of at least 3.00.
3. Have a cumulative GPA of at least 3.00 for all for-credit courses taken to date.
4. Declare their intention to seek the degree, which they can do before, during, or after any work in a pathway specialization.

Upon completion of these four steps the student is admitted to the MSEE program. Students may successfully complete a designated pathway specialization and declare intent at any point in their academic journey. Completion of a pathway specialization is not required for students to begin earning academic credit, only to earn the degree. Non-degree seeking students may enroll in for-credit courses.

All courses attempted and/or completed for credit will appear on an official CU Boulder transcript (unless dropped by the drop deadline) and will count toward the cumulative GPA.

Program Requirements

The diagram displayed on the Electrical Engineering (https://www.colorado.edu/ecee/msee/) website shows how the program's courses and certificates can be stacked into the full 30 credit hour degree.

Up to 9 credits offered by the MS-DS or ME-EM on Coursera programs may be applied toward the Electrical Engineering MS degree required 30 credits. Courses must be graduate level and meet all applicable academic standards and may not be double counted toward two credentials of the same level. Only courses offered through Coursera may be used.

Embedded Systems Track
Computer Engineering / Embedded Systems Engineering

Computer engineering encompasses a wide range of topics surrounding this interaction between hardware and software. Computer engineers of the future will be versatile full-stack developers, comfortable with understanding the technical depths of software development while also possessing a wide knowledge of the underlying hardware implementations. The MSEE on Coursera curriculum in computer engineering emphasizes computer-aided verification and synthesis.

Embedded systems engineering is used in industries such as aerospace and defense, energy, industrial automation, health care, networking and communication, security, transportation and more. Embedded systems also drive the Internet of Things (IoT), enabling countless human-to-machine and machine-to-machine applications including home automation, security and more.

The MSEE on Coursera's Embedded Systems Engineering curriculum covers essential embedded technologies, synthesizes foundational principles, and directly applies them to current tools and trends. It is structured to provide you with a broad, versatile and highly competitive skill set. We emphasize practical, project-based learning across hardware and embedded software design that addresses numerous end markets, as well as multiple semiconductor technologies including sensors, controllers, programmable devices and development tools.

Industrial Internet of Things - Graduate Certificate
To earn a graduate certificate (9 credits), students must complete the required specializations.

Required specializations:

- Embedded Sensors and Motors Specialization
- Embedded Interface Design Specialization
- Developing Industrial Internet of Things Specialization

Advanced Embedded Linux Development Specialization

Code	Title	Credit Hours
ECEA 5305	Linux System Programming and Introduction to Buildroot	
ECEA 5306	Linux Kernel Programming and Introduction to Yocto	
ECEA 5307	Embedded System Topics and Project	

Embedding Sensors and Motors Specialization

Code	Title	Credit Hours
ECEA 5340	Embedding Sensors and Motors: Sensors, Sensor Circuit Design	
ECEA 5341	Embedding Sensors and Motors: Motors, Motor Control Circuits	
ECEA 5342	Embedding Sensors and Motors: Pressure and Motion Sensors	
ECEA 5343	Embedding Sensors and Motors: Sensor Manufact, Process Ctrl	

FPGA Design for Embedded Systems Specialization

Code	Title	Credit Hours
ECEA 5360	FPGA Design for Embedded Systems: Intro to FPGA Dsgn for ES	
ECEA 5361	FPGA Design for Embedded Systems: Hardwr Desc Lang FPGA Dsgn	
ECEA 5362	FPGA Design for Embedded Systems: FPGA Softcore Proc, IP Acq	
ECEA 5363	FPGA Design for Embedded Systems: Building FPGA Projects	

Developing Industrial Internet of Things Specialization

Code	Title	Credit Hours
ECEA 5385	Industrial IoT Markets and Security	
ECEA 5386	Developing Industrial IoT: Proj Planning, Machine Learning	
ECEA 5387	Developing Industrial IoT: Modeling and Debugging Embed Sys	

Real-time Embedded Systems Specialization

Code	Title	Credit Hours
ECEA 5315	Real-Time Embedded Systems: Concepts and Practices	
ECEA 5316	Real-Time Embedded Systems: Theory and Analysis	
ECEA 5317	Real-Time Embedded Systems: Mission-Critical, SW Application	
ECEA 5318	Real-Time Embedded Systems: Project	

Embedded Interface Design Specialization

Code	Title	Credit Hours
ECEA 5346	Embedded Interface Design: User Exp I/F Design for Emb Sys	
ECEA 5347	Embedded Interface Design: Rapid Prototyping Emb I/F Designs	

Code	Title	
ECEA 5348	Embedded Interface Design: M2M, IoT I/F Design & Protocols	

Network Systems: Principles and Practice (Linux and Cloud Networking)

Code	Title	Credit Hours
ECEA 5370	Network Systems Foundation	
ECEA 5371	Network Principles in Practice: Linux Networking	
ECEA 5372	Network Principles in Practice: Cloud Networking	

Sensors for a Carbon Free World Specialization

Code	Title	Credit Hours
ECEA 5349	Sensors for a Carbon Free World: Electric Vehicle Sensors	
ECEA 5350	Sensors for a Carbon Free World: Wind Turbine Sensors	
ECEA 5351	Sensors for a Carbon Free World: Solar Power Sensors	

Engineering Genetic Circuits Specialization

Code	Title	Credit Hours
ECEA 5934	Engineering Genetic Circuits: Design	
ECEA 5935	Engineering Genetic Circuits: Modeling and Analysis	
ECEA 5936	Engineering Genetic Circuits: Abstraction Methods	

Spectrum Engineering - Graduate Certificate
The spectrum engineering graduate certificate requires 12 credit hours of coursework. Three hours of coursework is recommended, though not required.

Code	Title	Credit Hours
Recommended Specialization		**3**
ECEA 5453	The Electromagnetic Spectrum	
ECEA 5454	Signal Fundamentals	
ECEA 5455	Economics, Management and Policy	
Required Specializations		**12**
ECEA 5450	The Science of Spectrum Access	
ECEA 5451	Radio Frequency Engineering	
ECEA 5452	Signals and Propagation	
ECEA 5456	Radio Services and Broadcast Applications	
ECEA 5457	Mobile Communication: Cellular and Wi-Fi	
ECEA 5458	Radio Determination and Space Applications	
ECEA 5459	The Electromagnetic Spectrum	
ECEA 5460	History of Spectrum Management	
ECEA 5461	Spectrum Sharing	
ECEA 5462	Consumer Demand and Valuation	

Code	Title	
ECEA 5463	Firm Supply and the Structure of the Market	
ECEA 5464	Optimal Pricing with Market Power	

Power Electronics Track

Power Electronics - Graduate Certificate
To earn a graduate certificate (9 credits), students must complete the required specializations/courses.

Required specializations:

- Power Electronics Specialization
- Modeling and Control of Power Electronics Specialization
- Power Electronics Project Course: ECEA 5715

Power Electronics Specialization

Code	Title	Credit Hours
ECEA 5700	Power Electronics: Introduction to Power Electronics	0.8
ECEA 5701	Power Electronics: Converter Circuits	1.0
ECEA 5702	Power Electronics: Converter Control	1.2
ECEA 5703	Power Electronics: Magnetics Design	1.0

Modeling and Control of Power Electronics Specialization

Code	Title	Credit Hours
ECEA 5705	Modeling, Control of Power Elec: Avged-Sw Modeling and Sim	0.8
ECEA 5706	Modeling, Control of Power Elec: Tech Dsgn-Oriented Analysis	0.6
ECEA 5707	Modeling, Control of Power Elec: Input Filter Design	0.6
ECEA 5708	Modeling, Control of Power Elec: Current-mode Control	1.2
ECEA 5709	Modeling, Control of Power Elec: Mod/Ctrl 1-Phase Rect/Inv	0.6

Power Electronics Project Course

Code	Title	Credit Hours
ECEA 5715	Power Electronics Capstone Project	1.2

Algorithms for Battery Management Systems Specialization

Code	Title	Credit Hours
ECEA 5730	Introduction to Battery-Management Systems	0.8
ECEA 5731	Equivalent-Circuit Cell-Model Simulation	0.8
ECEA 5732	Battery State-of-Charge (SOC) Estimation	1.0
ECEA 5733	Battery State-of-Health (SOH) Estimation	0.8
ECEA 5734	Battery-Pack Balancing and Power Estimation	0.8

Photovoltaic Power Electronics Specialization

Code	Title	Credit Hours
ECEA 5716	Open-Loop Photovoltaic Power Electronics Laboratory	1.0
ECEA 5717	Closed-Loop Photovoltaic Power Electronics Laboratory	1.0
ECEA 5718	Photovoltaic Power Electronics Battery Management Laboratory	1.0

Power Semiconductor Devices Specialization (3.6 credits)

Code	Title	Credit Hours
ECEA 5721	Introduction to Power Switches	0.6
ECEA 5722	High-Voltage p-n and Schottky Diodes	1.2
ECEA 5723	MOSFETs, IGBTs and more	1.2
ECEA 5724	Power Device Fabrication	0.6

Control Systems Analysis Specialization is part of the Systems and Controls Track

Code	Title	Credit Hours
ECEA 5800	Control Systems Analysis: Modeling of Dynamic Systems	
ECEA 5801	Feedback Control and Root Locus Design	
ECEA 5802	Frequency-Domain and State-Space Design	

Photonics and Optics Track

Semiconductor Photonics - Graduate Certificate

Admission to a graduate degree-seeking program in the ECEE department is not required for students pursuing the certificate. Certificate credit hours may be applied towards a full master's degree, provided the student is admitted to the electrical engineering graduate program as a degree-seeking student.

The semiconductor photonics certificate is comprised of 3 specializations, each of which is comprised of 3–4 individual online courses (MOOCs), which deliver about one month of content:

To complete a certificate, you must complete the following required specializations/courses.

Semiconductor Photonics Graduate Certificate (9 credits)

Required specializations:

- Optical Engineering Specialization
- Semiconductor Specialization
- Active Optical Devices Specialization

Optical Engineering Specialization

Code	Title	Credit Hours
ECEA 5600	Optical Engineering: First Order Optical System Design	1.0
ECEA 5601	Optical Engineering: Optical Efficiency and Resolution	1.0
ECEA 5602	Optical Engineering: Design High-Performance Optical Systems	1.0

Semiconductor Devices Specialization

Code	Title	Credit Hours
ECEA 5630	Semiconductor Devices: Semiconductor Physics	1.0
ECEA 5631	Semiconductor Devices: Diode: pn junction and metal semiconductor contact	1.0
ECEA 5632	Semiconductor Devices: Transistor: Field Effect Transistor and Bipolar Junction Transistor	1.0

Active Optical Devices Specialization

Code	Title	Credit Hours
ECEA 5605	Active Optical Devices: LEDs and Semiconductor Lasers	1.2
ECEA 5606	Active Optical Devices: Nanophotonics and Detectors	1.2
ECEA 5607	Active Optical Devices: Displays	0.6

Quantum Mechanics for Engineers Specialization

Code	Title	Credit Hours
ECEA 5610	Foundations of Quantum Mechanics	1.4
ECEA 5611	Theory of Angular Momentum	0.8
ECEA 5612	Approximation Methods	0.8

For further details regarding Photonics content under our online MSEE degree through Coursera, see Photonics and Optics (https://www.colorado.edu/ecee/academics/online-programs/ms-ee-coursera/curriculum/photonics-and-optics/).

Learning Outcomes

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