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.

**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.

**Coursera Option**

This program is also available as a completely online master's degree (https://www.colorado.edu/ecee/msee) through Coursera.

**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 (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) or Photonics (https://www.colorado.edu/ecee/graduate-program/degrees/photonics) 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 courses.

**Program Tracks**

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

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choose five of the following:</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>ECEN 5023</td>
<td>Special Topics (Low Power Embedded Design Techniques)</td>
<td></td>
</tr>
<tr>
<td>ECEN 5053</td>
<td>Special Topics (Embedding Sensors and Actuators)</td>
<td></td>
</tr>
<tr>
<td>ECEN 5613</td>
<td>Embedded System Design</td>
<td></td>
</tr>
<tr>
<td>ECEN 5623</td>
<td>Real-Time Embedded Systems</td>
<td></td>
</tr>
<tr>
<td>ECEN 5803</td>
<td>Mastering Embedded Systems Architecture</td>
<td></td>
</tr>
<tr>
<td>ECEN 5813</td>
<td>Principles of Embedded Software (Low Power Embedded Design Techniques)</td>
<td></td>
</tr>
</tbody>
</table>
Electrical Engineering - Professional Master of Science (MSEE)

ECEN 5823 Internet of Things Embedded Firmware (IoT Embedded Firmware)
ECEN 5863 Programmable Logic Embedded System Design

ESE Program Electives
Choose two of the following (or additional ESE courses): 6
ECEN 5013 Special Topics (Advanced Embedded Software Development)
ECEN 5013 Special Topics (ASIP and IP Core Processor Design)
ECEN 5013 Special Topics (Practical PCB Design and Manufacture / Accelerator)
ECEN 5023 Special Topics (Soft Processor Design for FPGA)
ECEN 4/5033 Introduction to Computer Security
ECEN 5053 Special Topics (Embedded Interface Design)
ECEN 4/5224 High Speed Digital Design
ECEN 5593 Advanced Computer Architecture
ECEN 5763 Embedded Machine Vision and Intelligent Automation

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.

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.

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.

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECEN 5797</td>
<td>Introduction to Power Electronics</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 5807</td>
<td>Modeling and Control of Power Electronic Systems</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 5817</td>
<td>Resonant and Soft-Switching Techniques in Power Electronics</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 5517</td>
<td>Power Electronics and Photovoltaic Power Systems Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 5XXX</td>
<td>Select one 5000-level project laboratory in power electronics (offered every fall)</td>
<td>3</td>
</tr>
</tbody>
</table>

**Electives**
Select one of the following power electronics electives: 3

**Electric Vehicles**
ECEN 5017 Power Electronics for Electric Drivetrain Vehicles; fall
ECEN 5737 Adjustable-Speed AC Drives (spring)

**Analog and Mixed-Signal IC Design**
ECEN 5827 Analog IC Design (fall)

ECEN 5837 Mixed-Signal IC Design Lab (alternate spring semesters)
ECEN 5XX8 Integrated Circuits and Devices for Power Electronics (alternate spring semesters)

**Grid Integration of Renewables**
ECEN 5XX7 Control of Power Electronics in AC Systems and Microgrids
ECEN 5XX7 Renewable Energy and the Future Power Grid
ECEN 5XX7 Advances in Control and Optimization of Power Systems
ECEN 5XX7 Power System Analysis

**Technical Electives**
Choose three technical electives with advisor approval. 9
Recommended electives include courses in control systems, RF/microwaves and engineering management.

**Open Elective**
Choose an additional elective course. 3

Total Credit Hours 27

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

**Photonics (PHO) Track**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECEN 5156</td>
<td>Physical Optics</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 5696</td>
<td>Fourier Optics</td>
<td>3</td>
</tr>
<tr>
<td>ECEN 5345</td>
<td>Introduction to Solid State Physics</td>
<td>3</td>
</tr>
</tbody>
</table>

**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 6006 3
ECEN 5016 Special Topics (Quantum Mechanics) 3
ECEN 5005 Special Topics (Photovoltaic Devices) 3
ECEN 5015 3
ECEN 5031 3
ECEN 5026 3

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

**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.