ELECTRICAL ENGINEERING, MSE

The MSE Program in Electrical Engineering gives students the theoretical and technological foundation needed to deal with the new ideas and new applications that are the hallmarks of modern electrical engineering. A major advantage of our MSE program is that it allows students to focus their education according to their interests and goals, from nanotechnology and circuits, to embedded systems or robotics. The MSE Program in Electrical Engineering gives students the theoretical foundation and the interdisciplinary skills needed to deal with the new ideas and new applications that are the hallmarks of modern electrosience. A major advantage of our MSE Program allows you to tailor your education to your own interests and goals, from Electromagnetics and Photonics, sensors and MEMS to VLSI and Nanotechnology.

For more information: http://www.ese.upenn.edu/current-students/masters/index.php (http://www.ese.upenn.edu/current-students/masters/)

Electrical Engineering Degree Requirements
10 course units are required for MSE in Electrical Engineering.¹

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Course Units</th>
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<tbody>
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<td>5</td>
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EE Core
Select 5 required course units in any of the three areas below:

**Physical Devices and Nano Systems**
- ESE 510 Electromagnetic and Optics
- ESE 521 The Physics of Solid State Energy Devices
- ESE 523 Quantum Engineering
- ESE 525 Nanoscale Science and Engineering
- ESE 529 Introduction to Micro- and Nano-electromechanical Technologies
- ESE 536 Nanofabrication and Nanocharacterization
- ESE 574 The Principles and Practice of Microfabrication Technology

**Circuits and Computer Engineering**
- ESE 519 Introduction to Embedded Systems
- ESE 532 System-on-a-Chip Architecture
- ESE 535 Electronic Design Automation
- ESE 570 Digital Integrated Circuits and VLSI-Fundamentals
- ESE 572 Analog Integrated Circuits
- ESE 578 RFIC (Radio Frequency Integrated Circuit) Design
- ESE 668 Mixed Signal Circuit Design and Modeling

**Information and Decision Systems**
- ESE 500 Linear Systems Theory
- ESE 504 Intro to Linear, Nonlinear and Integer Optimization
- ESE 505 Feedback Control Design and Analysis

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<tbody>
<tr>
<td>ESE 507</td>
<td>Introduction to Networks and Protocols</td>
</tr>
<tr>
<td>ESE 512</td>
<td>Dynamical Systems for Engineering and Biological Applications</td>
</tr>
<tr>
<td>ESE 528</td>
<td>Estimation and Detection Theory</td>
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<tr>
<td>ESE 530</td>
<td>Elements of Probability Theory</td>
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<tr>
<td>ESE 531</td>
<td>Digital Signal Processing</td>
</tr>
<tr>
<td>ESE 542</td>
<td>Statistics for Data Science</td>
</tr>
<tr>
<td>ESE 545</td>
<td>Data Mining: Learning from Massive Datasets</td>
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</table>

**ESE Electives**
Select 2 ESE electives ³ 2

**SEAS Electives**
Select 1 SEAS elective ⁴ 5 1

**Open Electives**
Select 2 open electives ⁶ 2

**Total Course Units**
10

¹ Students must complete ten (10) course units at the graduate level (500+).
- A maximum of two (2) graduate-level course units may be transferred from another school to apply towards the degree. These cannot have been used to fulfill requirements of an undergraduate degree.
- Students must be registered with the 500-level course number to be taken.
- Students must complete ten (10) course units at the graduate level (500+).
- ESE 597 Master’s Research Seminar
- ESE 599 Thesis
- A maximum of 1 ESE 599 course unit can be used toward the degree.
- If a thesis is completed, it will count for 2 course units of ESE 597 Master’s Thesis.

² Students can select any combination from this list, and are not limited to a single area.

³ Select any graduate-level ESE course at the 500 and 600 level.

⁴ Each course taken several times and counted more than once towards the degree.

⁵ Only the following EAS courses are allowed:
- EAS 507 Intellectual Property and Business Law for Engineers
- EAS 510 Technical Communication and Academic Writing for Non-native Speakers of English
- EAS 512 Engineering Negotiation
- EAS 545 Engineering Entrepreneurship I
- EAS 546 Engineering Entrepreneurship II
- EAS 595 Foundations of Leadership
- ESE 680 Special Topics in Electrical and Systems Engineering can be taken several times and counted more than once towards the degree. Each ESE 680 Special Topics in Electrical and Systems Engineering course taken must address different topics to be eligible.
- A maximum of 1 ESE 599 course unit can be used toward the degree.

⁶ Select from graduate courses at Penn in SEAS, SAS, Medicine, Law, Wharton MBA, Social Policy, and Education. These must have technical/scientific content and relevance to the student’s program. Approval must be obtained from the ESE department prior to enrollment in the course.

The degree and major requirements displayed are intended as a guide for students entering in the Fall of 2021 and later. Students should consult with their academic program regarding final certifications and requirements for graduation.