EMBEDDED SYSTEMS AND INTERNET OF THINGS AT SHADY GROVE

Program Director: Romel Gomez, Ph.D.

The Bachelor of Science in Embedded Systems will provide students with a solid foundation in key emerging technologies of the Internet of Things (IoT), the ability to integrate devices into complete IoT systems, and an understanding of how IoT fits within the wider context of information and communications technology, including data analytics and cloud computing. At the senior level, students will be able to specialize in one of the following tracks: Hardware, Computational, or Security track. It is expected that graduates will be in high demand in such occupational areas as computer developers, computer systems analysts, network architects and administrators, information security analysts, information systems analysts and computer programs.

Admission to the Major
As an undergraduate program within the A. James Clark School of Engineering, the Embedded Systems major is a Limited Enrollment Program (LEP). Admission to this program will follow the School of Engineering’s admissions criteria found on the LEP website: http://www.lep.umd.edu.

Beyond the LEP gateway criteria, students will need to fulfill the following requirements to gain admission to the Embedded Systems major:

- Completion of all first and second year required major courses with a minimum grade of a "C-"
- Completion of all lower-level University General Education requirements.
- Completion of 60 credits.

A minimum grade point average of 3.0 in all courses taken at the University of Maryland and all other institutions is required for internal and external transfer students.

Due to the similarity in curriculum content and the physical location of course offerings, students in the Electrical Engineering, Computer Engineering, and Computer Science programs at UMD will not be eligible to add Embedded Systems as a second major or degree.

This program is mainly intended for students transferring from a Maryland public community college. While students at the College Park campus can pursue the program, they will not be able to seek admission into the School of Engineering and the Embedded Systems major until they have completed the Engineering LEP gateway courses, required first and second year major courses, lower-level General Education requirements, and have earned at least 60 credits. The junior and senior years would take place at the Shady Grove campus.

Program Objectives
The program education objective of this program is to produce a well-trained workforce in the emerging technologies of internet of things. The Bachelor of Science in Embedded Systems and Internet of Things will produce engineering graduates who:

- Use their hardware and software engineering design training and problem-solving skills to contribute professionally in an industrial, research and applications environment;
- Demonstrate initiative, leadership, teamwork, and continued professional development;
- Demonstrate understanding of the impact of their professional activities on society.

Program Learning Outcomes
1. An ability to apply knowledge of computing and mathematics appropriate to the program’s student outcomes and to the discipline;
2. An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution;
3. An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs;
4. An ability to function effectively on teams to accomplish a common goal;
5. An understanding of professional, ethical, legal, security and social issues and responsibilities;
6. An ability to communicate effectively with a range of audiences;
7. An ability to analyze the local and global impact of computing on individuals, organizations, and society;
8. Recognition of the need for and an ability to engage in continuing professional development;
9. An ability to use current techniques, skills, and tools necessary for computing practice.

Requirements
First & Second Year
Prior to being admitted to the Embedded Systems and Internet of Things major, students should have completed the Engineering LEP gateway courses, basic math/science courses, lower-level General Education requirements, and at least 60 credits.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH140</td>
<td>Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>MATH141</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>ENGL101</td>
<td>Academic Writing</td>
<td>3</td>
</tr>
<tr>
<td>CHEM135</td>
<td>General Chemistry for Engineers</td>
<td>3</td>
</tr>
<tr>
<td>PHYS161</td>
<td>General Physics: Mechanics and Particle Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>PHYS260</td>
<td>General Physics: Vibration, Waves, Heat, Electricity and Magnetism</td>
<td>3</td>
</tr>
<tr>
<td>PHYS261</td>
<td>General Physics: Vibration, Waves, Heat, Electricity and Magnetism (Laboratory)</td>
<td>1</td>
</tr>
<tr>
<td>Programming Requirement</td>
<td></td>
<td>2-4</td>
</tr>
<tr>
<td>ENES100</td>
<td>Introduction to Engineering Design</td>
<td>3</td>
</tr>
<tr>
<td>One of the following MATH2xx courses:</td>
<td></td>
<td>3-4</td>
</tr>
<tr>
<td>MATH246</td>
<td>Differential Equations for Scientists and Engineers</td>
<td></td>
</tr>
<tr>
<td>MATH241</td>
<td>Calculus III</td>
<td></td>
</tr>
<tr>
<td>MATH240</td>
<td>Introduction to Linear Algebra</td>
<td></td>
</tr>
<tr>
<td>General Education Requirements/Additional Electives</td>
<td></td>
<td>28-31</td>
</tr>
</tbody>
</table>
Embedded systems will accept any of the following programming courses or their equivalents:
- ENEE140
- CMSC131
- CMSC106
- Any introductory course in C, C++, Java, or Python (student must submit the course to ECE Department for Evaluation)

## Junior & Senior Year at Shady Grove

### Tracks

#### Hardware Track

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENEB346</td>
<td>(Linear Algebra for Machine Learning Applications)</td>
<td>3</td>
</tr>
<tr>
<td>ENEB444</td>
<td>Operating Systems for Embedded Systems</td>
<td>3</td>
</tr>
<tr>
<td>ENEB456</td>
<td>(Machine Learning Tools)</td>
<td>3</td>
</tr>
</tbody>
</table>

**Elective Courses**

Select one of the following three courses:
- ENEB451 (Network Security)
- ENEB452 Advanced Software for Connected Embedded Systems
- ENEB453 (Web Based Application Development)
- ENEB455 Advanced FPGA System Design using Verilog for Embedded Systems
- ENEB457 Foundations of Databases for Web Applications

**Total Credits**

18

#### Computational Track

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>ENEB345</td>
<td>(Probability and Statistical Inference)</td>
<td>3</td>
</tr>
</tbody>
</table>

**Elective Courses**

Select four of the following five courses:
- ENEB345 (Probability and Statistical Inference)
- ENEB451 (Network Security)
- ENEB453 (Web Based Application Development)
- ENEB456 (Machine Learning Tools)
- ENEB457 Foundations of Databases for Web Applications

**Total Credits**

18

#### Security Track

<table>
<thead>
<tr>
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<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENEB346</td>
<td>(Linear Algebra for Machine Learning Applications)</td>
<td>3</td>
</tr>
<tr>
<td>ENEB444</td>
<td>Operating Systems for Embedded Systems</td>
<td>3</td>
</tr>
<tr>
<td>ENEB451</td>
<td>(Network Security)</td>
<td>3</td>
</tr>
</tbody>
</table>

**Elective Courses**

Select one of the following two courses:
- ENEB345 (Probability and Statistical Inference)
- ENEB453 (Web Based Application Development)
- ENEB455 Advanced FPGA System Design using Verilog for Embedded Systems
- ENEB456 (Machine Learning Tools)
- ENEB457 Foundations of Databases for Web Applications (Foundations of Databases for Web Applications)

**Total Credits**

18

### Four Year Plan

Click here (https://eng.umd.edu/four-year-plans/) for roadmaps for four-year plans in the A. James Clark School of Engineering.

Additional information on developing a four-year academic plan can be found on the following pages:
- 4yearplans.umd.edu (http://4yearplans.umd.edu/)
- the Student Academic Success-Degree Completion Policy (https://academiccatalog.umd.edu/undergraduate/registration-academic-requirements-regulations/academic-advising/) section of this catalog