

Course description for EECS 598

Embedded Systems: An Application-Centered Approach

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Description

Embedded systems are computers within other devices such as wearable devices, automobiles, sensor networks, and medical devices. The focus of this course is to give students an understanding of the process of going from an idea to a product or research finding in the field of embedded systems.

We will start with a survey of the embedded system design process, with consideration of reliability, ease-of-use, performance, power consumption, and cost. We will also survey fundamental and important recent research results in the field. Very early in the course, students will be required to start defining an embedded system design problem based on customer needs through direct interaction with potential customers. Customers may be end consumers, businesses, or academic researchers. Students will then be required to develop embedded system prototypes or research concepts to serve identified customer needs.

Graduate students are welcome. Undergraduate students are very much welcome, but are warned that this will not be a typical undergraduate course. To succeed, students will need to be highly responsible and capable of thriving in an environment of uncertainty. It will be necessary to solve problems with incomplete information and iteratively re-solve based on new learnings and findings. On certain technical matters, I will deliver authoritative lectures. However, when it comes to your particular project, I will instead serve as a guide, helping you to learn what you need to know in order to make progress.

Required text

You will need to read substantial portions of the following book: “The Startup Owners’s Manual: A Step-by-Step Guide for Building a Great Company”, Steve Blank and Bob Dorf, March 2012. This book is most useful in describing a method of determining customer needs. The process is applicable to products and to most classes of research. Approximate price: \$30.

I will also assign reading from embedded system design books, but the specific book depends on your project. You should expect to spend \$40-\$60 for these books, depending on whether you get new, used, or e-book versions.

I will provide numerous research papers and other technical documents, which will be free. You will also be expected to find papers, technical notes, and other material on your project, although I will explain how to do this.

Course goals

Prepare students for product–market search and/or research in the field of embedded systems. Provide an understanding of the embedded system design process, or at least common variants of it. Introduce real-time systems and embedded operating systems basics. Complete original projects that may serve as foundations for products or further research.

Prerequisites

EECS 311 or 312 or 373 or 482 or the equivalent of one of these or permission of instructor. In short, you need to know enough about an important aspect of embedded system design (circuits, architectures, system integration, firmware, or operating systems) to make major contributions on your team project. Please email me if you would like to discuss whether your background is appropriate in more detail.

1 Lecture topics

I may adjust a few of these topics or change the order depending on the projects that students in the course select.

1. Introduction to embedded systems

2. The product–market search process.
3. Embedded system design challenges.
4. A survey of types of embedded systems.
5. Overview of heterogeneous multiprocessor system-on-chip design problem
6. Models and languages
7. Formal methods for designing reliable embedded systems
8. Heterogeneous multiprocessor synthesis
9. Reliability optimization
10. Real-time systems
11. Scheduling
12. Compilation techniques for embedded systems
13. Embedded operating systems
14. Low-power and power-aware design
15. Communication challenges in distributed embedded systems
16. Novel fabrication techniques for compact and low-power embedded systems
17. Emerging applications (e.g., sensing and actuation intensive applications and user-aware computing)
18. Hardware and software data compression for use in embedded systems

Projects

Starting from the first week of the course, students will start a product–market search process. The goal of this process will be to determine which project direction will best satisfy needs of potential customers. This process will be followed both for those interested in the product design process and those interested in selecting research topics: customers may be researchers and the product may be a research finding.

I will provide examples of project topics, but you are most likely to succeed if you enter the course with a vague interest in discovering or creating something embedded system related that other people in the world would care about. If you want to get started with the process before the course starts (and you should!), please email me for suggestions.

Exams

There will be a final exam covering the assigned reading and activities; the purpose of the exam is to determine whether students have a broad knowledge of the embedded systems research field and the product–market search process. It will be short and cover the basics. The emphasis of the course will be on the projects.

There will be brief quizzes quite frequently. They won't carry much weight, but will make it embarrassing to fall behind on required reading.

Grading

- Product–market search: 30%
- Projects: 30%
- Presentations: 25%
- Exam and quizzes: 15%