Master Course Description for EE484/EE584 (ABET sheet)

Title: Sensors and Sensor Systems

Credits: 4

UW Course Catalog Description

Introduction to optical and solid-state chemical and physical sensors. Topics include transduction mechanisms, design parameters, fabrication methods and applications. Prerequisite: E E 331.

Coordinator: Denise Wilson, Professor, Electrical and Computer Engineering

Goals: This course provides juniors, seniors, and graduate students who have an interest in sensors with an in-depth examination of modern sensor technologies and the application of those technologies to healthcare, agriculture, vehicle safety, sports training, and other contemporary problems of interest. For graduate students and interested graduate students, the course also provides a design experience where student teams can choose a project that incorporates the sensor technology of their choice into a practical and relevant engineering design.

Learning Objectives: At the end of this course, students will be able to:

1. *Analyze* sensor behavior using the governing mechanisms and underlying principles of contemporary sensors and sensor systems.
2. *Formulate and solve* design problems that require the effective use of sensors and related design elements including electronic interface circuits.
3. *Work* in teams with heterogeneous knowledge and skills.
4. *Identify* sensor performance metrics that are relevant to specific sensors, sensing systems, and applications.
5. *Calculate* sensor performance metrics from experimental data.
6. *Identify, understand, and apply* (when applicable) relevant standards to the design of sensors and sensing systems.
7. *Demonstrate* an awareness of benefits and drawbacks of popular technologies as they are applied to different types of sensing.

Textbook: *Class notes, textbook excerpts, and journal articles.*

Prerequisites:

1. Devices and Circuits I (EE 331) or Instructor Permission

Prerequisites by Topic:

1. Fundamental circuit analysis
2. Discrete electronic circuit design
3. Computer literacy with Matlab or Python, word processing, presentation and spreadsheet software
4. Novice capability in Labview or another form of Data Acquisition including the use of Arduino or similar microcontrollers for acquiring data

Topics:

NOTE: In order to avoid content overload or superficial coverage, specific sensors covered in EE484 will depend on the theme (application focus) for a particular offering of the course. For example, an application focus of gait monitoring will emphasize mechanical, optical, and magnetic sensors for detecting strain, bending, acceleration, orientation, and position. An application focus of indoor air quality monitoring, in contrast, would emphasize optical, chemical, and biological sensors for detecting specific chemicals, biological analytes, and particles.

1. Introduction - 0.5 week
2. Theme/Application Focus Overview - 0.5 week
3. Sensor Performance Metrics - 1.0 week
4. Electronic Interface Circuits - 1.0 week
5. Sensor Technologies and Underlying. Principles - 5 weeks
6. Statistical Analysis of (Sensor-based) Experimental Data - 0.5 week
7. Design Project Presentations - 0.5 week

Course Structure: The class typically meets for two lectures a week, each consisting of two 80-minute sessions. The sessions consist of short lectures on sensor topics, examples of sensor technologies and their use in practical systems, small group problem solving exercises, and short tutorials on various other skills (e.g. teamwork, technical communication, statistical analysis of data) that support the goals of the class. Grading for the course includes formative assessment (homeworks and in-class problems) and summative assessment (midterm and final exam)

Computer and Laboratory Resources: Design projects and homeworks will require standard software packages (Matlab, MS Excel, MS Word, MS Powerpoint), programming languages (Python, R) and file sharing (Google, OneDrive). Students may also choose to use campus Maker spaces to gain access to 3-D printing, soldering, and other tools to support design projects.

Grading:

Undergraduate Students: Three exams make up 45% of the grade (15% per exam); homework assignments make up 35% of the grade; in-class problems make up 20% of the grade.

Graduate Students: Three exams make up 45% of the grade (15% per exam); in-class problems make up 20% of the grade; the design project makes up 35% of the grade. The design project will be constrained to the theme/application focus of the course but will otherwise allow for students to make open-ended design choices regarding the types of sensors and configuration of those sensors into a system design to address the application at hand. Graduate students will be required to submit a design project proposal, block diagram, and figures & tables document and make a final project presentation/demonstration. Graduate students will also be encouraged to complete the homework in order to prepare for exams but are not required to submit the homework for a grade.

Optional: undergraduate students may choose to augment their EE484 experience by joining a design project team and receiving credit via EE400X (special topicx) or a similar for-credit option.

ABET Student Outcome Coverage: This course addresses the following outcomes:

H = high relevance, M = medium relevance, L = low relevance to course.

(1) *An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics* (H) The analysis and design of sensor systems requires basic (science) understanding of the governing mechanisms of both sensor and transduction techniques. The interaction between sensor and transduction must also be understood mathematically (including noise analysis). The sensor system design problem presents itself as a series of interconnected engineering problems. Students are expected to use mainstream math processing, data acquisition, and data presentation software to design, analyze, characterize, and summarize sensor and sensor system performance. Students must also use general purpose test equipment and electronic interface circuits to extract system performance from their designs. Evidence of this outcome will emerge from open-ended homework and exam problems.

(3) *An ability to communicate effectively with a range of audiences* (M) Students will complete homework in teams. Teams must prepare assignments using high level technical writing skills that produces explanations and solutions that can be readily understood by technical layman.

(5) *An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives* (M) Students work in teams of 3-4 individuals to complete homework assignments and (where relevant) design projects. Students offer heterogeneous expertise to the team and are expected to articulate their contributions and value to the team.

(6) *An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions* (M). The last two weeks of the course focus on analyzing experimental data from sensors and summarizing relevant performance metrics of sensors and sensor systems to establish the goodness of those sensors relative to commercial technologies (used as benchmarks).

(7) *An ability to acquire and apply new knowledge as needed, using appropriate learning strategies* (L) Students are expected to draw on resources outside of the course readings and course lecture content to support homework assignments and in-class problems.

Prepared By: Denise Wilson

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