Master Course Syllabus for EE 483 (ABET sheet)

Title: Nanotechnology Design

Credits: 4

UW Course Catalog Description

Coordinator: Scott Dunham, Professor, Electrical Engineering

Goals: This capstone design course provides seniors with chosen area of concentration or interest in Sensors and Devices with skills in the open-ended design of a nanoscale solid state device using advanced TCAD tools.

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

1. *Formulate* and *solve* open-ended design problems for electronic and/or optoelectronic devices.

2. *Write* formal project reports.

3. *Make* formal project presentations.

4. *Work* in teams.

5. *Apply* governing mechanisms of device technologies, basic device physics, sources of device variation, and computer simulation to the design of solid state devices whose performance is defined and demonstrated using both standard and specialized metrics.

6. *Demonstrate* an awareness of benefits and drawbacks of predominant device technologies.

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

References

1. Ben G. Streetman and Sanjay K. Banerjee, *Solid State Electronic Devices,* Pearson.
2. *Sentaurus Device User Guide,* Synopsys.

Prerequisites: EE482 or Instructor Permission

Prerequisites by Topic:

1. Understanding of basic semiconductor device physics

2. Knowledge of operation of PN junctions and MOS transistors

3. Ability to apply electrostatics (Poisson's equation)

4. Computer literacy with Matlab, word processing, presentation and spreadsheet software

Topics:

1. Review of Basic Device Physics - 1 week

2. Technology computer aided design tools and applications - 1 week

3. Engineering Design, Design of Experiments, and Statistical Analysis of Data - 1 week

4. Project Reports, Presentations, and Design Project Feedback - 7 weeks

Outcome Coverage: This course provides the ABET major design experience and addresses several basic ABET outcomes.

Outcomes: High, Medium, Low indicates level of coverage

(a, Medium) *An ability to apply knowledge of mathematics, science, and engineering.* The design of solid state devices requires basic (science) understanding of the governing mechanisms of device operation. The interaction between device structure and performance must also be understood mathematically (including variability). Design and implementation of solid state devices to meet performance metrics requires significant application of engineering principles and design methodologies. The device must meet specified and useful (standardized) performance metrics. Demonstration of these metrics through appropriate testing protocols shows the student's achievement of this outcome.

(b, Medium) *an ability to design and conduct experiments, as well as to analyze and interpret data.* The design project requires that students benchmark performance metrics of their device designs against both available commercial products as well as their target metrics in order to establish their usefulness in the designated market. Experiments must be designed to show, statistically, that device design remains within acceptable limits of the benchmark.

(c, High) *an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.* Solid state devices have a vast array of applications with strong impact on the environmental, health, safety, reliability, or social impact of the systems in which they are incorporated. Students develop device specifications and figures of merit in the context of improving a targeted societal impact. For example, students may design a thin film solar cell that reduces manufacturing cost while offering comparable efficiency and reduced environmental impact relative to current technology.

(d, High) *an ability to function on multi-disciplinary teams.* Students will operate in teams of 3-4 to design their devices. Students offer heterogeneous expertise to the device design that evolves as a function of natural interest in particular aspects of the design over others. Students are allowed as much flexibility in assigning team function as possible within the constraints of completing a successful demonstration of their designs. Some students may focus on primary performance characteristics, others on cost or manufacturability or environmental impact.

(e, Medium) *an ability to identify, formulate, and solve engineering problems.* The device design problem presents itself as a series of interconnected engineering problems. In the open-ended design environment, the engineering problems are not explicitly stated, but must be identified by the design team before they can be solved. Evidence of this should appear in the project report and progress reports.

(f, Medium) *an understanding of professional and ethical responsibility.* Students are asked to assess the potential consequences of the design/technology they develop from an ethical perspective. Does the technology (design) in and of itself satisfy a particular code(s) of IEEE ethics? Are unanticipated consequences of the technology possible - are they positive or negative?

(g, High) *an ability to communicate effectively.* Teams must prepare an extensive written project report, and make an oral presentation at the end of the class. Team contributions to the final report are submitted individually and as a final paper product. Teams must demonstrate an effective "storytelling" approach in their final oral presentation, which will be evaluated via a peer marketability survey of each device design. Final reports will be graded based not only on technical content, but also demonstration of effective and convincing technical writing.

(k, High) *an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.* Students are expected to use both mainstream math processing and data presentation software as well as specialized device simulation software to design, analyze, characterize, and summarize device performance. Evidence of the use of these tools, and associated techniques, appears in the project report.

ABET Criterion 4 Considerations

Engineering standards - Students must identify performance specifications which include both standard and application-specific metrics, and then evaluate their designs based on these metrics.

Realistic constraints - The device design chosen and demonstrated by each student team must demonstrate performance metrics competitive with an appropriate benchmark with a cost, power consumption, and manufacturability acceptable for designated application.

Preparer: S.T. Dunham

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