

Master Course Description for EE 332 (ABET sheet)

Title: Devices and Circuits II

Credits: 5 (4 lecture; 1 lab)

UW Course Catalog Description:

Coordinator: Chris Rudell, Associate Professor, Electrical and Computer Engineering

Goals: To teach the physics, characteristics, applications, analysis, and design of circuits using field-effect transistors with an emphasis on small-signal behavior and analog circuits. To understand and apply the principles of device modeling to circuit analysis and design. To gain hands-on experience with laboratory instrumentation and analog circuit troubleshooting, in addition to being introduced to industry-standard Computer Aided Design (CAD) circuit simulation software such as Spectre, SpectreRF and Pspice.

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

1. *Calculate* model parameters for FET devices in Cadence Spectre.
2. *Design* and construct simple single and multi-stage amplifier circuits using mostly FET (CMOS) devices with some limited exposure to bipolar devices.
3. *Explain* the design concepts behind commercial op-amps such as the 741, OP-7, OP-27.
4. *Obtain* a good foundation for senior level electronics design courses such as EE-433, EE-436 and EE-473.
5. *Design* an analog circuit project from an open ended specification.
6. *Use* the Cadence-based simulation tool set for simulation using Spectre and Pspice and employ common practices for circuit simulation of layout and extracted views.

Textbook:

R. C. Jaeger and T. N. Blalock, *Microelectronic Circuit Design*, 5th Ed., New York: McGraw-Hill, 2015.

Prerequisites by Topic:

1. Introductory circuit theory and analysis (EE-215)
2. Basic computer skills
3. Hands-on experience with laboratory instruments (EE-215 and EE-233)
4. Understanding of Fourier Series and analysis

Topics:

1. Introduction to electronic systems: 0.5 week
2. Introduction to FET semiconductor devices and biasing: 1 week

3. Small signal models for FETs: 0.5wk
4. Single-ended amplifiers: 2 weeks
5. Differential amplifiers: 1 week
6. Output stages 0.5 week
7. Basic operational amplifier design: 0.5 week
8. Operational amplifiers: 1 week
9. High frequency amplifiers: 2 weeks
10. Feedback and stability: 1 week

Course Structure: Class meets four days per week for three 50 minute lectures, one 50 minute problem session, plus one three-hour laboratory session each week. There is weekly homework due that includes circuit simulation computer (Cadence-based Spectre Simulations) projects. There are five laboratory experiments including an extensive design project with a formal written report. There will be two midterms and one final in class examination.

Computer Resources: Cadence-based Spectre simulation using the linux lab in Sieg Hall for circuit simulation. MathCad or MATLAB for circuit analysis.

Laboratory Projects:

1. Introductory session (not graded)
2. Basics of transistor operation
3. Transistor amplifier fundamentals
4. Single transistor amplifiers
5. Differential pair amplifiers
6. Output stages
7. Design project (multi-week, open ended)

Laboratory Structure: The course meets for 3 hours per week to conduct laboratory experiments from a lab manual which accompanies the class. The first labs consist of creating a breadboard circuit, then performing a number of measurement tasks using oscilloscopes, spectrum analyzers, DC and AC signal sources. Measurements are written up in a report, then turned in for grading. The labs are conducted in EEB 137 where a parts room provides components as needed for the experiments. The laboratory portion of the course concludes with a larger multi-week project.

Grading: Weights given; each midterm examination (10%), final examination (20%), design project and laboratory reports (30%), homework and tutorials (20%).

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 vast majority of the lectures deal with the application of circuit theory, device modeling and electronic

circuit analysis. Mathematical formulations are commonplace throughout the course. In addition, problem formulation and solving skills are required to define and resolve device, circuit and simulation problems.

- (2) *An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors* **(M)** Some laboratory projects could lead to engineering-based designs that help promote public health, safety, welfare, cultural and social factors, in a very generic sense. The circuits analysis and design techniques used in this class could lead to larger electronic systems which do impact all of the aforementioned areas.
- (3) *An ability to communicate effectively with a range of audiences* **(M)** Design project reports are required to be styled and formatted to present the instructor or TA. Emphasis is placed upon clear descriptions of circuit and device operation, with illustrative schematic diagrams.
- (4) *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)** The lab and project design problems are addressed by teams of 2-3 students who must work together to complete breadboard circuit projects which include measurements of commonly accepted figures of merit.
- (5) *An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions* **(M)** The course involves direct experience with the design of semiconductor integrated circuits and experimentation with simulation software. Laboratory experiments require students to measure and acquire data as well as interpret the results in their lab reports.
- (6) *An ability to acquire and apply new knowledge as needed, using appropriate learning strategies* **(M)** The course focuses on an intermediate-level of circuit analysis and design of electronic circuits. Knowledge acquired in this course is necessary for higher-level advanced circuit classes such as EE-433, EE-473 and EE-436.

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