ECE 333 - Electronics I
For the current syllabus, see the BB, this is for orientation only

Dr. Jacek M. Zurada, Professor
Department of Electrical and Computer Engineering, Lutz 405
PHONE: 502 852-6314 | FAX: 502 852-3940
URL: http://ci.louisville.edu/zurada EM: jacek.zurada@louisville.edu
(open door policy, making an appointment recommended only for longer consultations)

Online Catalog Description:

ECE 333 Electronics I. Credit 3. Prerequisite: ECE 220, ECE 221. Co-requisites: ECE 320, ECE 334. Introduction to electronic devices and the basic circuits. The course deals with the op-amp, diode, the bipolar junction transistor, and the field-effect transistor. Biasing, small-signal and large signal analysis and the principles employed in the design of electronic circuits are included in the course.

Textbook and OUP Student Website:

Sedra and Smith, Microelectronic Circuits, 7th ed., Oxford University Press 2015, ISBN 978-0-19-933913-6
http://global.oup.com/us/companion.websites/9780199339136/student/
http://global.oup.com/us/companion.websites/9780199339136/student/spice/

Objectives:

The course is designed to give sophomore/junior students an ability to analyze and design linear circuits using discrete semiconductor devices. The fundamentals of linear-integrated circuits are also included.

Teaching Assistant:

TBD

Course Learning Outcomes: Students who complete this course will be able to:

1. Describe fundamental electrical characteristics of semiconductors.
2. Analyze circuits containing diodes and resistors to determine the voltage at all the nodes and the current through all the elements.
3. Analyze and design half-wave and full-wave rectifier circuits with and without filters using diodes and capacitors.
4. Analyze and design wave shaping circuits using diodes.
5. Describe the fundamental characteristics of Metal-Oxide-Semiconductor Field-Effect-Transistors (MOSFET's).
6. Analyze circuits containing MOSFET's and resistors to determine the voltage at all nodes and the current through all elements.
7. Analyze basic amplifier circuits constructed with MOSFET's to determine input resistance, output resistance and gain.
8. Describe the fundamental characteristics of Bipolar Junction Transistors (BJT's).
9. Analyze circuits containing BJT's and resistors to determine the voltage at all nodes and the current through all elements.
10. Analyze basic amplifier circuits constructed with BJT's to determine input resistance, output resistance and gain.
11. Specify general amplifier requirements.
12. Analyze and design circuits using operational amplifiers.
13. Describe the factors that determine the frequency response of amplifiers.
14. Write elementary SPICE programs to simulate the electrical characteristics of MOSFET's and BJT's.
15. Write elementary SPICE programs to simulate the operation of basic MOSFET and BJT amplifier circuits.

Topics Covered by Class Schedule (3 sessions/week, 50 minutes/session), Chapters in brackets:
1. Introduction (1 class) [1]
2. Physics and electrical characteristics of P-N junction diodes (1 class) [3,4]
3. Diode modeling and diode circuit analysis (2 classes) [4]
4. Rectifier circuits (3 classes) [4]
5. Wave shaping circuits (2 classes) [4]
6. Introduction to SPICE (1 class) [Appendix B, Students Website]
7. MOSFET physics and electrical characteristics (3 classes) [5]
8. MOSFET DC circuits and biasing (3 classes) [5]
9. BJT physics and electrical characteristics (3 classes) [6]
10. BJT DC circuits and biasing (3 classes) [6]
11. Small signal analysis of BJT amplifier circuits (3 classes) [7]
12. BJT high frequency model and frequency response of CE amplifier (2 classes) [7]
13. Small signal analysis of MOSFET amplifier circuits (3 classes) [7]
14. MOSFET high frequency model and frequency response of CS amplifier (2 classes) [7]
15. Op-amps, differential, inverting, non-inverting and multistage amplifiers, linear integrated circuits (3 classes) [2]
16. Frequency response, gain-bandwidth product (2 classes) [2]
17. Exams (4 classes, tentatively)

Topics Covered by Laboratory Schedule:
    See ECE 334.

Computer Use:
    Selected homework problems are done using PSPICE.

Evaluation:

Homework :	30%, late assignments accepted before solutions posted, with 10% penalty/day	
Tests (~4)	48%, closed books/notes, only non-programmable calculators allowed	
Final exam	22%, TBD	

Grading Scale:

[97, 100] = A+   [92, 97) = A   [88, 92) = A-   [84, 88) = B+   [80, 84) = B   [76, 80) = B-
[72, 76) = C+   [68, 72) = C   [64, 68) = C-   [60, 64) = D+   [56, 60) = D   [52, 56) = D-
[00, 52) = F

Academic Integrity
    Students are reminded of academic integrity. Except for initial discussion of homework problems, assignments need to be done as individual efforts and bear the usual hallmark of individual's work. Cheating will not be tolerated, and academic penalties will be imposed if cheating is detected. For more information of general nature please refer to the Code of Student Rights and Responsibilities at http://louisville.edu/dos/policies-and-procedures/code-of-student-rights-and-responsibilities.html

<u>**Title IX/Clery Act Notification**</u>
Sexual misconduct (including sexual harassment, sexual assault, and any other nonconsensual behavior of a sexual nature) and sex discrimination violate University policies. Students experiencing such behavior may obtain **confidential** support from the PEACC Program (852-2663), Counseling Center (852-6585), and Campus Health Services (852-6479). To report sexual misconduct or sex discrimination, contact the Dean of Students (852-5787) or University of Louisville Police (852-6111).

Disclosure to University faculty or instructors of sexual misconduct, domestic violence, dating violence, or sex discrimination occurring on campus, in a University-sponsored program, or involving a campus visitor or University student or employee (whether current or former) is **not confidential** under Title IX. Faculty and instructors must forward such reports, including names and circumstances, to the University's Title IX officer.

For more information, see the <u>Sexual Misconduct Resource Guide</u>.

ECE 334 Electronics I Laboratory

Note: Grading Scale, Academic Integrity, Title IX/Clery Act Notifications apply from ECE 333 Course Outline

Catalog Description:
> ECE 334 Electronics I Laboratory, Credit 1. Prerequisite: ECE 221. Corequisite: ECE 320, ECE 333. Weekly laboratory to illustrate experimental analysis and design principles of electronic circuits.

Prerequisite (by Topic):
> Network theory including dependent sources, two-port descriptions and network functions.

Textbook:
> Laboratory Explorations to Accompany Microelectronic Circuits, 7th Ed. Oxford University Press, by Gaudet and Smith (one copy per group recommended)

Reference:
> Sedra and Smith, Microelectronic Circuits, 7th Ed., Oxford University Press, 2015.

Objectives:
> The student is required to use theoretical knowledge in the actual design, construction, testing, and operation of various electronic circuits covered in the ECE 333 course. Students use component kits, boards, and standard measuring equipment (oscilloscopes, signal generators, voltmeters and ammeters).

Lab Instructor: TBD

Course Learning Outcomes: At the completion of this course, students will be able to:
1. Operate equipment and instrumentation such as power supplies, multi-meters, function generators, and oscilloscopes.
2. Construct an electronic circuit from a schematic diagram.
3. Analyze the electrical characteristics of diodes, field-effect transistors and bipolar-junction transistors by using laboratory equipment.
4. Accurately document experimental work.
5. Work successfully in teams.

Topics Covered by Laboratory Schedule:
1. Oscilloscope and Function Generator (1 class)
2. Measurement Techniques (1 class)
3. Diode Characteristics (1 class)
4. Half-wave and Full-wave Rectification (1 class)
5. Light Emitting and Zener Diodes (1 class)
6. JFET Characteristics (1 class)
7. Design of JFET (MOSFET) Bias Circuits (1 class)
8. Common-Source Transistor Amplifiers (1 class)
9. BTJ Characteristics (1 class)
10. Design of BJT Bias Circuits (1 class)
11. Common-emitter Amplifiers (1 class)
12. Design of Common-emitter Amplifiers (1 class)
13. Linear Op-Amp Circuits (2 classes)

Evaluation:
> Lab reports: 100%. All lab reports are graded evenly

Preparation:
Make sure that you review the lab assignment before the scheduled lab, study the appropriate material and perform hand calculations and SPICE simulations (if applicable). Read the complete assignment for a specific lab as part of your preparation to meet all the requirements. All preparation work must be included in your lab report.

Expectations:
All members must be present when a lab is performed in a group, and all members must fully participate in all aspects of the experiment. Makeup labs will be limited and will be allowed only with prior arrangement with the instructor, or for extraordinary circumstances.

Do your lab work carefully and make sure of the following before you leave the lab:

- have you taken note of all the data needed?
- have scope traces been correctly labeled?
- have scope traces been correctly scaled?
- does your data make sense?

Reports:
Each group submits one report. Complete the report on your tablet and print a copy for the TA. The report must be done neatly and must include all preparation work, measurements and graphs. Diagrams are to be drawn neatly, axes and units clearly labeled. If measurements do not agree with the expectations, the errors require addressing.
Lab reports handed in late will only be accepted by prior arrangement. They shall be due before the start of the following lab and not later than one week after the lab was performed.
One team member can write the lab report for one lab, and then another team member writes for the next lab. Alternatively, team members can write different sections of every report. Either way, indicate which way the lab report is written on the cover page.

Tentative Schedule:

Lab	Topic	Comments
1	Oscilloscope, Function Generator, Digital Multi-meter, and DC Voltage Source Operations	Explanation and Handout will be given in lab.
2	Lab 4.1 – Diode I-V Transfer Curve Complete *Part 1: Design and Analysis*, prior to the lab as preparation.	**Required**: Complete parts 2 and 3 in the lab Optional: complete part 4
3	Lab 4.2 – Fun with Diodes I: Rectifiers Complete *Part 1: Design and Analysis*, prior to the lab as preparation.	**Required**: Complete parts 2 and 3 in the lab Optional: complete part 4
4	Lab 5.1 – NMOS I-V Characteristics Complete *Part 1: Design and Analysis*, prior to the lab as preparation.	**Required**: Complete parts 2 and 3 in the lab Optional: complete part 4
5	Lab 7.7 – NMOS Source Follower Complete *Part 1: Design and Analysis*, prior to the lab as preparation.	**Required**: Complete parts 2, 3 and 4 in the lab Optional: complete part 5
6	Lab 6.1 – NPN I-V Characteristics Complete *Part 1: Design and Analysis*, prior to the lab as preparation.	**Required**: Complete parts 2 and 3 in the lab Optional: complete part 4
7	Lab 7.9 – NPN Common-Emitter Amplifier Complete *Part 1: Design and Analysis*, prior to the lab as preparation.	**Required**: Complete parts 2, 3 and 4 in the lab Optional: complete part 5
8	Lab 7.17 – NMOS vs. NPN: Common-Source/Common-Emitter Amplifier Comparison Complete the *Hand calculations and Simulations of Parts 1 and 2*, prior to the lab as preparation.	**Required**: Complete the prototyping and measurements of parts 1 and 2, and part 3 in the lab
9	Lab 2.1 – Inverting Op-Amp Configuration Complete *Part 1: Design and Analysis*, prior to the lab as preparation.	**Required**: Complete parts 2 and 3 in the lab Optional: complete part 4
10	Lab 2.4 – Instrumentation amplifier Complete *Part 1: Design and Analysis*, prior to the lab as preparation.	**Required**: Complete parts 2 and 3 in the lab Optional: complete part 4