



# San Francisco State University

## Electrical Engineering

### Course Outline for ENGR 301 Microelectronics Laboratory

Fall, 2024

#### **Bulletin Description:**

ENGR 301 Microelectronics Laboratory

Section 02, Fr 3:30pm - 6:15pm

This course contains measurement techniques, device characterization, experimental verification and LTspice simulation of second-order transient and frequency responses, diodes, BJTs, FETs, and their applications. This course is second in a series of courses (ENGR 301 or ENGR 302, ENGR 696 and ENGR 697), that after completed with a C or better will culminate in the satisfaction of the University Written English Proficiency/GWAR.

#### **Prerequisites:**

ENGR 353 (may be taken concurrently or completed with “C” or better). Engineering students must have a copy of the course approval form on file.

#### **Textbook:**

Lab Manual for ENGR 301, downloadable from Canvas.

#### **References:**

1. Razavi, B.: Fundamentals of Microelectronics, 2<sup>nd</sup> edition, John Wiley Press, 2014.
2. Online LTspice tutorials.
3. Online Eagle Tutorials.

#### **Instructor: Mojan Norouzi**

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**Prerequisites by Topic:**

1. Ability to use standard instrumentation such as multi-meters, oscilloscope, power supplies and function/pulse generators.
2. Ability to conduct experiments, perform laboratory measurements and plot/interpret experimental data.
3. Ability to use LTspice (or other spice simulator) for simple circuit simulations.
4. Ability to write laboratory reports, emphasizing technical merit as well as communication skills, both graphic and written.

**Course Objectives:**

1. To measure the characteristics of common electronic devices, such as diodes, BJTs, FETs, and op amps.
2. To observe experimentally the behavior of the aforementioned devices in a variety of common applications, such as rectification, regulation, amplification.
3. To simulate the aforementioned circuits via LTspice, and to compare with experimental observations.
4. To plot, analyze, interpret data, and to prepare technical reports of appropriate quality.

**Topics:**

1. Second-order step responses under various damping conditions, frequency responses, Bode Plots.
2. Diode characteristics, and basic diode applications, such as rectifiers and regulators.
3. BJT characteristics, and basic BJT applications.
4. MOSFET characteristics, and basic MOSFET applications.

**Evaluation:**

- Lab report: 60%
- Quiz: 10%
- Final Project: 30%

**Expectations:**

1. Lab report must be submitted on time (Hard and soft copy).
2. There will be 4 quizzes (closed book and note).
3. Students should be in class every lab session. However, if necessary, the student can miss **only 1** class session without any penalty. Subsequent absences will result in 1 point deduction.



<b>A</b>	<b>A-</b>	<b>B+</b>	<b>B</b>	<b>B-</b>
≥ 90%	85% ~ 89%	80% ~ 84%	75% ~ 79%	70% ~ 74%
<b>C+</b>	<b>C</b>	<b>C-</b>	<b>F</b>	
65% ~ 69%	60% ~ 64%	55% ~ 59%	≤ 54%	

**Relationship to Other Courses:**

This course extends the introductory laboratory practices of ENGR 206 to a more advanced level, focusing on the electronic devices studied in ENGR 353, which students are encouraged to take concurrently or prior to ENGR 301. ENGR 301 also prepares the student for ENGR 442, 445, 453, and 455, in which it is a prerequisite.

**Disability Statement Policy**

Students with disabilities who need reasonable accommodations are encouraged to contact the instructor. The [Disability Programs and Resource Center (DPRC)] is available to facilitate the reasonable accommodations process. The DPRC is located in the [Student Service Building and can be reached by telephone (voice/TTY 415-338-2472) or by email ([dprc@sfsu.edu](mailto:dprc@sfsu.edu)). (<http://www.sfsu.edu/~dprc>)].



### **Student Disclosures of Sexual Violence**

SF State fosters a campus free of sexual violence including sexual harassment, domestic violence, dating violence, stalking, and/or any form of sex or gender discrimination. If you disclose a personal experience as an SF State student, the course instructor is required to notify the Title IX Coordinator by completing the report form available at <http://titleix.sfsu.edu>, emailing [ypsam@sfsu.edu](mailto:ypsaem@sfsu.edu) or calling 338-2032.

### **To disclose any such violence confidentially, contact:**

- The SAFE Place - (415) 338-2208; [http://www.sfsu.edu/~safe\\_plc/](http://www.sfsu.edu/~safe_plc/)
- Counseling and Psychological Services Center - (415) 338-2208; <http://psyservs.sfsu.edu/>
- For more information on your rights and available resources: <http://titleix.sfsu.edu>

### **Policy on Observance of Religious Holidays**

If a student wishes to observe religious holidays and such observances require the student to be absent from class activities, it is the responsibility of the student to inform the instructor, in writing, about such holidays during the first two weeks of the class each semester. If such holidays occur during the first two weeks of the semester, the student must notify the instructor, in writing, at least three days before the date that he/she will be absent.

### **Performance Criteria:**

#### *Objective 1*

- 1.1 Students will demonstrate an ability to characterize practical operational amplifiers.
- 1.2 Students will demonstrate an ability to characterize junction diodes. Students will demonstrate an ability to characterize bipolar transistors.
- 1.3 Students will demonstrate an ability to characterize field-effect transistors.

#### *Objective 2*

- 1.1 Students will be able to verify experimentally popular diode applications such as rectification and regulation, and compare with theoretical prediction.
- 1.2 Students will be able to verify experimentally popular BJT applications such as amplification and digital logic, and compare with theoretical predictions.
- 1.3 Students will be able to verify experimentally popular FET applications such as amplification and digital logic, and compare with theoretical predictions

#### *Objective 3*

- 3.1 Students will demonstrate a skill to use LTspice to simulate the transient and frequency responses of a second-order circuit, and compare with experimental observations.
- 3.2 Students will demonstrate a skill to use LTspice to simulate the diode circuits investigated in the lab, and compare with measured data.
- 3.3 Students will demonstrate a skill to use LTspice to simulate the BJT and MOSFET amplifiers investigated in the lab, and compare with measured data.
- 3.4 Students will demonstrate a skill to use LTspice to simulate the BJT and MOSFET logic circuits investigated in the lab, and compare with measured data.



*Objective 4*

- 4.1 Students will demonstrate an ability in collecting, plotting, and interpreting experimental data, comparing with theoretical predictions, and accounting for discrepancies.
- 4.2 Students will demonstrate a skill in the presentation of experimental results via effective graphic means, such as i-v characteristics, Bode Plots, voltage transfer curves, and waveforms.
- 4.3 Students will demonstrate a skill in technical report preparation emphasizing both technical merit and effective writing.