San Francisco State University
Electrical Engineering

Course Outline for ENGR 301 Electrical Measurements

Bulletin Description:
301 Electrical Measurements (1) F,S
Prerequisite: ENGR 300 and 353 (may be taken concurrently). Measurement techniques, device characterization, experimental verification, and PSpice simulation. 2nd-order transient and frequency responses. Characterization of op amps, diodes, BJTs and FETs. Diode circuits, transistor amplifiers, simple logic gates. Laboratory. Extra fee required.

Textbook:
Franco, Sergio and Klingenberg, Larry: *Lab Manual for ENGR 301*, downloadable from the Web (URL to be provided by the instructor).

References:
1. Sedra, Adel S., and Smith, Kenneth C.: *Microelectronics*, 4th Ed, Oxford Univ. Press, 1997.
2. Roberts, Gordon W., and Sedra, Adel S.: *SPICE*, 2nd Ed.; Oxford Univ. Press, 1997.

Coordinator:
Sergio Franco, Professor of Electrical Engineering

Prerequisites by Topic:
1. Ability to use standard instrumentation such as multi-meters, oscilloscope, power supplies, and function/pulse generators, as gained in ENGR 206.
2. Ability to conduct experiments, perform laboratory measurements and plot/interpret experimental data, as gained in ENGR 300.
3. Ability to use PSpice 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, and to compare with theoretical prediction. {A.1, B.1, B.2}*
2. To observe experimentally the behavior of the aforementioned devices in a variety of common applications, such as rectification, regulation, amplification, and digital logic, and to compare with theoretical prediction. {A.2, B.1, B.2}
3. To simulate the aforementioned circuits via PSpice, and to compare with experimental observations. {B.3}
4. To plot, analyze, and interpret data, and to prepare technical reports of appropriate quality.

{B.1, B.2}

**Refers to School of Engineering desired outcome*

Topics:

1. Second-order step responses under various damping conditions; frequency responses, Bode Plots.
2. Static and dynamic nonidealities of practical op amps.
3. Diode characteristics, and basic diode applications as rectifiers and regulators.
4. Transistor (BJT and MOSFET) characteristics, and basic transistor applications as amplifiers and logic circuits.
5. Computer simulation of op amp, diode, and transistor circuits using PSpice; comparison with experimental observations.

Professional Component:

1. Engineering Sciences: 100%
2. Engineering Design: 0%

Evaluation

<u>(This part is prepared by the instuctor actually teaching the lab)</u>

Performance Criteria:

<u>Objective 1</u>

- 1.1 Students will demonstrate an ability to characterize practical operational amplifiers. [2,3,4]*, {A.1, B.1, B.2}**
- 1.2 Students will demonstrate an ability to characterize junction diodes. [2,3,4], {A.1, B.1, B.2}
- 1.3 Students will demonstrate an ability to characterize bipolar transistors. [2,3,4], {A.1, B.1, B.2}
- 1.4 Students will demonstrate an ability to characterize field-effect transistors. [2,3,4], {A.1, B.1, B.2}

<u>Objective 2</u>

- 2.1 Students will be able to verify experimentally popular diode applications such as rectification and regulation, and compare with theoretical prediction. [2,3], {A.2, B.1, B.2}
- 2.2 Students will be able to verify experimentally popular BJT applications such as amplification and digital logic, and compare with theoretical predictions. [2,3], {A.2, B.1, B.2}
- 2.3 Students will be able to verify experimentally popular FET applications such as amplification and digital logic, and compare with theoretical predictions [2,3], {A.2, B.1, B.2}

<u>Objective 3</u>

- 3.1 Students will demonstrate a skill to use PSpice to simulate the transient and frequency responses of a second-order circuit, and compare with experimental

observations. [4], {B.3}

3.2 Students will demonstrate a skill to use PSpice to simulate the diode circuits investigated in the lab, and compare with measured data. [4], {B.3}

3.3 Students will demonstrate a skill to use PSpice to simulate the BJT and MOSFET amplifiers investigated in the lab, and compare with measured data. [4], {B.3}

3.4 Students will demonstrate a skill to use PSpice to simulate the BJT and MOSFET logic circuits investigated in the lab, and compare with measured data. [4], {B.3}

Objective 4

4.1 Students will demonstrate an ability in collecting, plotting, and interpreting experimental data, comparing with theoretical predictions, and accounting for discrepancies. [1,2], {B.1, B.2}

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. [1,2], {B.1, B.2}

4.3 Students will demonstrate a skill in technical report preparation emphasizing both technical merit and effective writing. [1,2], {B.1, B.2}

*Numbers in brackets [] refer to evaluation method
**Related School outcomes {}

Class/Laboratory Schedule:
One 3-hour lab/week

Scheduled Experiments:
1. Time and Frequency Response of Series *RLC* Circuits
2. Operational Amplifier Characteristics
3. Diode Characteristics and Applications
4. BJT Characteristics and Applications
5. MOSFET Characteristics and Applications
6. Logic Circuit Characteristics and Simple Logic Gates

Notes on Prerequisites:
Engineering students must have a copy of the course approval form on file. Non-engineering students must submit a copy of the grade report showing the appropriate course grades for ENGR 205 and 206.

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, to which it is a required prerequisite.