COURSE OUTLINE

ELEC-211
Analog Circuits
4 Semester Hours

HOWARD COMMUNITY COLLEGE

Description

The student will become capable of assembling and analyzing analog circuits. Topics include: FET characteristics and circuits, differential amplifiers, integrated circuit fabrication, negative and positive feedback, operational amplifier characteristics, analysis of common operational amplifier circuits, Class B power amplifiers; power supply characteristics, and circuits using discrete and integrated circuit technology. Prerequisite: ELEC-114. (3 hours lecture, 3 hours lab)

Overall Course Objectives

Upon completion of this course, the student will be able to:

1. Compare the four differential amplifier configurations and determine the voltage gain, differential input resistance, and the output resistance for a given differential amplifier configuration.
2. Define common mode rejection ratio (CMRR) and explain its significance.
3. Analyze a given differential amplifier or design a differential amplifier to meet the given specifications using swamping resistors with constant current bias circuit.
4. Explain the use of a level translator circuit with the cascaded differential and design it to meet the given requirements.
5. Discuss the general properties of an operational amplifier (op-amp), draw the schematic symbol for an op-amp showing its three signal terminals and discuss the important considerations given in selecting an IC package.
6. Extract from data sheets some of the basic op-amp characteristics and define the terms: input offset voltage, input offset current, CMRR, large signal voltage gain and slew rate.
7. List the electrical characteristic of an ideal op-amp, draw an equivalent circuit of an op-amp, and draw and explain the three open-loop op-amp configurations.
8. Discuss the characteristics of positive and negative feedback circuits and draw the block diagram for each of the four negative feedback configurations and explain their significance.
9. Calculate the closed-loop voltage gain, the input resistance, the output resistance, the bandwidth, and the total output offset voltage for the following: noninverting amplifier, voltage follower (special case of noninverting amplifier), and inverting amplifier.
10. Draw the three differential amplifier configurations based on the number of op-amps used and compare and contrast the three differential amplifier configurations.
11. Compare and contrast an ideal op-amp and the practical op-amp, design offset-voltage compensating networks and determine the total output offset voltage.
12. Define the frequency response of an op-amp and show graphically on the open-loop gain curve of an op-amp the relationship between the closed-loop gain and the bandwidth for a noninverting amplifier.
13. Define circuit stability, break frequency, bandwidth, slew rate and unity-gain frequency and explain the differences between bandwidth, transient response and slew rate.
14. Explain the major differences between dc and ac amplifiers, analyze the operation of an ac amplifier, and discuss the operation of an ac amplifier with a single power supply.
15. Analyze or design op-amp circuits for the following linear amplifiers: a summing amplifier, a scaling amplifier, an averaging amplifier, a subtractor circuit, an instrumentation amplifier, a voltage-to-current converter, a low-voltage dc voltmeter, a zener diode tester, an integrator and a differentiator.
16. Analyze or design and draw the frequency response for the following: a low-pass, a high-pass, a band-pass, a band-reject and an all-pass filter.

17. Discuss oscillator principles, oscillator types, and frequency stability for the following oscillators: phase shift, Wien bridge, quadrature, square wave and triangular wave generators, and a voltage-controlled oscillator.
18. Discuss the operation of a basic comparator circuit, draw its input-output waveforms and explain the operation of a zero-crossing detector, a Schmitt trigger circuit.
19. Discuss the operation of some of the most commonly used D/A and A/D converters.
20. Explain the operation of positive and negative clipper, clamper, absolute-value output circuit, peak detector and sample-and-hold circuit.

Major Topics

I. Differential Amplifiers
   - A. Types
   - B. Constant Current Bias
   - C. Cascaded Diff Amp
   - D. Level Translator

II. Introduction to Op-Amps
   - A. Block Diagram
   - B. Schematic Symbol and ICs
   - C. Manufacturers Designations
   - D. Device Identification

III. Characteristics of an Op-Amp
   - A. Data Sheets
   - B. Ideal Op-Amp
   - C. Open-Loop Op-Amp Configurations

IV. Op-Amp with Negative Feedback
   - A. Feedback Configurations
     1. Noninverting
     2. Inverting
     3. Differential
   - B. Gain and Bandwidth

V. Practical Op-Amp
   - A. Total Output Offset Voltage
   - B. Noise
   - C. CMRR

VI. Frequency Response of an Op-Amp
   - A. Frequency Response (open-loop and closed-loop)
   - B. Circuit Stability
   - C. Slew Rate

VII. Linear Applications
   - A. DC and AC Amplifiers
   - B. Single Supply Voltage
   - C. Summing, Scaling and Averaging Amplifiers
   - D. Instrumentation Amplifier
   - E. Converters
   - F. Integrator and Differentiator

VIII. Active Filters and Oscillators
   - A. Active Filters
   - B. Oscillators
   - C. Voltage-Controlled Oscillator

IX. Comparators and Converters
   - A. Basic Comparator
   - B. Zero-Crossing Detector
   - C. Schmitt Trigger
   - D. A/D and D/A Converters
   - E. Clippers and Clampers
   - F. Sample-and-Hold Circuit

Course Requirements

Grading/exams: Grading procedures will be determined by the individual faculty member but will include tests, a final exam and lab reports.

Writing: Each lab will require a written comprehensive summary of results.

Math: Algebra and trigonometry are utilized to calculate circuit operations.

Other Course Information

This course is a course in Biomedical, Computer, Electronic and Telecommunications Technology programs.