

COURSE OUTLINE

ELEC-114

Semiconductor Devices

3 Semester Hours

HOWARD COMMUNITY COLLEGE

Description

The student will learn and apply solid-state theory of diodes and bipolar transistors across the following topics: diode rectifiers and filtering, zener regulation, clippers and clampers, biasing circuits, small signal amplifiers, frequency effects, Class A amplifiers and the transistor switch. The student will be able to analyze with equivalent circuits, single-stage and multi-stage amplifiers and understand the characteristics of diodes and transistors. Prerequisite: Eligible to enroll in ENGL-101; Pre- or Co-requisite: ELEC-107 or ELEC-112. (2 hours lecture, 3 hours lab)

Overall Course Objectives

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

1. Describe how a pn junction (semiconductor diode) is formed, discuss its characteristics and explain how it works with respect to forward bias and reverse bias.
2. Explain what the diode characteristic curve indicates for the ideal model, the barrier potential model and the complete model (barrier potential, forward resistance, and reverse resistance) and define the terms anode and cathode.
3. Explain how various rectifier circuits (half-wave, center-trapped full wave, and full wave bridge) function and calculate the average output voltage and peak inverse voltage for each rectifier type.
4. Describe how a capacitor filter smoothes out a rectified voltage and explain how the value of the filter capacitor determines the amount of ripple voltage.
5. Explain the operation of diode limiters (clippers), diode clampers, and voltage doubler and triplers.
6. Interpret diode data sheets and troubleshoot (pencil-paper and in lab) diode circuits.
7. Explain the zener diode characteristic curve, discuss various zener characteristics and parameters and use a zener diode for voltage regulations (line regulation and load regulation).
8. Describe the basic construction of a bipolar junction transistor (BJT), identify npn and pnp transistors, define the transistor currents and how they are related and interpret the characteristic curves of a transistor.
9. Explain how a transistor is biased for use as an amplifier and how the transistor produces gain in amplifier circuits.
10. Identify various transistor packaging configurations and their terminals, troubleshoot basic transistor bias circuits and test transistors in-circuit or out-of-circuit.
11. Define linear operation in relation to transistor characteristic curves and loadline, and analyze the bias of a transistor that operates as a linear amplifier.
12. Explain how the dc bias point (Q point) affects the linear operation of a transistor and determine by graphical analysis how much input signal a given biased transistor can take without being driven into either cutoff or saturation.
13. Discuss various types of dc bias circuits (calculating Q point and determining load line) and their characteristics and explain the meaning of bias stability and describe how the type of bias affects the stability of a transistor circuit.
14. Analyze a transistor amplifier using r parameters in the CE, CC and CB configuration and explain (calculate) voltage gain, input resistance, and output resistance of an amplifier.
15. Explain how loading and emitter bypass capacitors affect the voltage gain of an amplifier and distinguish between direct-coupled, transformer coupled, and capacitively coupled amplifiers.
16. Show how voltage gain is increased by connecting amplifiers in cascade (express voltage gain and power gain in decibels) and troubleshoot multistage amplifiers.

17. Distinguish between large-signal and small signal operation, define class A, class B, and class C operation and discuss factors that contribute to non-linear distortion.
18. Explain the operation of a class B push-pull amplifier and cross over distortion.
19. Define what is meant by frequency response of an amplifier and identify (calculate) the critical frequencies caused by coupling, bypass and transistor internal capacitances.
20. Define the midrange gain and roll-off of an amplifier and draw a Bode plot (gain vs. frequency) of an amplifier.
21. Measure an amplifier's frequency response by two methods: amplitude vs. frequency and step response.
22. Analyze junction field-effect transistors (JFET) bias circuits and determine the gain of a FET amplifier.
23. Design an inverter circuit (transistor used as a non-linear switch) and accurately measure the rise-time, fall-time, delay-time, storage-time, and on and off time using a delayed-sweep oscilloscope and use speed-up capacitors to improve the switching characteristics.

Major Topics

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| I. Diodes | |
| A. Semiconductor Materials and PN Junctions | |
| B. Applications | |
| II. Bipolar Junction Transistors | |
| A. Parameters | |
| B. Bias and Amplification | |
| C. Packages and Terminal Identification | |
| III. Bipolar Transistor Biasing | |
| A. DC Operating Point and Load Line | |
| B. Types of Bias | |
| C. Stability | |
| IV. Small-Signal Bipolar Amplifiers | |
| A. Small Signal Amplifications | |
| B. Amplifier Gain | |
| C. CE, CC and CB Amplifiers | |
| D. Multistage Amplifiers | |
| | V. Power Amplifiers |
| | A. Class A |
| | B. Class B Push-Pull |
| | C. Class C |
| | VI. Amplifier Frequency Response |
| | A. Midrange Gain |
| | B. Critical Frequencies and Roll-Off |
| | C. Bode Plot |
| | D. Response Measurement Techniques |
| | VII. Junction Field-Effect Transistors (JFET) |
| | VIII. Transistor As A Switch (Inverter) |

Course Requirements

Grading/Exams: Final grades will be calculated on the basis of tests, lab reports and a final exam.

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

Math: Algebra and trigonometry are utilized to calculate circuit operation and gain.

Other Course Information

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