Solid State Circuits (CETT 1441)

Credit: 4 semester credit hours (3 hours lecture, 4 hours lab)

Prerequisite: CETT 1403 & CETT 1405

Course Description

A study of various devices incorporated in circuits and their applications. Emphasis on circuit construction, measurement, and analysis.

Required Textbook and Materials

1. *Solid State Fundamentals* by Gary Rockis, American Technical Publishers
    a. ISBN number is 978-0-8269-1637-2
2. Flash Drive – 1GB Minimum
3. Notebook.

Course Objectives

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

1. Analyze circuit operation with various semiconductor device application.
2. Measure, test, and troubleshoot circuits containing various semiconductor devices.
3. Describe the AC small signal development from input to output of a FET voltage follower/configuration.
4. Describe the AC small signal development from input to output of a BJT push-pull amplifier.

Course Outline

A. Safety
    1. Tool Safety
    2. Grounding
    3. PPE
    4. Electrical Shock
    5. Overcurrent Protection
    6. Lockout/Tagout
    7. Fire Safety
    8. Hazardous Locations
    9. Electrostatic Discharge
    10. Binary-Coded-Decimal System

B. PC Board Construction and Repair
    1. PC Board Construction
    2. PC Board Service
    3. Soldering PC Boards

C. Semiconductor Diodes
    1. Rectifiers
    2. Diode Markings
    3. Understanding Semiconductor Materials
    4. Operating Characteristic Curves
    5. Testing Diodes
    6. Diode Installation and Service
    7. Diode Power Capacity and Derating
    8. Practical Applications of Diodes
    9. Zener Diode
    10. Zener Diode Test
    11. Zener Diode Applications

D. DC Power Supplies-Single Phase
    1. Rectifiers
    2. AC and DC voltage Measurements in Rectifier Circuits
    3. Testing Half-wave Rectifiers
    4. Testing Full-wave Rectifiers

5. Testing Full-wave Bridge Rectifiers
6. Power Supply Filters
7. Filters and Peak Inverse Voltage
8. Voltage Divider
9. Voltage Multiplier

E. Solid State Transducers
1. Thermistor
2. NTC Thermister Applications
3. PTC Thermister Applications
4. Testing Thermisters
5. Solid State Pressure Sensor
6. Semiconductor Photoelectric Transducers
7. Hall Effect Sensors
8. Light Emitting Diodes
9. Liquid Crystal Displays

F. Transistor As A DC Switch
1. Transistor Terminal Arrangements
2. Biasing Transistor Junctions
3. Transistor Operating Characteristic Curves
4. Transistor as a DC Switch
5. Establishing a Load Line
6. Biasing Transistors
7. Power Dissipation
8. Testing Transistors
9. Transistor Switching Applications

G. Silicon Controlled Rectifier (SCR)
1. SCR Characteristic Curves
2. SCR Construction
3. SCR for Phase Control
4. SCR Applications
5. SCR Mounting and Cooling
6. Testing an SCR

H. Triac, Diac, And Unijunction Transistor
1. Triac
2. Diac
3. Unijunction Transistor(UJT)

I. Transistor As An AC Amplifier
1. Amplifier Gain
2. Bandwidth
3. Decibel
4. Types of Transistor Amplifiers
5. Setting The Operating Point on the Load Line
6. Classes of Operation
7. Input and Output Impedances
8. Transistor Specification Sheets
9. Transistor Testers
10. Transistor Service Tips

J. Field-Effect Transistor And Multistage Amplifier
1. Field-effect Transistor (FET)
2. JFET
3. MOSFET
4. Multistage Amplifiers

K. Integrated Circuit
1. Advantages and Disadvantages of ICs
2. IC Packages
3. PIN Numbering System
4. IC Fabrication
5. Types of IC Systems
6. IC Data Sheets
7. Sockets
8. DIP IC Removal
9. DIP IC Replacement
10. Large Scale Integration (LSI)
11. Very Large Scale Integration (VLSI)

L. Fiber Optics
1. Advantages and Disadvantages
2. Nature of Light
3. Optical Fiber
4. Light Sources
5. Attenuation
6. Fiber Coupling
7. Light-activated Devices
8. Optocoupler / Optoisolator
9. Bar Code and Bar Code Scanning
10. Tachometer Probe
11. Colorimeter
12. High-voltage Switching
13. Fiber Optic Cable Advantages
14. Fiber Optic Cable Applications
15. Cleanliness
16. Fiber Optic Cable Types
17. Fiber Optic Cable Safety Considerations
18. Fiber Optic Cable Installation
19. Pulling Fiber Optic Cable
20. Splicing
21. Measuring Power and Continuity

Grade Scale

90 – 100	A
80 – 89	B
70 – 79	C
60 – 69	D
0 – 59	F

Course Requirements

1. Describe the three modes of operation in a bipolar transistor and the relationship between them.
2. Draw the circuit, waveforms and write the formulas for calculating the proper operation of a saturated switching circuit.
3. Describe how to determine whether a transistor is cutoff, in the linear mode, or saturated.
4. List the factors that determine switching speed and compare them to a non-saturated switching circuit.
5. List the practical steps for designing a saturated switch logic inverter.
6. Design a series logic driver circuit and a shunt logic driver circuit to meet specific requirements.
7. Describe an N-channel and a P-channel MOSFET.
8. Draw the diagram of an N-channel and a P-channel MOSFET inverter.
9. Draw a discrete component astable multivibrator clock, determine its approximate frequency and explain its operation.
10. Draw a conventional astable multivibrator (IC clock), determine its approximate frequency and explain its operation.
11. Draw the circuit of a crystal oscillator and explain its characteristics.
12. Draw the circuit of and calculate the components for an LM 555 astable multivibrator (clock).
13. Draw the circuit of and calculate the components for an LM 555 monostable multivibrator(one shot).
14. Theoretically troubleshoot an inoperative LM 555 circuit from voltage measurements and waveforms to determine a fault.
15. Draw IC one shot circuits, using 74123 and the required reference that would output a specified pulse width or a specified pulse width or a specified pulse delay.
16. Explain the operation and characteristics of other clocks and one shots as required.
17. Draw and explain the operation of a two phase clock.
18. Explain a simple discrete component one shot multivibrator and draw the input and output waveforms showing their relationship.
19. Design a testing circuit and procedure to determine if an op-amp is good.
20. List, from memory, the major characteristics of op-amps.
21. Draw, from memory, the diagram of an inverting and non-inverting amplifier to give specific Av, Zi, etc. using direct coupling.

22. Draw, from memory, Vi max and Vo (max) for a given supply voltage and amplification, for both inverting and non-inverting amplifiers.
23. Determine, from memory, the cut-off frequency, any one component value and bandpass characteristics of active high pas and low pass filters.
24. Draw, from memory, an op-amp integrator showing the relationship of the input and output waveforms with a square wave applied.
25. Draw, from memory, an op-amp differentiator showing the relationship of the input and output waveforms with a square wave applied.
26. Draw, from memory, a voltage follower and determine the approximate Zi, Zo and voltage swings possible.
27. Design a comparator circuit, with calculated values for all components, such that the output will clearly indicate whether and input voltage is within the two specified limits of the window.
28. Design and op-amp differential (instrumentation) circuit that could be used as a very sensitive Wheatstone bridge balance detector.
29. Design a summing amplifier circuit to produce an output from four inputs (calculate the component values to give the inputs a 8, 4, 2, 1 weight).
30. Troubleshoot any or all of these circuits by choosing from a list of conditions which one/ones could cause the given erroneous operation.

Disabilities Statement

The Americans with Disabilities Act of 1992 and Section 504 of the Rehabilitation Act of 1973 are federal anti-discrimination statutes that provide comprehensive civil rights for persons with disabilities. Among other things, these statutes require that all students with documented disabilities be guaranteed a learning environment that provides for reasonable accommodations for their disabilities. If you believe you have a disability requiring an accommodation, please contact the Special Populations Coordinator at (409) 880-1737 or visit the online resource:
http://www.lit.edu/depts/stuserv/special/defaults.aspx

Student Code of Conduct Statement

It is the responsibility of all registered Lamar Institute of Technology students to access, read, understand and abide by all published policies, regulations, and procedures listed in the *LIT Catalog and Student Handbook*. The *LIT Catalog and Student Handbook* may be accessed at www.lit.edu or obtained in print upon request at the Student Services Office.

Course Schedule

Week	Topic	Reference
1	Course introduction and policies • Lecture • Lab: Multisim	Handouts
2/3	Safety / PC Board Construction and Repair • Lecture • Lab: Multisim • Test One	Chapters 1/2
4/5	Semiconductor Diodes	Chapter 3

	• Lecture • Lab: Experiments • Project: As Assigned	
6/7	DC Power Supplies-Single Phase • Lecture • Lab: Chapter Exercises • Project: As Assigned	Chapter 4
8	Solid State Transducers • Lecture • Lab: Experiments • Project: As Assigned • Test Two	Chapter 5
9/10	Transistor as a DC Switch • Lecture • Lab: Experiments • Project: As Assigned	Chapter 6
11	Silicon Controlled Rectifiers • Lecture • Lab: Experiments • Project: As Assigned	Chapter 7
12	Triac, Diac, and Unijunction Transistor • Lecture • Lab: Experiments • Project: As Assigned • Test Three	Chapter 8
13	Transistor as an AC Amplifier • Lecture • Lab: Experiments • Project: As Assigned	Chapter 9
14	Field-Effect Transistor and Multistage Amplifier • Lecture • Lab: Experiments • Project As Assigned	Chapters 10
15	Integrated Circuit • Lecture • Lab: Experiments • Project: As Assigned	Chapter 11
16	Fiber Optics • Lecture • Lab: Experiments • Project: As Assigned • Test Four	Chapter 12