ESYST 103 - Solid State Systems

Approval Date: Effective Term:

Department: ELECTRONIC SYSTEMS TECHNOLOGY
Division: Career Technical Education
Units: 4.00
Grading Option: Letter Grade
Transferability: CSU Transferable
Course is: AA/AS Degree

Contact Hours per Term:
Lecture/Discussion: 3.00
Lab: 3.00
Recommended Class Size: 35

Discipline/Minimum Qualifications:
Electronics

Catalog Description:
Presents integration of PC boards, ICs, modules, and sub-assemblies into equipment and complete systems.

Schedule Description:
Presents integration of PC boards, ICs, modules, and sub-assemblies into equipment and complete systems.

Student Learning Outcome:
Lecture:

1. Compare and contrast the structure and functionality of the different integrated circuits used as operational amplifiers, power amplifiers, differential amplifiers, and oscillators, and propose a practical application for each.

Lab:

1. Install, connect, test, and operate at least one complete analog/linear electronic system.

Course Objectives:
Lecture:
1. Explain semiconductor material structure and how it can be doped to produce P and N-type materials.
2. Identify basic methods for biasing MOSFETs as amplifiers and switches.
3. Identify a complementary symmetry class AB amplifier and explain its operation.
4. Define power management and explain what a power management IC does.
5. Compare and contrast the functionality of BJTs and MOSFETs used in power amplifiers.
6. Calculate the efficiency of any type of power supply given the necessary values.
7. Differentiate the functions of a DC-DC converters and inverters.
8. Calculate the output voltage and current in a circuit using a 3-terminal regulator.
9. Identify the block diagram of a 555 timer IC and explain its operation as an astable (clock) oscillator and as a one shot multivibrator.

Lab:

1. Draw the output waveforms of half wave and full wave rectifier circuits.
2. Draw a generic block diagram of a power supply identifying all the major circuits.
3. Draw a diagram of a bus architecture power supply and name the most common circuits.
4. Measure and troubleshoot electrical signal outputs for power supply circuits.
5. Measure and troubleshoot electrical signal outputs for oscillator circuits.
6. Measure and troubleshoot electrical signal outputs for operational amplifier circuits.

Course Content Outline:

Lecture:

1. Semiconductor Fundamentals
   1. Semiconductor materials.
   2. Structure of semiconductors.
   3. Compound semiconductors.
   4. Doping, P and N-type semiconductors
2. PN Junctions and Diodes
   1. Depletion region.
   2. Forward and reverse bias and current flow.
   3. The ideal diode and practical models.
3. Special Diodes
   1. Light emitting diodes (LEDs)
   2. Zener diodes
   3. Schottky diodes
   4. Varactor diodes
   5. PIN diodes
4. Power Supply Fundamentals
   1. Definition and general block diagram of a power supply.
   2. Rectifiers: half wave, full wave, bridge.
   3. Transformers
5. Regulation, defined and measurement.
6. Zener regulator
7. Three terminal regulators ICs.

5. Transistors
   1. Generic concepts, 3-terminal devices for controlling current flow.
   2. Transistors functions: switching and amplification.

6. Field Effect Transistors
   1. MOSFET structure and types: enhancement mode, depletion mode, N and P.
   2. MOSFET biasing.
   3. Basic MOSFET amplifiers.
   4. Basic MOSFET switches. CMOS.
   5. JFET structure and types: P and N-type.
   6. Basic JFET biasing.
   7. Basic JFET amplifiers.

7. Bipolar Junction Transistors (BJTs)
   1. BJT structure and types: NPN and PNP
   2. BJT biasing.
   3. Basic BJT amplifiers.
   4. Basic BJT switches.

8. Amplifier Fundamentals (block diagram level)
   1. Specifications (gain, input/output impedance), maximum power/voltage output, frequency response.
   2. Amplifier Classifications (A, AB, B, C, etc.)
   3. Expressing amplifier gain and power in dB/dBm.
   4. Relationship between amplifier bandwidth and pulse response.

9. Power Amplifiers
   1. Emitter/source followers.
   2. Push pull amplifier with transformers.
   4. Bridge amplifiers.

10. Differential Amplifiers
    1. Configuration.
    2. Characteristics, features and benefits (common mode rejection)
    3. Typical MOSFET and BJT circuits.
    4. Constant current sources and mirrors and biasing.

11. Operational Amplifiers
    1. Characteristics, specifications and features.
    2. Common op amp circuits (inverter, non-inverting amplifier, follower, differential amplifier, integrator, and comparator).
    3. Active filters.

12. Integrated Circuit Amplifiers
    1. Instrumentation amplifiers
    2. Programmable gain amplifiers
    3. Video amplifiers
    4. RF amplifiers
    5. Power amplifiers
6. Class D switching amplifiers.

13. Oscillators (emphasis on ICs)
   1. Basic feedback concepts.
   2. LC and RC oscillators
   3. 555 timer IC and oscillator circuits.
   4. Quartz crystals
   5. Crystal oscillators

   1. Linear regulators including low drop out (LDO).
   2. Switching regulators: types, configurations, circuits.
   3. Switching regulator advantages and benefits.
   4. DC-DC converters.
   5. DC-AC inverters and UPS.
   6. The power supply bus.
   7. Power management.

15. Power Switches and Thyristors
   1. Silicon controlled rectifiers
   2. Triacs and diacs
   3. Power MOSFETs
   4. IGBT
   5. Power switch and thyristor applications.

16. Examples of Linear Solid State Systems
   1. Audio amplifiers for stereo, surround sound, public address, and auto sound, music
   2. Home solar power system.
   3. Analog controller, industrial applications.

Lab:

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• Instruments and techniques for measuring and troubleshooting electrical signal outputs for power supply circuits.
• Instruments and techniques for measuring and troubleshooting electrical signal outputs for oscillator circuits.
• Instruments and techniques for measuring and troubleshooting electrical signal outputs for operational amplifier circuits.

Methods of Instruction:
Lab, Lecture:

Methods of Evaluation:
Exams/Tests/Quizzes
Problem Solving
Skill Demonstrations
Exams

Typical Assignments:

**Reading:**
Text Readings Technical specifications for electronic components Schematics for electronic circuits

**Writing, Problem Solving or Performance:**
Given an integrated circuit and a specified voltage input calculate the voltage drop through a given resistor on the output side of the IC. Calculate the gain through an amplifier.

**Other:**

Required Materials Examples:

**Book 1**
**Author:** Robert L. Boylestad and Louis Nashlesky  **Publication Date:** 2008  **Edition:** 10th
**Title:** Electronic Devices and Circuit Theory  **Publisher:** Prentice Hall

**Book 2**
**Author:** Jack Hudson and Jerry Luecke  **Publication Date:** 2005  **Edition:** 2nd
**Title:** Basic Communications Electronics  **Publisher:** Master Publishing

Course Preparation:

**Prerequisite(s):** ESYST 102

**Co-Requisite(s):** None

**Recommended:** None

Document Content Review

**Target Course Skills**
Condition on Enrollment
Established
Faculty
Lee Hilliard Samuel Bolanos

Basic Content Review
Lecture: Compare and contrast the effects of capacitance and inductance in circuits. Describe the properties of magnetic fields and materials, explain electromagnetism, electromagnetic induction and relate to the operation of common magnetic devices. Apply Ohm’s and Kirchhoff’s laws to solve series, parallel, and series-parallel circuit problems. Explain the construction and operation of a transformer and make transformer calculations of voltage step-up/down and impedance. Define phase shift and calculate voltages,
currents, impedance and phase angle in RC, RL and RLC circuits. Define and identify a sine wave and
determine frequency, period, peak, peak-to-peak (pp) and root mean square (rms) values. Calculate
projected electrical signal outputs for given DC series-parallel resistive circuits. Calculate projected
electrical signal outputs for a given RC circuit. Calculate projected electrical signal outputs for a given RL
circuit. Calculate projected electrical signal outputs for a given RLC circuit. Lab: Demonstrate the use of
various electronic measuring instruments. Measure electrical signal outputs for given DC series-parallel
resistive circuits. Measure electrical signal outputs for a given RC circuit. Measure electrical signal outputs
for a given RL circuit. Measure electrical signal outputs for a given RLC circuit.