

ELEC A260: AUTOMATION 2 SEMICONDUCTOR MOTOR CONTROL CIRCUITS

Item	Value
Curriculum Committee Approval Date	12/08/2021
Top Code	093400 - Electronics and Electric Technology
Units	4 Total Units
Hours	108 Total Hours (Lecture Hours 54; Lab Hours 54)
Total Outside of Class Hours	0
Course Credit Status	Credit: Degree Applicable (D)
Material Fee	Yes
Basic Skills	Not Basic Skills (N)
Repeatable	No
Open Entry/Open Exit	No
Grading Policy	Standard Letter (S)

Course Description

Diagnose semiconductor circuits for industrial motor control: power supplies, amplifiers, active filters, oscillators, solid state motor control, phase inverters, Variable Speed Drives (VSD). ADVISORY: ELEC A047, ELEC A135, ELEC A150, and ELEC A173 or concurrent enrollment. Transfer Credit: CSU.

Course Level Student Learning Outcome(s)

1. Demonstrate proficiency in the selection and use of industry-standard test equipment.
2. Differentiate and distinguish the critical differences between the solid state and electro-mechanical control devices.
3. Construct and perform diagnostics of semiconductor circuits typically found in Motor Control Circuits: electrical, electronic, electro-mechanical, instrumentation, robotic, and automation systems.
4. Communicate, using both verbal and written modalities, an explanation of circuit performance, assembly and test procedures and mission critical criteria.

Course Objectives

- 1. Demonstrate the ability to use state-of-the-art test equipment to troubleshoot analog circuits. Equipment will include programmable oscilloscopes, digital multimeters, triple-output D.C. power supplies, analog milliammeters and A.C. signal generators.
- 2. Describe the physical relationships that govern the operation of semiconductors.
- 3. Fully identify the three basic circuit approximations of diodes.
- 4. Explain the characteristics of light-emitting diodes, Schottky diodes, varactor diodes, zener diodes and zener regulators.
- 5. Apply the principles of diode theory to the analysis of rectifiers, voltage multipliers, clippers, clampers and logic gates.
- 6. Identify the component parts and functions of oscilloscopes.
- 7. Explain the basic operation of bi-polar transistors, JFETS and MOSFETS.

- 8. Analyze the operation of transistors in small-signal amplifiers, large-signal amplifiers, and power amplifiers.
- 9. Prepare a written analysis of data collected during an experiment.
- 10. Demonstrate ability to use circuit analysis software.

Lecture Content

Fundamental Concepts Review Ohm's Law Series resistors Parallel resistors Voltage Divider Theorem Current Divider Theorem Kirchhoff's Voltage Law Kirchhoff's Current Law Thevenin's Theorem Norton's Theorem Superposition Theorem Oscilloscopes Purpose Cathode ray tube Overall block diagram Vertical input system Horizontal system Synchronization and triggering Dual trace operation Diodes The pn junction Forward bias Reverse bias The diode curve The ideal diode The second approximation The third approximation D.C. resistance of a diode Manufacturer's specifications Temperature effects Power rating Switching speed Peak Inverse Voltage Special diodes The light-emitting diode Schottky diodes The varactor Zener diodes The zener regulator Diode applications The half-wave rectifier The full-wave rectifier The bridge rectifier The Capacitor (Storage Tank) Ripple Filter Zener Voltage regulation Oscilloscopes Purpose Cathode ray tube Overall block diagram Vertical input system Horizontal system Synchronization and triggering Dual trace operation Relay Transistor switch-mode motor control Relay motor control Review Manufacturer's Specifications Switch voltage Switch current Input Voltage Input Current Switching Speed Diode Clamp Amplification Factor, Gain Power Out vs. Power In Voltage Out vs Voltage In Current Out vs Current In Bipolar transistors Structure Cutoff Saturation Wiring Diagram Manufacturer's specifications Temperature effects Power rating Switching speed Peak Voltages Amplification factor Input impedance Power gain Source impedance Output impedance Transistor Voltage Regulator Base bias Zener reference Voltage-divider bias PNP biasing Specifications Troubleshooting Ripple Filter Capacitor High Frequency filter Capacitor Thyristors Silicon Controlled Rectifier SCR Triac Analog AC Load Control Motor speed control Incandescent Lighting dimmer Field Effect Transistors Junction Field Effect Transistors (JFET) Metal-Oxide Silicon field-effect transistors (MOSFETS) Amplifiers The A.C. resistance of a diode Operational Amplifier Feedback Inverting Non-inverting Common-emitter Amplifier Swamping the emitter diode Cascaded stages Emitter Follower Using the emitter follower The Darlington amplifier Class C Push Pull Amplifier H- Bridge Motor Control Stepper Motor Control Variable Speed Drives

Lab Content

Troubleshooting analog circuits Programmable oscilloscopes Digital multimeters Triple-output D.C. power supplies Analog milliammeters A.C. signal generators Analysis using Diode Theory Principles Rectifiers Voltage multipliers Clippers Clampers Logic gates Analysis of Transistor Operation Small-signal amplifiers Large-signal amplifiers Power amplifiers Circuit Analysis Software Build, test, and troubleshoot appropriate circuits pertaining to the following topics: Rectifier diodes and zener diodes Power supplies Voltage regulators Bi-polar transistors and associated circuitry Cascaded amplifiers JFET amplifiers MOSFETS

Method(s) of Instruction

- Lecture (02)
- Lab (04)

Instructional Techniques

Lecture, lab, class discussion, video and skill demonstration

Reading Assignments

Students will read assigned chapters from the textbook. Students will review text and portfolios from AC, DC, Logic courses.

Writing Assignments

Prepare technical report for each project from research, class notes and laboratory experience. Portfolio that contains research data, notes from class, notes from laboratory experience. The final outcome of these projects will be presented in the form of a technical report.

Out-of-class Assignments

Research topics found in each project per syllabus. Student will keep a portfolio to account for all content in each of the projects.

Demonstration of Critical Thinking

Written examinations plus a final exam will be used to test the students mastery of the lecture and written material. Students will participate in class discussions, answering instructor s reinforcement questions and analyzing hypothetical circuits with the aid of scientific electronic calculators during each of the lecture periods Students will participate in practical examinations that will require them to build, test, and troubleshoot appropriate circuits pertaining to the following topics: Rectifier diodes and zener diodes Power supplies Voltage regulators Bi-polar transistors, and associated circuitry Cascaded amplifiers JFET amplifiers MOSFETS Students will demonstrate the ability to prove mathematically the electrical parameters of each of the circuits discussed.

Required Writing, Problem Solving, Skills Demonstration

The student will keep a portfolio and a syllabus (spreadsheet) to account for, all content, in each of the projects, assigned for the course. The portfolio will contain: research data, notes from class, notes from laboratory experience. The final outcome of these projects will be presented in the form of a technical report per the guideline standard for the Electronics Technology program.

Textbooks Resources

1. Required Bimal, K. Bose. Power Electronics Motor Drives, latest ed. San Diego: Academic Press, 2006 Rationale: -

Other Resources

1. Instructor handouts