Electronics: Semiconductor Technology and Signal Devices (30S)

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Course Code: EXB30S
Credit: 1.0
Prerequisite: Introduction to Electronics Technology (20S)
Suggested Grade Level: Grade 11
Delivery Format: Classroom instruction, lab activities, and project-based learning

Course Description

This course introduces students to the properties, theory, and applications of semiconductor devices used in low-power and signal-level electronic circuits. Students will explore diodes, transistors, and operational amplifiers, and will learn how these components are applied in amplification, rectification, switching, and signal processing. The course emphasizes both theoretical understanding and hands-on circuit construction, troubleshooting, and testing.

General Learning Outcomes (GLOs)

- Understand Semiconductor Fundamentals – Explain the atomic structure, energy bands, and charge carriers in semiconductors. Differentiate between intrinsic and extrinsic materials and describe doping effects.
- Analyze Diode Operation – Describe forward/reverse biasing, V-I characteristics, and applications in rectifiers, clippers, clampers, and LED circuits.
- Understand and Apply Transistor Theory – Explain operation of BJTs (NPN/PNP) and FETs (JFET/MOSFET) in small-signal applications. Use transistors for switching, amplification, and waveform shaping.
- Apply Operational Amplifiers – Analyze op-amp characteristics and configurations (inverting, non-inverting, comparator, integrator, differentiator).
- Design and Test Signal-Level Circuits – Build, simulate, and troubleshoot amplifiers, oscillators, filters, and logic signal circuits.
- Use Test Equipment Effectively – Measure voltage, current, resistance, and signal waveforms using multimeters and oscilloscopes.
- Demonstrate Safety and Professional Practices – Follow ESD safety, component handling, and proper documentation methods.

Unit Breakdown

Unit 1: Semiconductor Theory

- Structure and properties of semiconductors
- Intrinsic vs. extrinsic materials
- Energy bands and bandgap concepts
- Charge carriers and conductivity

Unit 2: Diodes and Applications

- PN junction operation
- Forward/reverse bias
- Zener diodes for voltage regulation
- Rectification: half-wave, full-wave, bridge
- Signal shaping: clippers, clampers, LED indicators

Unit 3: Bipolar Junction Transistors (BJTs)

- NPN and PNP transistor structure
- Input/output characteristics
- Biasing methods (fixed, voltage divider, emitter-stabilized)
- Small-signal amplifiers (common emitter, common collector)
- Switching applications

Unit 4: Field-Effect Transistors (FETs)

- JFET operation and characteristics
- MOSFET types (enhancement, depletion)
- Biasing methods for FETs
- Low-power switching and amplification uses

Unit 5: Operational Amplifiers

- Ideal vs. real op-amp parameters
- Basic configurations (inverting, non-inverting, buffer)
- Active filters (low-pass, high-pass, band-pass)
- Oscillator and comparator circuits

Unit 6: Signal Processing Circuits

- Audio preamps and tone control
- Sensor interface circuits
- Analog-to-digital interfacing principles

Unit 7: Testing, Troubleshooting, and Applications

- Systematic fault-finding methods
- Using datasheets for component selection
- Building and testing real-world signal devices (e.g., audio amplifier, light sensor circuit)

Unit 8: Capstone Project

- Students design and build a complete low-power signal device (e.g., amplified microphone, LED VU meter, small radio receiver)
- Includes proposal, schematic design, simulation, breadboarding, and final presentation

Assessment

Employability Skills	10%
Labs, Theory, and Skills	60%
Final Project (Capstone)	30%

Resources

- Comprehensive Course in AC/DC Electronics (Global Specialties Lab Manual)

- Datasheets for diodes, transistors, MOSFETs, IGBTs, SCRs, TRIACs, etc

- Tinkercad Circuits for simulation and virtual testing