Course Outline: Semiconductor Power Devices (30S)

Instructor: Mr.Pulver
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Course Code: EXC30S
Credit: 1.0
Prerequisite: Semiconductor Technology & Signal Devices (30S)
Suggested Grade Level: Grade 11
Delivery Format: Classroom instruction, lab activities, and project-based learning

Course Description

This course provides students with a solid foundation in power semiconductor devices and their applications in modern electronics. Students will study the operation and characteristics of power diodes, thyristors, transistors, MOSFETs, and IGBTs, and apply them in power control, rectification, regulation, and motor control systems. The course combines theory with extensive lab work, culminating in a capstone project where students design and construct a functional electronic system.

General Learning Outcomes (GLOs)

- Explain the structure and function of semiconductor power devices (diodes, SCRs, TRIACs, MOSFETs, IGBTs).

- Design, build, and analyze circuits for rectification, regulation, and power control.

- Apply PWM and switching methods to regulate power and control motors.

- Evaluate efficiency, power dissipation, and thermal management in circuits.

- Investigate real-world applications of power electronics in renewable energy, robotics, and electric vehicles.

- Follow safe practices for working with high-power devices and circuits.

Unit Breakdown

Unit 1: Introduction to Semiconductors

- Review of semiconductor properties

- Conductors vs insulators vs semiconductors

- Intrinsic vs extrinsic materials

- Energy bands and carrier movement

- Lab: Lab 35 – Diode Rectifier (introductory hands-on)

Unit 2: Diodes and Transistors

- PN junction diode operation and characteristics

- Forward and reverse biasing

- Zener diodes and voltage regulation

- LED applications

- BJTs as switches and amplifiers

- MOSFETs (intro to power applications)

- Labs: Lab 35–39 (diodes, rectifiers, Zener, LED), Lab 51–53 (BJTs), Lab 60 (Transistor Power Control)

Unit 3: Power Devices and Power Electronics

- Power diodes in high-current applications

- Thyristors (SCRs) and TRIACs for AC regulation

- Power MOSFETs and IGBTs for high-power switching

- Applications in inverters and motor drives

- Labs: Lab 40 (SCR), Lab 41 (TRIAC), Lab 59 (SCR Power Control), Gap-Filler Lab 3 (MOSFET as a Switch), Gap-Filler Lab 6 (Thermal Management)

Unit 4: Power Supply Circuits and Motor Control

- Rectifiers: half-wave, full-wave, bridge

- Filtering with capacitors and inductors

- Voltage regulators (linear and switching)

- Pulse Width Modulation (PWM) for motor control

- Labs: Lab 36–37 (Rectifiers & filtering), Lab 38 (Zener Regulation), Gap-Filler Lab 4 (Linear vs Switching Regulators), Gap-Filler Lab 5 (PWM Motor Speed Control)

Unit 5: Applications in Power Electronics

- Motor control in robotics and automation

- Renewable energy systems (solar inverters, wind turbines)

- Electric vehicle systems (chargers, inverters, controllers)

- Labs: Lab 56–58 (Oscillators, linked to inverter theory), Application projects (motor controller, renewable demo)

Unit 6: Review and Final Evaluation

- Comprehensive review of semiconductor power devices

- Troubleshooting integrated circuits (rectifier + regulator + switch)

- Written exam and practical assessment

Unit 7: Capstone Project

- Students design and build a functional power electronics device (e.g., adjustable DC power supply, motor speed controller, light dimmer)

- Steps: Proposal → Schematic → Simulation → Breadboard → PCB → Presentation

- Deliverables: Final working device, written reflection/report, class presentation/demo

Assessment Breakdown

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

Resources

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

- Supplemental Gap-Filler Labs (MOSFETs, PWM, Regulators, Thermal Mgmt)

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

- Tinkercad Circuits for simulation and virtual testing