PARVATHANENI BRAHMAYYA
SIDDHARTHA COLLEGE OF ARTS & SCIENCE
Autonomous
Siddhartha Nagar, Vijayawada–520010
Re-accredited at 'A+' by the NAAC

Course Code				**23ELMAP234**			
Title of the Course				**Semiconductor devices and materials Lab**			
Offered to: (Programme/s)				B.Sc. (H)- Electronics			
L	**0**	**T**	**0**	**P**	**2**	**C**	**1**
Year of Introduction:	**2024-25**			**Semester:**			**3**
Course Category:	Major			**Course Relates to:**	Global		
Year of Revision:				**Percentage:**			
Type of the Course:				Skill development			
Crosscutting Issues of the Course :							
Pre-requisites, if any				Familiarity with basic electronic components			

Course Description:

This laboratory course provides hands-on experience with semiconductor devices and materials, reinforcing the theoretical concepts learned in lectures. Students will engage in a series of experiments designed to understand the physical properties, operational principles, and practical applications of various semiconductor devices such as diodes, transistors, and field-effect transistors (FETs). Through these experiments, students will develop skills in circuit design, testing, and analysis, which are crucial for careers in electronics and semiconductor technology.

Course Aims and Objectives:

S.NO	COURSE OBJECTIVES
1	**Understand Semiconductor Properties**: Develop a thorough understanding of the intrinsic and extrinsic properties of semiconductor materials and their significance in electronic devices.
2	**Circuit Design and Analysis**: Acquire practical skills in designing, assembling, and analyzing circuits that incorporate semiconductor devices like diodes and transistors.
3	**Device Characterization**: Learn to characterize and measure the performance parameters of various semiconductor devices through hands-on experimentation.
4	**Fabrication Techniques**: Gain insights into the processes and techniques involved in semiconductor device fabrication, including photolithography, doping, and thin-film deposition.
5	**Application of Devices**: Apply the knowledge of semiconductor devices to real-world applications in electronics, enhancing problem-solving and critical-thinking abilities.

Course Outcomes

At the end of the course, the student will be able to…

CO NO	COURSE OUTCOME	BTL	PO	PSO
CO1	Develop a thorough understanding of the fundamental properties of semiconductor materials.	K4	2	1
CO2	Gain practical experience in designing and testing semiconductor circuits.	K4	2	1
CO3	Analyze and interpret experimental data to understand the behavior and characteristics of semiconductor devices.	K5	2	1
CO4	Apply semiconductor device concepts to real-world applications in electronics.	K5	2	1
CO5	Understand the processes involved in the fabrication of semiconductor devices.	K3	2	1

For BTL: K1: Remember; K2: Understand; K3: Apply; K4: Analyze; K5: Evaluate; K6: Create

CO-PO MATRIX									
CO NO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2
CO1		2						2	
CO2		2						2	
CO3		3						3	
CO4		3						3	
CO5		2						2	

Use the codes 3,2,1 for High, Moderate and Low correlation Between CO-PO-PSO respectively

Course Structure

This lab list covers the key areas of a **Semiconductor devices and materials Lab** course, providing hands-on practice with using Bread board and Analog IC's and multimeter.

Unit 1:

Experiment 1: Understanding Intrinsic and Extrinsic Semiconductors (Module 1)

Objective: To study the characteristics of intrinsic and extrinsic semiconductors.

Components Used:

- Intrinsic silicon wafer
- Doped silicon wafer (n-type and p-type)
- Multimeter
- Heat source

Circuit Design: No specific circuit design is required. This experiment involves direct measurements on the semiconductor wafers.

Testing and Activity:

1. **Testing**:
    - Measure the resistance of the intrinsic silicon wafer using a multimeter.
    - Heat the intrinsic silicon wafer and observe the change in resistance.
    - Measure the resistance of the doped silicon wafers (n-type and p-type) at room temperature.
2. **Activity**:
    - Compare the resistance values of intrinsic and extrinsic semiconductors.
    - Discuss how doping affects the electrical properties of semiconductors.

Experiment 2: PN Junction Diode Characteristics (Module 2)

Objective: To study the V-I characteristics of a PN junction diode.

Components Used:

- PN junction diode
- Resistors
- Variable DC power supply
- Multimeter

Circuit Design:

- Connect the diode in series with a resistor and a variable DC power supply.
- Connect a multimeter across the diode to measure the voltage and current.

Testing and Activity:

1. **Testing**:
    - Gradually increase the supply voltage and record the current through the diode and the voltage across it.
    - Plot the V-I characteristics of the diode.
2. **Activity**:
    - Identify the forward and reverse bias regions.

- Discuss the significance of the knee voltage in the forward bias region.

Experiment 3: Full-Wave Rectifier (Module 3)

Objective: To design and analyze a full-wave rectifier circuit.

Components Used:

- 4 PN junction diodes
- Transformer
- Load resistor
- Capacitors
- Oscilloscope

Circuit Design:

- Connect the diodes in a bridge configuration.
- Connect the transformer's secondary winding to the bridge rectifier.
- Connect a load resistor and a capacitor filter at the output.

Testing and Activity:

1. **Testing**:
    - Apply an AC voltage to the transformer's primary winding.
    - Measure the output voltage across the load resistor using an oscilloscope.
2. **Activity**:
    - Observe and record the output waveform.
    - Discuss the effect of the capacitor filter on the output voltage.

Experiment 4: Designing a BJT Amplifier (Module 5)

Objective: To design and test a common-emitter BJT amplifier.

Components Used:

- NPN transistor (e.g., 2N3904)

- Resistors
- Capacitors
- Signal generator
- Oscilloscope

Circuit Design:

- Design a common-emitter amplifier circuit with appropriate biasing resistors.
- Include coupling and bypass capacitors.

Testing and Activity:

1. **Testing**:
    - Apply an AC signal to the input of the amplifier.
    - Measure the input and output signals using an oscilloscope.
2. **Activity**:
    - Calculate the voltage gain of the amplifier.
    - Discuss the role of biasing and coupling capacitors in amplifier design.

Experiment 5: Zener Diode as a Voltage Regulator

Objective

To study the voltage regulation characteristics of a Zener diode and verify its behavior as a voltage regulator.

Components Used

- Zener diode (e.g., 5.1V Zener diode)
- Resistors (e.g., 470Ω)
- Variable DC power supply
- Multimeter
- Breadboard and connecting wires

Circuit Design

1. **Circuit Diagram**:
    - Connect the anode of the Zener diode to ground.
    - Connect a resistor in series with the cathode of the Zener diode.
    - Connect the other end of the resistor to the positive terminal of the variable DC power supply.
    - The cathode of the Zener diode is also connected to a load resistor which is then connected to ground.
2. **Setup**:
    - Adjust the power supply voltage to vary from 0V to above the Zener breakdown voltage (e.g., 7V).
    - Ensure proper connections to avoid short circuits.

Testing and Activity

1. **Testing**:
    - Gradually increase the input voltage from 0V to above the Zener voltage while measuring the voltage across the Zener diode.
    - Observe and record the voltage at which the Zener diode starts conducting and maintaining a constant voltage (the Zener breakdown voltage).
2. **Activity**:
    - Plot the input voltage vs. output voltage across the Zener diode.
    - Analyze the regulation characteristics of the Zener diode and confirm the voltage stabilization behavior.
    - Discuss the applications of Zener diodes in voltage regulation circuits.

Experiment 6: Common Base (CB) Configuration of BJT

Objective

To study the input and output characteristics of a BJT in a common base (CB) configuration.

Components Used

- NPN BJT (e.g., 2N2222)
- Resistors (e.g., 1kΩ, 10kΩ)
- Power supply
- Signal generator
- Multimeter
- Breadboard and connecting wires

Circuit Design

1. **Circuit Diagram**:
    - Connect the emitter of the BJT to a signal generator through a resistor.
    - Connect the base of the BJT to a fixed bias voltage through a resistor.
    - Connect the collector to the positive terminal of the power supply through a load resistor.
    - Connect the power supply ground to the signal generator ground and the breadboard ground.
2. **Setup**:
    - Ensure all connections are secure and the signal generator is set to a low-frequency signal.

Testing and Activity

1. **Testing**:
    - Measure the input characteristics by varying the emitter current (Ie) and recording the base-emitter voltage (Vbe) while keeping the collector voltage constant.
    - Measure the output characteristics by varying the collector-emitter voltage (Vce) and recording the collector current (Ic) for different values of emitter current (Ie).

2. **Activity**:
    - Plot the input and output characteristic curves.
    - Analyze the behavior of the BJT in the CB configuration and identify the active, saturation, and cutoff regions.
    - Discuss the applications of the CB configuration in amplifiers and other circuits.

Experiment 7: Common Emitter (CE) Configuration of BJT

Objective

To study the input and output characteristics of a BJT in a common emitter (CE) configuration and determine the voltage gain.

Components Used

- NPN BJT (e.g., 2N3904)
- Resistors (e.g., 1kΩ, 10kΩ)
- Capacitors (e.g., 10µF)
- Power supply
- Signal generator
- Oscilloscope
- Multimeter
- Breadboard and connecting wires

Circuit Design

1. **Circuit Diagram**:
    - Connect the emitter of the BJT to ground through a resistor.
    - Connect the base to a signal generator through a coupling capacitor and a base resistor.
    - Connect the collector to the positive terminal of the power supply through a load resistor.

- Connect another coupling capacitor between the collector and the output to the oscilloscope.

2. **Setup**:
    - Ensure all connections are secure and the signal generator is set to a low-frequency signal.

Testing and Activity

1. **Testing**:
    - Apply a small AC signal to the base of the BJT and measure the input and output signals using an oscilloscope.
    - Record the input signal amplitude (Vin) and output signal amplitude (Vout) to calculate the voltage gain (Av = Vout/Vin).
2. **Activity**:
    - Plot the input and output waveforms.
    - Analyze the gain and frequency response of the CE amplifier.
    - Discuss the importance of biasing in maintaining the transistor in the active region for amplification.

Experiment 8: Field Effect Transistor (FET) Characteristics

Objective

To study the transfer and output characteristics of a Junction Field Effect Transistor (JFET) and understand its behavior.

Components Used

- N-channel JFET (e.g., J201)
- Resistors (e.g., 1kΩ, 10kΩ)
- Power supply
- Signal generator
- Multimeter

- Breadboard and connecting wires

Circuit Design

1. **Circuit Diagram**:
    - Connect the drain of the JFET to the positive terminal of the power supply through a load resistor.
    - Connect the source to ground.
    - Connect the gate to a variable resistor (potentiometer) to control the gate-source voltage (Vgs).
    - Connect a signal generator to the gate for small-signal analysis.
2. **Setup**:
    - Ensure all connections are secure and the signal generator is set to a low-frequency signal.

Testing and Activity

1. **Testing**:
    - Measure the transfer characteristics by varying the gate-source voltage (Vgs) and recording the drain current (Id).
    - Measure the output characteristics by varying the drain-source voltage (Vds) and recording the drain current (Id) for different values of gate-source voltage (Vgs).
2. **Activity**:
    - Plot the transfer and output characteristic curves.
    - Analyze the behavior of the JFET in different regions of operation (ohmic region, active region, and cutoff region).
    - Discuss the applications of JFETs in analog switches and amplifiers.

Experiment 9: MOSFET Characteristics (Module 7)

Objective: To study the characteristics of an n-channel MOSFET.

Components Used:

- n-channel MOSFET (e.g., IRF540)
- Resistors
- Variable DC power supply
- Multimeter

Circuit Design:

- Connect the MOSFET in a common-source configuration.
- Connect the gate to a variable resistor to control the gate voltage.

Testing and Activity:

1. **Testing**:
    - Measure the drain current (Id) and drain-source voltage (Vds) for different gate-source voltages (Vgs).
    - Plot the transfer and output characteristics of the MOSFET.
2. **Activity**:
    - Identify the cutoff, triode, and saturation regions.
    - Discuss the significance of the threshold voltage.

Experiment 10: Power Semiconductor Devices (Module 7)

Objective: To study the characteristics of a power MOSFET.

Components Used:

- Power MOSFET (e.g., IRF540)
- Resistors
- Variable DC power supply
- Multimeter

Circuit Design:

- Connect the MOSFET in a common-source configuration.

- Use a resistor as the load.

Testing and Activity:

1. **Testing**:
    - Measure the drain current (Id) for different gate voltages (Vgs).
    - Observe the switching characteristics of the MOSFET.
2. **Activity**:
    - Discuss the application of power MOSFETs in switching power supplies.
    - Analyze the thermal management considerations.

Lab Manual:

Supplied by the Department

References:

1. [Reference 1 - Author(s), Year of Publication, Title, Edition, Publisher]
2. [Reference 2 - Author(s), Year of Publication, Title, Edition, Publisher]

LAB EXAMINATION PATTERN

23ELMAP234: Semiconductor devices and materials Lab

Semester: III MAX Marks:35M **Time:3Hrs**

(A) SEE Evaluation Procedure

1. For Aim, Apparatus, circuit diagram, Flow chart	**5M**
2.For Observation table, formulas, Program	**5M**
3. Experiment Procedure and Execution	**10M**
4.Output of Experiment	10M
5. Practical Record	**2M**
6. Viva voce	**3M**

(B) CONTINUOUS ASSESMENT(Internal) 15 MARKS

15 marks for the continuous assessment (Day to day work in the laboratory shall be evaluated for 15 marks by the concerned laboratory teacher based on the regularity/ record/viva). Laboratory teachers are mandated to ensure that every student completes 80%-90% of the lab assessments.

TOTAL: (A)+(B) = 50 MARKS

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