

EE-106 Semiconductor Devices and Circuits

Course Title	Semiconductor Devices and Circuits	Course Code	EE-106
Semester/Year	I Year	Course Group	Core
Teaching Scheme in Periods (L:T:P)	4:1:0 (Weekly)	Credits	3
Methodology	Lecture + Tutorials	Total Contact Periods	150
CIE	60 Marks	SEE	40 Marks

Course Description

The Semiconductor Devices and Circuits (EE-106) course provides a comprehensive understanding of semiconductor materials, diodes, transistors, amplifiers, oscillators, and integrated circuits. It enables students to analyse electronic devices and circuits used in power supplies, amplification, signal generation, and measurement, forming a strong foundation for advanced subjects like power electronics and electric vehicle systems.

PREREQUISITES:

Basic knowledge of Physics and Mathematics.

COURSE OBJECTIVES

- To understand the fundamentals of semiconductor materials and devices
- To study diodes, rectifiers and regulated power supplies
- To understand transistor operation and amplifier principles
- To introduce oscillators, integrated circuits and electronic instruments
- To Prepare students for advanced subjects like Power Electronics and EV Systems

COURSE OUTCOMES (COS)

Upon completion of the course, the student will be able to:

CO No.	Course Outcome Description	CL
CO1	Explain semiconductor materials, energy bands, and charge transport mechanisms	U
CO2	Analyse PN junction diodes and special purpose diodes	A
CO3	Analyse rectifier circuits and regulated power supplies	A
CO4	Explain BJT construction, configurations, and characteristics	U
CO5	Explain FET, MOSFET, and oscillator principles	U
CO6	Apply operational amplifiers and electronic instruments in basic circuits	A

CL: R = Remembering, U = Understanding, A = Application

CO-PO MAPPING MATRIX

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	Linked POs
CO1	3	–	–	–	–	–	–	1
CO2	3	–	2	–	–	–	–	1, 3
CO3	3	1	–	–	–	–	–	1, 2
CO4	3	1	1	–	–	–	–	1, 2, 3
CO5	3	1	–	1	1	–	–	1, 2, 4, 5
CO6	2	1	1	–	–	–	–	1, 2, 3

Correlation Scale: 1 = Low, 2 = Medium, 3 = High

COURSE CONTENTS

UNIT – I: Semiconductor Fundamentals & PN Junction

DURATION:25 HOURS

Energy band theory of solids, classification of materials into conductors, insulators and semiconductors. Intrinsic and extrinsic semiconductors, doping process, n-type and p-type semiconductors. Charge carriers – electrons and holes, effect of temperature on semiconductors. Formation of PN junction

diode, depletion region, barrier potential. Forward and reverse biasing of PN junction diode, V-I characteristics. Zener diode – operation and characteristics. Introduction to LED, photodiode and LDR with applications.

UNIT – II: Rectifiers & Power Supplies

DURATION:20 HOURS

Need for rectification. Half-wave rectifier, full-wave rectifier and bridge rectifier – working principles, circuit diagrams and waveforms. Ripple factor and efficiency (qualitative). Filters used in power supplies – capacitor filter and LC filter. Voltage regulation, Zener diode as voltage regulator. Block diagram of regulated power supply and applications.

UNIT – III: Bipolar Junction Transistors

DURATION:20 HOURS

Construction and operation of NPN and PNP transistors. Transistor action, current components. Transistor configurations – CB, CE and CC. Input and output characteristics of transistor in CE configuration. Comparison of CB, CE and CC configurations. Biasing of transistor – need and methods (concept). Transistor as amplifier and switch.

UNIT – IV: Amplifiers & Feedback

DURATION:30 HOURS

Amplifier – definition, gain and bandwidth. Classification of amplifiers. Coupling methods – RC coupled and transformer coupled amplifiers. Frequency response of RC coupled amplifier. Power amplifiers – concept and applications. Feedback – definition, advantages and types of feedback. Effects of feedback on gain and bandwidth.

UNIT – V: FETs, MOSFETs & Oscillators

DURATION:25 HOURS

Field Effect Transistor (FET) – construction and working of JFET, characteristics. MOSFET – enhancement and depletion types, advantages of

MOSFET over BJT. Applications of MOSFET in power electronics and EV systems. Oscillators – principle, conditions for oscillations. RC phase shift oscillator, Hartley oscillator and Colpitts oscillator – working principles and applications.

UNIT – VI: Linear ICs & Electronic Instruments

DURATION:26 HOURS

Integrated circuits – advantages and classification. Operational amplifier – ideal characteristics and applications. Op-amp as inverting amplifier, summing amplifier, integrator and differentiator. IC 741 and IC 555 timer – pin configuration and applications. Electronic instruments – CRO, block diagram and applications. Digital frequency meter and function generator.

REFERENCE BOOKS & E-LEARNING RESOURCES

V.K. Mehta & Rohit Mehta – Principles of Electronics, S. Chand, Boylestad & Nashelsky – Electronic Devices and Circuit Theory, G.K. Mithal – Electronic Devices and Circuits, Khanna Publishers, B.L. Theraja – Electrical Technology, Ramakant Gayakwad – Op-Amps and Linear ICs, J.B. Gupta – Electronics Engineering, Millman & Halkias – Integrated Electronics
NPTEL – Semiconductor Devices (IIT), NPTEL – Analog Circuits, <https://nptel.ac.in>
<https://www.allaboutcircuits.com>, <https://www.electronics-tutorials.ws>, <https://ocw.mit.edu>
<https://www.analog.com>, <https://www.renesas.com>

SUGGESTED LEARNING OUTCOMES

Upon completion of this unit, the student shall be able to:

UNIT – I: Semiconductor Fundamentals & PN Junction Diodes

- 1.1 Explain energy band theory of solids.
- 1.2 Classify materials into conductors, insulators and semiconductors.
- 1.3 Define intrinsic and extrinsic semiconductors.
- 1.4 Explain the doping process in semiconductors.
- 1.5 Differentiate between n-type and p-type semiconductors.
- 1.6 Identify charge carriers in semiconductors.
- 1.7 Explain the effect of temperature on semiconductors.
- 1.8 Explain the formation of PN junction diode.
- 1.9 Explain depletion region and barrier potential.

- 1.10 Explain forward biasing of PN junction diode.
- 1.11 Explain reverse biasing of PN junction diode.
- 1.12 Draw and explain V–I characteristics of PN junction diode.
- 1.13 Explain the working of Zener diode.
- 1.14 Draw and explain V–I characteristics of Zener diode.
- 1.15 Explain the working and applications of LED.
- 1.16 Explain the working and applications of photodiode.
- 1.17 Explain the working and applications of LDR.

UNIT – II: Rectifiers & Power Supplies

- 2.1 Explain the need for rectification.
- 2.2 Define a rectifier.
- 2.3 Explain the working of half-wave rectifier with waveform.
- 2.4 Explain the working of full-wave rectifier with waveform.
- 2.5 Explain the working of bridge rectifier with waveform.
- 2.6 Compare half-wave and full-wave rectifiers.
- 2.7 Define ripple factor.
- 2.8 Explain rectifier efficiency (qualitative).
- 2.9 State the need for filters in power supplies.
- 2.10 List different types of filters used in power supplies.
- 2.11 Explain the working of capacitor filter.
- 2.12 Explain the working of LC filter (basic idea).
- 2.13 Define voltage regulation.
- 2.14 Explain Zener diode as a voltage regulator.
- 2.15 Draw and explain the block diagram of regulated power supply.
- 2.16 List the applications of regulated power supplies.

UNIT – III: Bipolar Junction Transistors (BJT)

- 3.1 Define a transistor.
- 3.2 Explain the construction of NPN and PNP transistors.
- 3.3 Explain the working principle of BJT.
- 3.4 Identify emitter, base and collector regions.
- 3.5 Explain transistor action.
- 3.6 Explain current components in a transistor.
- 3.7 State different transistor configurations.
- 3.8 Explain CB configuration.
- 3.9 Explain CE configuration.
- 3.10 Explain CC configuration.
- 3.11 Draw input and output characteristics of CE configuration.
- 3.12 Compare CB, CE and CC configurations.
- 3.13 Explain the need for transistor biasing.
- 3.14 List basic biasing methods.

- 3.15 Explain transistor as an amplifier.
- 3.16 Explain transistor as a switch.

UNIT – IV: Amplifiers & Feedback

- 4.1 Define an amplifier.
- 4.2 Define gain and bandwidth.
- 4.3 Classify amplifiers based on frequency and function.
- 4.4 Explain coupling methods used in amplifiers.
- 4.5 Explain RC coupled amplifier.
- 4.6 Draw and explain frequency response of RC coupled amplifier.
- 4.7 Explain transformer coupled amplifier.
- 4.8 List applications of RC and transformer coupled amplifiers.
- 4.9 Explain the concept of power amplifier.
- 4.10 Differentiate between voltage and power amplifiers.
- 4.11 Define feedback.
- 4.12 List advantages of feedback.
- 4.13 Classify types of feedback.
- 4.14 Explain the effect of feedback on gain.
- 4.15 Explain the effect of feedback on bandwidth.

UNIT – V: FETs, MOSFETs & Oscillators

- 5.1 Define Field Effect Transistor (FET).
- 5.2 Explain the construction of JFET.
- 5.3 Explain the working of JFET.
- 5.4 Draw and explain JFET characteristics.
- 5.5 Define MOSFET.
- 5.6 Differentiate between enhancement and depletion MOSFETs.
- 5.7 Compare MOSFET and BJT.
- 5.8 List advantages of MOSFET.
- 5.9 Explain applications of MOSFET in power electronics.
- 5.10 Explain applications of MOSFET in EV systems.
- 5.11 Define an oscillator.
- 5.12 State the conditions for oscillations.
- 5.13 Explain RC phase shift oscillator.
- 5.14 Explain Hartley oscillator.
- 5.15 Explain Colpitts oscillator.
- 5.16 List applications of oscillators.

UNIT – VI: Linear ICs & Electronic Instruments

- 6.1 Define an integrated circuit (IC).
- 6.2 Classify integrated circuits.
- 6.3 List advantages of ICs.
- 6.4 Define operational amplifier (op-amp).

- 6.5 List ideal characteristics of op-amp.
- 6.6 Explain op-amp as inverting amplifier.
- 6.7 Explain op-amp as summing amplifier.
- 6.8 Explain op-amp as integrator.
- 6.9 Explain op-amp as differentiator.
- 6.10 Draw and explain IC 741 pin configuration.
- 6.11 State applications of IC 741.
- 6.12 Draw and explain IC 555 timer pin configuration.
- 6.13 State applications of IC 555 timer.
- 6.14 Explain CRO block diagram.
- 6.15 List applications of CRO.
- 6.16 Explain digital frequency meter.
- 6.17 Explain function generator.

SUGGESTED STUDENT ACTIVITIES

1. Visit the library or internet centre and collect information about basic electronic components.
2. Draw neat diagrams of:
 - PN junction diode
 - Transistor (NPN and PNP)
 - Rectifier circuits
3. Prepare simple charts showing:
 - Symbols of diodes, transistors and ICs
 - Basic electronic components used in circuits
4. Identify and list electronic components available in the laboratory.
5. Observe rectifier and amplifier circuits during lab demonstrations.
6. Use simulation software to study simple diode and rectifier circuits (if available).
7. Prepare short assignments on topics like:
 - Applications of diodes
 - Uses of transistors
 - Importance of power supplies
8. Work in groups to make a simple electronic circuit, such as:
 - LED indicator circuit
 - Basic DC power supply
9. Note down real-life applications of electronic devices used in daily life.
10. Maintain a simple notebook to record important points learned in this course.

Model Question Paper
State Board of Technical Education and Training, Telangana
DEEE – I Year

MID – I Examination

Course Code: EE-106

Course Name: Semiconductor Devices and Circuits

Duration: 1 Hour

Max. Marks: 20 Marks

PART – A

Answer all questions. Each question carries ONE mark

(4 × 1 = 4 Marks)

1. Define intrinsic semiconductors.
2. Define PN junction diode.
3. State the need for rectification.
4. What is a rectifier?

PART – B

Answer ANY TWO questions. Each question carries THREE marks

(2 × 3 = 6 Marks)

5(a). Explain the formation of PN junction diode.

(OR)

5(b). Draw the symbol of Zener diode and state its application.

6(a). Compare half-wave and full-wave rectifiers.

(OR)

6(b). List different types of filters used in power supplies.

PART – C

Answer ANY TWO questions. Each question carries FIVE marks

(2 × 5 = 10 Marks)

7(a). Explain the working of PN junction diode under forward and reverse bias with neat diagrams.

(OR)

7(b). Draw and explain the V–I characteristics of PN junction diode.

8(a). Explain the working of bridge rectifier with neat circuit diagram and waveforms.

(OR)

8(b). Explain the Zener diode as a voltage regulator with neat circuit diagram.

State Board of Technical Education and Training, Telangana
DEEE – I Year

MID – II Examination

Course Code: EE-106

Course Name: Semiconductor Devices and Circuits

Duration: 1 Hour

Max. Marks: 20 Marks

PART – A

Answer all questions. Each question carries ONE mark

(4 × 1 = 4 Marks)

1. Define transistor.
2. List different transistor configurations.
3. Define amplifier.
4. What is feedback?

PART – B

Answer ANY TWO questions. Each question carries THREE marks

(2 × 3 = 6 Marks)

5(a). Explain CE transistor configuration.

(OR)

5(b). Compare CB and CE configurations.

6(a). Define gain and bandwidth.

(OR)

6(b). List advantages of negative feedback.

PART – C

Answer ANY TWO questions. Each question carries FIVE marks

(2 × 5 = 10 Marks)

7(a). Explain transistor as an amplifier with neat diagram.

(OR)

7(b). Explain RC coupled amplifier with frequency response.

8(a). Explain the working principle of RC phase shift oscillator.

(OR)

8(b). Explain the working of Hartley oscillator with neat circuit diagram.

State Board of Technical Education and Training, Telangana
DEEE – I Year

Course Code: EE-106

Course Name: Semiconductor Devices and Circuits

Duration: 2 Hours

Max. Marks: 40 Marks

PART – A

Answer all questions. Each question carries ONE mark

(8 × 1 = 8 Marks)

1. Define extrinsic semiconductor.
2. Draw the symbol of LED.
3. Define ripple factor.
4. List the types of rectifiers.
5. Define transistor biasing.
6. What is bandwidth?
7. Define operational amplifier.
8. State the necessity of time base voltage.

PART – B

Answer ANY FOUR questions. Each question carries THREE marks

(4 × 3 = 12 Marks)

9(a). Explain the working of Zener diode.

(OR)

9(b). Draw the V–I characteristics of Zener diode.

10(a). Compare half-wave and bridge rectifiers.

(OR)

10(b). Explain capacitor filter.

11(a). List advantages of MOSFET over BJT.

(OR)

11(b). Draw the pin diagram of IC 741.

12(a). List applications of CRO.

(OR)

12(b). List parts of function generator.

PART – C

Answer ANY FOUR questions. Each question carries FIVE marks

(4 × 5 = 20 Marks)

13(a). Explain the input and output characteristics of transistor in CE configuration.

(OR)

13(b). Explain transistor as a switch.

14(a). Explain the working of full-wave rectifier with neat diagram and waveforms.

(OR)

14(b). Explain regulated power supply with block diagram.

15(a). Explain op-amp as inverting amplifier with neat circuit diagram.

(OR)

15(b). Explain op-amp as summing amplifier.

16(a). Explain CRO block diagram and its applications.

(OR)

16(b). Explain the working principle of digital frequency meter.