II Year I Semester	L	T	P	C
17EC301	3	1	0	3

ELECTRONIC DEVICES & CIRCUITS

Preamble

This course introduces the concepts of semi-conductor physics and operation of various semi-conductor devices. Realization of rectifiers, amplifiers and oscillators using semi-conductor devices and their analysis is also introduced in this course.

Learning objectives

1. Know the properties of semiconductor materials.
2. Understand the operation and principles of P-N diode and special diodes.
3. Understand various types of rectifiers and filters.
4. Know the working of BJT and need for transistor biasing and stabilization.
5. Know the working of FET and other Transistors.

Unit – 1

Overview of Semiconductors:

Insulators, Semiconductors and Metals – Classification using Energy gap, Intrinsic and Extrinsic Semiconductors – Electrons and Holes, Conductivity, Mobility, Drift and Diffusion Currents, Transportation of Charge Carriers - Generation and Recombination of Carriers, Charge Densities in Semiconductors, Hall Effect - Quantitative Analysis and Applications, Continuity Equation, Mass Action Law, Einstein's Equation, Fermi level in intrinsic and extrinsic semiconductors.

Unit – II

Junction Diode Characteristics:

P-N Junction Diode - Formation of P-N Junction, Open Circuited P-N Junction, Biased PN Junction-Forward Bias, Reverse Bias, Current Components in P-N Junction Diode, Law of Junction, Diode Current Equation-Quantitative Analysis, V-I Characteristics of Diode Forward Bias, Reverse Bias, Breakdown in P-N Junction Diode, Temperature Dependence on V-I Characteristics, Diode Resistance-Static Resistance, Dynamic Resistance, Reverse Resistance, Diode Capacitance-Transition Capacitance, Diffusion Capacitance, Energy Band Diagram of P-N Junction Diode.

Unit – III

Special Diodes and Rectifiers:

Breakdown Mechanisms - Zener Breakdown and Avalanche Breakdown, Zener Diode-V-I Characteristics, Applications, Construction, Operation, Characteristics and applications of LED, Photodiode, LCD, Schottky diode, Varactor Diode and Tunnel diode.

Basic Rectifier setup, Half Wave Rectifier, Full Wave Rectifier, Bridge Rectifier, Inductive and Capacitive Filters, L– Section and π- Section, Derive and compare rectifier parameters with and without filter.

Unit – IV

Bipolar Junction Transistor (BJT) & Other Transistors:

Bipolar Junction Transistor – Types, Symbols and Operation, Transistor Current Components, Transistor Equation - Relation among IC, IB, ICBO, Transistor Configurations -CB, CE and CC, Transistor as a switch, Transistor switching times, Transistor as an Amplifier, Characteristics of Transistor in Common Base Configuration, Common Emitter and Common Collector Configurations - Input and output characteristics, Early effect, Transistor parameters, Current amplification factor, Relation among α, β, and γ, Comparison of CB, CE and CC Configurations, Punch Through/Reach through, Typical transistor junction voltage values,

Photo Transistor, Silicon Controlled Rectifier, Two-Transistor version, Diac, Triac, UJT-Negative Resistance Property and Applications (Quantitative treatment)

Unit –V

BJT Biasing and Thermal Stability:

Need For Biasing, Operating Point, Load Line Analysis - D.C. Load Line, A.C. Load Line, Biasing - Methods, Basic Stability, Fixed Bias, Collector-to-base Bias and Self Bias, Stabilization against variations in VBE, Ic and β, Stability Factors S, S' and S'', Bias Compensation - Thermistor, Sensistor, Diode Compensation for variation in ICO, Thermal Runaway, Thermal Stability, heat sinks.

Unit – VI:

FET & Biasing:

FET Types and Symbols - JFET and MOSFET/IGFET, JFET: N-Channel and P-Channel Construction, Operation, Characteristics - Drain and Transfer, FET as Voltage Variable Resistor, Parameters - Drain Resistance, Amplification factor, Trans conductance, Pinch-off voltage, MOSFET - Types-Depletion MOSFET - N Channel and P Channel, Enhancement MOSFET- N-Channel and P-Channel, Construction, Operation, Characteristics - Transfer and Drain Characteristics for Depletion and Enhancement Modes, Comparison between JFET and MOSFET, Comparison of BJT and FET. Biasing – Fixed method, self-bias method and voltage divider method, FET Common Source Amplifier, Common Drain Amplifier, Generalized FET Amplifier

Course Outcomes:

- Students are able to understand the basic concepts of semiconductor physics, which are useful to understand the operation of diodes and transistors.
- Students are able to explain the operation and characteristics of PN junction diode and special diodes.
- Ability to understand operation and design aspects of rectifiers and regulators.
- Students are able to understand the characteristics of various transistor configurations. They become familiar with different biasing, stabilization and compensation techniques used in transistor circuits.
- Students are able to understand the operation and characteristics of FET, Thyristors, Power IGBTs and Power MOSFETs.
- Students are able to understand the merits and demerits of positive and negative feedback and the role of feedback in oscillators and amplifiers.

Text Books:

1. “Electronic Devices and Circuits”, J. Millman, C. Halkias, Tata McGraw-Hill, Third Edition, 2010.
2. “Electronic Devices and Circuit Theory”, R.L. Boylestad and Louis Nashelsky, Pearson Publications, Eleventh Edition, 2013.
3. “Electronic Devices and Circuits”, G.S.N Raju, I.K International Publishing Housing Pvt. Ltd
4. “Electronic Devices and Circuits”, David A Bell, Fifth Edition 2008, Oxford University Press.

Reference Books:

1. “Integrated Electronics: Analog and Digital Circuits and Systems” J. Millman and Halkias, TMH.
2. Electronic Devices and Circuits– Salivahanan, N. Suresh Kumar, A. Vallavaraj, Tata McGraw-Hill, Second Edition, 2008.
3. “Micro Electronic Circuits” Sedra and Smith, Oxford University Press.
4. “Electronic Devices and Circuits” G.K. Mithal, Khanna Publishers.