II Year II Semester	**L**	**T**	**P**	**C**
Code:20EC4629	**3**	**1**	**0**	**4**

MICROELECTRONIC DEVICES AND CIRCUITS (Honors)

Course Objectives:

1. To understand the concepts of uniform semiconductors and their excitations
2. To solve the flow problems of non-uniform carrier injection
3. To study and develop junction profiles with necessary equations
4. To know the working principle and characteristics of a MOS Capacitor
5. To familiarize with the switching transients in devices and circuits

UNIT–I: Uniform Semiconductors in Equilibrium & Uniform Excitation of Semiconductors

Thermal Equilibrium, Intrinsic Silicon, Extrinsic Silicon – Donors and Acceptors, Detailed Balance, Equilibrium Carrier Concentration. Elemental Semiconductors, Compound Semiconductors. The Effects of Changing Temperature - Uniform Electric Field – Drift, Drift Motion and Mobility, Drift Current and Conductivity, Temperature Variation of Mobility and Conductivity. Uniform Optical Excitation – Minority Carrier Lifetime, Population Transients, High-Level Injection Populations and Transients. Photoconductivity and Photoconductors – Basic Concepts, Specific Device Issues

UNIT–II: Non-uniform Carrier Injection: Flow Problems

A Model for Diffusion, Diffusion Current Density, Other Diffusion Important in Devices, Modeling Non-uniform Situations – Total Current Densities, The Continuity Equations, Gauss's Law, The Five Basic Equations. Developing the Diffusion Equation – Uniformly Doped Extrinsic Material, Low-Level Injection, Quasi-neutrality, Minority Carriers Flow by Diffusion, Time-Dependent Diffusion Equation, Quasistatic Diffusion, Flow Problems – Homogeneous Solutions, Particular Solutions, Boundary Conditions, The Total Current, The Currents, Electric Field, and Net Charge

UNIT–III: Uniformly and Non-uniformly Doped Semiconductors in Thermal Equilibrium

The Poisson-Boltzmann Equation, Gradual Spatial Variation of Doping. *p-n* Junction – The Depletion Approximation, Abrupt *p-n* Junction, Other *p-n* Junction Profiles, The Electrostatic Potential around a Circuit, Circuit models for Junction diodes, Circuit models for Bipolar Junction Transistors.

UNIT–IV: The MOS capacitor

The MOS Capacitor in Thermal Equilibrium, Isolated MOS Capacitor with Applied Voltage – Flat-band, Accumulation, Depletion, Threshold and Inversion. Biased MOS Capacitor with Contact to the Channel - Direct Contact to the Channel, Adjacent *p-n*Junction. Capacitance of MOS Capacitors versus Bias. Ions and Interface Charges in MOS Structures - Interface Charge, Oxide Charge, Types of MOS Capacitors – n-channel, p-type Si and p-channel, n-type Si

UNIT–V: Switching Transients in Devices and Circuits

General Techniques, Turning Devices ON and OFF – Bipolar Junction Devices, Field Effect Devices. Inverter Switching Times and Gate Delays - CMOS and Other MOSFET Inverters, TTL and ECL Gates, Device and Circuit Scaling

Course Outcomes:

A student who successfully fulfils this course requirement will be able to:

S.No	Course Outcome	BTL
1.	Classify the semiconductors and discuss the uniform excitation of semiconductors	L2
2.	Solve the flow problems of non-uniform carrier injection	L3
3.	Deduce expressions for Uniform and Non-uniformly doped Semiconductors in Thermal Equilibrium	L5
4.	Understand the Construction, working principle and characteristics of a MOS Capacitor	L2
5.	Analyse the Switching Transients in Devices and Circuits	L4

Correlation of COs with POs & PSOs:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	-	2	-
CO2	2	2	1	-	-	-	-	-	-	-	-	-	2	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO4	2	2	1	-	-	-	-	-	-	-	-	-	3	-
CO5	1	2	2	-	-	-	-	-	-	-	-	-	3	-

Text Books:

1. Microelectronic Devices and Circuits – Clifton G. Fonstad, Electronic Edition, 2006.
2. Microelectronic Circuits – Sedra and Smith, Oxford University Press, Seventh Edition, 2015.

Reference Books:

1. Microelectronics: Circuit Analysis and Design–Donald A. Neaman, Mc-Graw Hill, Fourth Edition, 2010.
2. Microelectronics –J. Millman and A. Grabel, Tata Mc-Graw Hill, Second Edition, 2009.