II B.Tech – II Semester (20EC4629) MICROELECTRONIC DEVICES AND CIRCUITS (Honors)

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Int. Marks	Ext. Marks	Total Marks	
30	70	100	

Pre-Requisites: Electronic Devices and Circuits

Course Objectives:

- To understand the concepts of uniform semiconductors and their excitations
- To solve the flow problems of non-uniform carrier injection
- To study and develop junction profiles with necessary equations
- To know the working principle and characteristics of a MOS Capacitor
- 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 Nonuniform 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:

After successful completion of the course, the students can be able to

S.No	Course Outcome				
1	Classify the semiconductors and discuss the uniform excitation of semiconductors				
2	Solve the flow problems of non-uniform carrier injection				
3	Deduce expressions for Uniform and Non-uniformly doped Semiconductors in Thermal Equilibrium				
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
CO 1	2	1	-	-	-	-	•	-	-	-	-	-	2	-
CO 2	2	2	1	-	-	-	-	-	-	-	-	-	2	-
CO 3	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO 4	2	2	1	-	-	-	-	-	-	-	-	-	3	-
CO 5	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.