SEMESTER S3

SOLID STATE DEVICES

Course Code	**PCECT302**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	Physics of Electrical Science (GBPHT121)	**Course Type**	Theory

Course Objectives:

1. This course explains the physical processes and working principles of semiconductor devices, while relating the device performance to material parameters and design criteria.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Review of Semiconductor physics:** Equilibrium and steady state conditions, Concept of effective mass and Fermi level, Density of states & Effective density of states, Equilibrium concentration of electrons and holes. **Excess carriers in semiconductors:** Generation and recombination mechanisms of excess carriers, quasi-Fermi levels. **Carrier transport in semiconductors**: Drift, conductivity and mobility, variation of mobility with temperature and doping, Hall Effect. Diffusion, Einstein relations, Poisson equations, Continuity equations, Current flow equations, Diffusion length, Gradient of quasi-Fermi level.	**13**
2	**PN junctions**: Contact potential, Electrical Field, Potential and Charge distribution at the junction, Biasing and Energy band diagrams, Ideal diode equation. **Bipolar junction transistor**: Transistor action, Base width	**12**

	modulation, Current components in a BJT, Derivation of current components.	
3	**Metal Semiconductor contacts**: Electron affinity and work function, Ohmic and Rectifying Contacts, current voltage characteristics. **Ideal MOS capacitor**: band diagrams at equilibrium, accumulation, depletion and inversion, surface potential, CV characteristics, effects of real surfaces, threshold voltage, body effect. **MOSFET**- Drain current equation of enhancement type MOSFET (derivation)- linear and saturation region, Drain characteristics, transfer characteristics.	**11**
4	**MOSFET scaling**: Need for scaling, constant voltage scaling and constant field scaling. Sub- threshold conduction in MOS. **Short channel effects in MOSFETs**: Channel length modulation, Drain Induced Barrier Lowering, Velocity Saturation, Threshold Voltage Variations and Hot Carrier Effects. **MESFET and FinFET**: Structure, operation and advantages.	**8**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply Fermi-Dirac statistics to compare equilibrium carrier concentration.	**K3**
CO2	State different carrier transport mechanisms in extrinsic semiconductors and obtain the current densities due to this transport.	**K3**
CO3	Apply the concept of semiconductor physics to solve the current components in semiconductor devices.	**K3**
CO4	Analyze the response of semiconductor devices for different biasing conditions	**K3**
CO5	Outline the effects of scaling in semiconductor devices.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping od Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**											
CO2	**3**	**2**										
CO3	**3**	**2**										**2**
CO4	**3**	**2**	**2**									**2**
CO5	**3**	**2**	**2**									**2**

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Semiconductor Physics and Devices	Neamen	McGraw Hill	4/e, 2017
2	Physics of Semiconductor Devices	Sze S.M	John Wiley	3/e, 2015
3	Semiconductor Devices: Physics and Technology	Sze S.M	John Wiley	3/e, 2016
4	Operation and Modelling of the MOS Transistor	Yannis Tsividis	Oxford University Press	3/e,2010

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://nptel.ac.in/courses/117106091
2	https://nptel.ac.in/courses/117106091
3	https://nptel.ac.in/courses/117106091
4	https://nptel.ac.in/courses/117106091