SRM University – AP, Andhra Pradesh

Neerukonda, Mangalagiri Mandal
Guntur District, Mangalagiri, Andhra Pradesh 522240

PHY 102 Solid State Device Physics

Course Code	PHY102	**Course Category**	Core Course	**L-T-P-C**	3	0	0	3
Pre-Requisite Course(s)	PHY101	**Co-Requisite Course(s)**	PHY102L	**Progressive Course(s)**	NA			
Course Offering Department	Physics	**Professional / Licensing Standards**						
Board of Studies Approval Date		**Academic Council Approval Date**						

Course Objectives / Course Learning Rationales (CLRs)

Objective 1: To apply concepts of quantum mechanics and wave-particle duality

Objective 2: To understand metal, semiconductor and insulators in terms of band structure

Objective 3: To describe and understand effect of PN junction and its electrical properties

Objective 4: To understand bipolar junction transistor and field effect transistors

Objective 5: Understand various optoelectronics devices namely solar cells, LED and PN junction diode laser

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Apply concept of wave-particle duality and solve particle in a box problem.	3	70%	65%
Outcome 2	Explain semiconductor in terms of band structure and doping effects	3	70%	65%
Outcome 3	Describe depletion region of PN junction and effect of forward and reverse biasing	2	70%	65%
Outcome 4	Describe operation of bipolar junction transistor and MOSFET	2	70%	65%
Outcome 5	Describe operation principles of solar cell, LED and laser	2	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)

	Scientific and Disciplinary Knowledge	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	2	1	2						2	3	1	2
Outcome 2	3	3	3	3	2	2			2			2	3	2	2
Outcome 3	3	3	3	3	2	2			2			2	3	2	2
Outcome 4	3	3	3	3	2	1			3			2	3	2	2
Outcome 5	3	3	3	3	3	1			2			3	3	2	2
Course Average	**3**	**3**	**3**	**3**	**3**	**2**			**2**			**2**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References
Unit 1	**Quantum Mechanics and Application**	**9**		
1.	Light as particle: Photoelectric effect, idea of photon	1	1	1, 2
2.	Wave particle duality; Matter waves - De Broglie hypothesis	1	1	1, 2
3.	Postulates of quantum mechanics, Wave function and its physical interpretation	1	1	1, 2
4.	Heisenberg's uncertainty principle-qualitative discussion	1	1	1, 2
5.	Schrödinger's equation	1	1	1, 2
6.	Probability current density, Equation of continuity, and its physical significance	1	1	1, 2
7.	Particle in an infinitely deep potential well (one - dimension)	1	1	1, 2
8.	Step potential and potential barrier: Qualitative discussion	1	1	1, 2
9.	Barrier penetration and tunnelling effect	1	1	1, 2
Unit 2	**Energy Bands and Charge Carriers in Semiconductors**	**9**		
10.	Crystal Lattices, Periodic Structures, Cubic Lattices, its plane and directions	1	2	1, 2
11.	Energy bands: Metals - semiconductors and insulators, direct and indirect bandgap semiconductors	1	2	1, 2
12.	Electrons and holes- intrinsic and extrinsic semiconductors	1	2	1, 2
13.	Doped materials - n-type material and p-type semiconductor material; Energy band diagrams	1	2	1, 2

14.	The Fermi Level, Electron and hole concentrations at equilibrium, Temperature dependence of carrier concentrations	1	2	1, 2
15.	Electrical conductivity and mobility, Drift velocity, Effects of temperature and doping on carrier mobility	1	2	1, 2
16.	Carrier Lifetime - Direct recombination, Indirect recombination; Trapping	1	2	1, 2
17.	Diffusion and drift of Carriers, Hall effect	1	2	1, 2
18.	Diffusion and recombination, The continuity equation	1	2	1, 2
Unit 3	**p-n Junction**	**9**		
19.	Steady state carrier injection; Diffusion length	1	3	1, 2
20.	Fabrication of p-n Junctions	1	3	1, 2
21.	Equilibrium condition of p-n Junction	1	3	1, 2
22.	The built-in potential, Equilibrium Fermi levels	1	3	1, 2
23.	Space charge width, electric field and junction capacitance	1	3	1, 2
24.	IV characteristics of forward and reverse biased p-n junction	1	3	1, 2
25.	Reverse-biased p-n junctions: Space charge width and electric field	1	3	1, 2
26.	Zener breakdown and avalanche breakdown	1	3	1, 2
27.	Metal–Semiconductor Junctions: Schottky Barriers, Rectifying Contacts, Ohmic Contacts (Qualitative discussions)	1	3	1, 2
Unit 4	**Transistors**	**9**		
28.	Bipolar Junction Transistor (BJT): Design, modes of operation and working principles	1	4	1, 2
29.	BJT IV characteristics	1	4	1, 2
30.	Field-Effect Transistor (FET): Design and working principles; Junction Field-Effect Transistor (JFET)	1	4	1, 2
31.	Metal-oxide-semiconductor Field-Effect Transistor (MOSFET): Design and working principles	1	4	1, 2
32.	D- MOSFET design and operation	1	4	1, 2
33.	E- MOSFET design and operation	1	4	1, 2
34.	MOSFET Output characteristics, Transfer characteristics	1	4	1, 2
35.	Short channel MOSFET I–V characteristics, Equivalent circuit for the MOSFET	1	4	1, 2
36.	Transistor applications	1	4	1, 2
Unit 5	**Optoelectronic Devices**	**9**		
37.	Electromagnetic spectrum	1	5	3. 4
38.	Optical absorption and electron-hole recombination	1	5	3. 4
39.	Photovoltaic effect	1	5	3. 4
40.	Solar Cells: Design and operation	1	5	3. 4
41.	Photodetectors: Design and operation	1	5	3. 4
42.	Light-emitting diodes: Design and operation	1	5	3. 4
43.	Introduction to LASER, Metastable state, Population inversion, stimulated emission, Einstein's A and B coefficients	1	5	3. 4
44.	Semiconductor LASER: Types, materials and fabrication	1	5	3. 4

45.	Population Inversion at a Junction, Emission Spectra for p-n junction LASER	1	5	3. 4

Recommended Resources

1. Solid State Electronic Devices - Ben G. Streetman and Sanjay Kumar Banerjee, VII Edition (2015), Publisher – PEARSON
2. Semiconductor Physics and Devices - Donald A. Neamen, Dhrubes Biswas, V Edition (2012), Publisher – Mc Graw Hill (Indian)

Other Sources

1. Concept of Modern Physics - Arthur Besier, Shobhit Mahajan, S Rai, 2017 Edition, Publisher - Tata McGraw Hill
2. Optics - Ajay Ghatak, Fifth Edition (2010), Publisher - Mcgraw Hill

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%		40%		60%		40%		60%	
	Understand										
Level 2	Apply	40%		60%		40%		60%		40%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Course Designers

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