PHY 102	Solid State Device Physics	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	Engineering Physics (PHY 101)				
Data Book / Codes/Standards	NIL				
Course Category	CORE				
Course designed by	Department of Physics				
Approval					

PURPOSE	The course aims to cover the fundamental formalism and applications of Physics. It mainly includes introduction to modern physics, fundamentals of quantum mechanics, solid state physics and devices							
LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	apply the fundamental concepts of modern physics and explain physics phenomenon							
2.	students' physical intuition and thinking process through understanding the theory							
3.	Understand basics of solid state physics and functioning of devices							

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I – Quantum Mechanics and Application	**9**			
1.	Light as particle: Photoelectric effect, idea of photon	1	C		1,2,3
2.	Wave particle duality Matter waves - De Broglie hypothesis	1	C		1,2,3
3.	Postulates of quantum mechanics, Wave function and its physical interpretation	1	C		1,2,3
4.	Heisenberg's uncertainty principle-qualitative discussion	1	C		1,2,3
5.	Schrodinger's equation	1	C-D		1,2,3
6.	Probability current density, Equation of continuity, and its physical significance	1	C-D		1,2,3
7.	Free particle, Particle in infinitely deep potential well (one - dimension)	1	D		1,2,3

8.	Step potential, Potential barrier (Qualitative discussion). Particle in three dimensional rigid box	1	D		1,2,3
9.	Barrier penetration and tunneling effect	1	D-I		1,2,3
	UNIT II – Energy Bands and Charge Carriers in Semiconductors	**9**			
10.	Crystal Lattices, Periodic Structures Cubic Lattices its plane and directions	1	D		1,2,3
11.	Energy bands: Metals - semiconductors and insulators, direct and indirect semiconductors	1	D		1,2,3
12.	Electrons and holes- intrinsic and extrinsic material, Doped materials - n-type material and p-type semiconductor material	1	D-I		1,2,3
13.	Electrons and holes in Quantum wells	1	D-I		1,2,3
14.	The Fermi Level, Electron and hole concentrations at equilibrium, Temperature dependence of carrier concentrations	1	D		1,2,3
15.	Electrical conductivity and mobility, Drift and resistance, Effects of temperature and doping on mobility	1	D-I		1,2,3
16.	Carrier Lifetime - Direct recombination, Indirect recombination; Trapping	1	D		1,2,3
17.	Diffusion and drift of Carriers, Built-in electric Fields, Hall effects	1	D		1,2,3
18.	Diffusion and recombination, The continuity equation	1	D-I		1,2,3
	UNIT III: PN Junctions	**9**			
19.	Steady state carrier injection; Diffusion length	1	C		1,2,3
20.	Fabrication of p-n Junctions	1	C-D		1,2,3
21.	Equilibrium condition of p-n Junctions	1	C-D		1,2,3
22.	The Contact potential, Equilibrium Fermi levels, Space charge and capacitance of p-n a junction	1	C-D		1,2,3
23.	Qualitative description of current flow at a forward biased p-n junctions	1	C-D		1,2,3
24.	Carrier injection from metal contact	1	D		1,2,3
25.	Reverse-biased p-n junctions; Steady state conditions	1	D		1,2,3
26.	Zener breakdown and Avalanche breakdown, Voltage rectifiers	1	D		1,2,3
27.	Metal–Semiconductor Junctions: Schottky Barriers, Rectifying Contacts, Ohmic Contacts	1	D		1,2,3
	UNIT-IV: Transistors	**9**			
28.	Bipolar Junction and Field Effect Transistor Operation – (BJT and FET) The Load Line, Amplification and Switching	1	C		1,2,3

29.	The Junction fabrication BJT and FET	1	C-D		1,2,3
30.	The Metal–Semiconductor FET	1	C-D		1,2,3
31.	The Metal–Insulator–Semiconductor FET Basic Operation and Fabrication	1	C-D		1,2,3
32.	The Ideal MOS Capacitor, MOS capacitance – voltage Analysis	1	D		1,2,3
33.	Time-dependent capacitance measurements, Current–voltage characteristics of MOS Gate Oxides	1	D-I		1,2,3
34.	MOS Field-effect Transistor - Output characteristics, Transfer characteristics	1	C-D		1,2,3
35.	Short channel MOSFET I–V characteristics, Equivalent circuit for the MOSFET	1	D		1,2,3
36.	Frequency Limitations of Transistors	1	D-I		1,2,3
	UNIT V: Optoelectronic Devices	**9**			
37.	Steady State Carrier Generation; Quasi-Fermi Levels	1	C		1,2,3,4
38.	Photoconductive devices, Current and voltage in an illuminated p-n junction	1	C-D		1,2,3,4
39.	Solar Cells and Photodetectors	1	D-I		1,2,3,4
40.	Light-emitting diodes	1	D		1,2,3,4
41.	Metastable state, Population inversion and Einstein's A and B coefficient	1	C-D		1,2,3,4
42.	Basic of semiconductor laser	1	C		1,2,3,4
43.	Population Inversion at a Junction, Emission Spectra for p-n junction Lasers	1	C-D		1,2,3,4
44.	Materials for Semiconductor Lasers, Fabrications	1	D-I		1,2,3,4
45.	Heterojunction Lasers	1	D		1,2,3,4
	Total contact hours	**45**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
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)
3	Concept of Modern Physics - Arthur Besier, Shobhit Mahajan, S Rai, 2017 Edition, Publisher - Tata McGraw Hill
4	Optics - Ajay Ghatak, Fifth Edition (2010), Publisher - Mcgraw Hill

5	Fiber optics and Lasers: The two revolutions - A. Ghatak, K. Tyagarajan (2006) Publisher -Macmillan

Course nature					**Theory**	
Assessment Method – Theory Component (Weightage 100%)						
In-semester	**Assessment tool**	Mid Term I	Mid Term II	CLA I	CLA II	**Total**
	Weightage	**15%**	**15%**	**10%**	**10%**	**50%**
End semester examination Weightage :						**50%**

PHY 102L	SOLID STATE DEVICE PHYSICS LABORATORY	L	T	P	C
		0	0	2	1
Co-requisite:	NIL				
Prerequisite:	PHY 101L				
Data Book / Codes/Standards	NIL				
Course Category	CORE				
Course designed by	Department of Physics				
Approval					

PURPOSE	The course aims to cover the application of fundamental formalism of Physics. It mainly includes modern physics, wave and optics, fiber optics, solid state physics.

LEARNING OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand basic equipment operation and analysis							
2.	Correlate fundamental concept of physics to laboratory experiments							

Sl. No	**Description of Experiments**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
1	Measurement of Planck's constant by Cs photocell	1	I-O		1, 2
2	To record the Franck-Hertz characteristic curve for neon emission	1	I-O		1, 2
3	Determine charge carrier type and concentration of a given semiconductor using Hall Effect	2	I-O		1, 2
4	Four-probe Resistivity Measurement	1	I-O		1, 2
5	Circuit Simulation Tutorials for p-n diodes (LTspice)	1	I-O		
6	Circuit Simulation Tutorials for Zener diodes (LTspice)	1	I-O		
7	Circuit Simulation Tutorials for Bipolar Junction Transistor (LTspice)	1	I-O		1, 2
8	Circuit Simulation Tutorials for MOSFET (LTspice)	1	I-O		1, 2
9	Determination of the beam quality factor (M-parameter) of a given semiconductor laser	1	I-O		1, 2
10	To determine the wavelength of a given semiconductor laser lights with the diffraction patterns by single slit and double slit	1	I-O		1, 2
11	a) To measure the photo-current as a function of the irradiance at constant voltage b) Current-voltage and current-load characteristics of a solar cell as a function of the irradiance	1	I-O		1, 2
12	To determine the wavelength of a semiconductor	2	I-O		1, 2

	laser using the Michelson interferometer				
13	a) Determination the wavelength of He-Ne laser using diffraction grating b) Determination the particle size of a given powder	1	I-O		1, 2
	Total contact hours (Including demo and repeat labs)	**15**			

LEARNING RESOURCES	
	TEXT BOOKS/REFERENCE BOOKS/OTHER READING MATERIAL
1	Physics for Scientist and Engineers, Ninth edition (2017) - Raymond A. Serway, John W. Jewett (Publisher - Cengage India Private Limited))
2	Physics laboratory manuals

Course nature				**Practical**	
Assessment Method – Practical Component (Weightage 100%)					
In-semester	**Assessment tool**	Lab performance	Practical model exam	Observation note	**Total**
	Weightage	**20%**	**20%**	**10%**	**50%**
End semester examination Weightage :					**50%**