SEMESTER S7

NANO ELECTRONICS

Course Code	PEMRT753	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GCPHT121	Course Type	Theory

Course Objectives:

1. Provide students with a comprehensive understanding of the principles, technologies, and applications of nano-scale electronic devices and systems.
2. Develop a solid foundation in the fundamentals of nanotechnology and nanoelectronics and understand the implications of nanotechnology on future electronic systems and devices

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SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to nanotechnology, Limitations of conventional microelectronics, characteristic lengths in mesoscopic systems, Quantum mechanical coherence. Low dimensional structures - Quantum wells, wires and dots, Density of states of 1D and 2D nanostructures. Basic properties of square quantum wells of finite depth, parabolic and triangular quantum wells	9
2	Introduction to methods of fabrication of nano-layers: physical vapour deposition- evaporation & Sputtering, Chemical vapour deposition, Molecular Beam Epitaxy, Ion Implantation, Formation of Silicon Dioxide- dry and wet oxidation methods. Fabrication of nano particle- grinding with iron balls, laser ablation, reduction methods, sol gel, self assembly, precipitation of quantum dots.	9
3	Quantum wells, multiple quantum wells, Modulation doped quantum wells, concept of super lattices Kronig - Penney model of super lattice. Transport of charge in Nanostructures - Electron scattering mechanisms, Hot electrons, Resonant tunnelling transport, Coulomb blockade, Effect of magnetic field on a crystal. Aharonov-Bohm effect, the Shubnikov-de Hass effect.	9

4	Nanoelectonic devices - MODFETS, Single Electron Transistor, CNT transistors – Properties of graphene. Resonant tunnel effect, RTD, RTT, Hot electron transistors Quantum well laser, quantum dot LED, quantum dot laser	**9**

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

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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	Explain quantum mechanical effects associated with low dimensional semiconductors	**K2**
CO2	Explain different processes involved in the fabrication of nanoparticles and nanolayers	**K2**
CO3	Explain different techniques for characterizing nano layers and particles	**K2**
CO4	Explain the different transport mechanisms in nano structures	**K2**
CO5	Illustrate the operating principle of nanoscale electronic devices like SET, Resonant tunnelling devices, Quantum lasers etc.	**K2**

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

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

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

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	Nanotechnology for Microelectronics and optoelectronics	J.M. Martinez-Duart, R.J. Martin Palma, F. Agulle Rueda	Elsevier Science	1st Edition, 2006
2	Nanotechnology and Nanoelctronics	W.R. Fahrner	Springer	1st Edition, 2005

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Nanoscience & Technology,	Chattopadhyay, Banerjee	PHI	2nd Edition, 2012
2	Introduction to Nanotechnology	Charles P. Poole Jr., Frank J. Owens	John Wiley & Sons	2nd Edition, 2022
3	Fundamentals of Nanoelectronics	George W. Hanson	Pearson Education	1st Edition, 2009
4	Nanoelectronics and nanosystems	K. Goser, P. Glosekotter, J. Dienstuhl	Springer	1st Edition, 2004

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Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc23_ee35/preview
2	https://onlinecourses.nptel.ac.in/noc22_ee121/preview
3	https://onlinecourses.nptel.ac.in/noc23_ph45/preview
4	https://onlinecourses.nptel.ac.in/noc21_ee59/preview