VELAMMAL COLLEGE OF ENGINEERING & TECHNOLOGY, MADURAI

DEPARTMENT OF PHYSICS

SEMESTER - II

21PH106	PHYSICS FOR MECHANICAL ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explain the basics of crystallography and its importance in studying materials properties.
- To illustrate the electrical properties of materials including free electron theory, applications of quantum mechanics and magnetic materials.
- To infer the knowledge on physics of semiconductors, determination of charge carriers and device applications
- To summarize the knowledge on different optical properties of materials, optical displays and applications
- To translate the significance of nano structures, quantum confinement in nano device applications.

UNIT I	CRYSTALLOGRAPHY	9

Crystal structures: BCC, FCC and HCP - Directions and planes - Linear and planar densities - Crystal imperfections- Edge and screw dislocations - Grain and twin boundaries - Burgers vector and elastic strain energy - Slip systems, plastic deformation of materials - X-ray diffraction - Braggs law - Powder X-ray diffraction.

UNIT II	ELECTRICAL AND MAGNETIC PROPERTIES OF MATERIALS	9

Classical free electron theory - Expression for electrical conductivity - Thermal conductivity, expression - Quantum free electron theory: Tunneling – degenerate states - Fermi-Dirac statistics - Density of energy states - Electron effective mass - Concept of hole. Magnetic materials: dia, para and ferromagnetic effects - Domain theory of ferromagnetism - Hysteresis behaviour - quantum interference devices - GMR devices.

UNIT III	SEMICONDUCTORS AND TRANSPORT PHYSICS	9

Intrinsic Semiconductors - Energy band diagram - direct and indirect band gap semiconductors - Carrier concentration in intrinsic semiconductors - extrinsic semiconductors - Carrier concentration in n-type & p-type semiconductors - Variation of carrier concentration with temperature - Carrier transport in Semiconductors: Drift, mobility and diffusion - Hall effect and devices - Ohmic contacts - Schottky diode.

UNIT IV	OPTICAL PROPERTIES OF MATERIALS	9

Classification of optical materials - Optical processes in semiconductors: optical absorption and emission, charge injection and recombination, optical absorption, loss and gain. Optical processes in quantum wells - Optoelectronic devices: light detectors and solar cells - light emitting diode - laser diode - optical processes in organic semiconductor devices - excitonic state - Electro-optics and nonlinear optics: Modulators and switching devices.

UNIT V	NANOELECTRONIC DEVICES	9

Quantum confinement - Quantum structures - quantum wells, wires and dots - Zener - Bloch oscillations - Resonant tunneling - Quantum interference effects - Mesoscopic structures - Single electron phenomena - Single electron Transistor. Semiconductor photonic structures - 1D, 2D and 3D photonic crystal. - Photo processes - Spintronics - Carbon nanotubes: properties and applications.

	TOTAL: 45 PERIODS

OUTCOMES: At the end of the course, learners will be able to:

CO1: Explain the basics of crystallography and its importance for various material properties.

CO2: Infer the electrical and magnetic properties of materials and their applications.

CO3: Relate the semiconductor physics and functioning of semiconductor devices.

CO4: Summarize the optical properties of materials and working principles of various optical devices.

CO5: Translate the importance of functional nanoelectronic devices.

TEXT BOOKS:

1. V. Raghavan, "Materials Science and Engineering: A First Course", Sixth Edition, Prentice Hall India Learning Private Limited, 2015.
2. S.O. Kasap, "Principles of Electronic Materials and Devices", Fourth Edition (Indian Edition), Mc-Graw Hill Publication, 2018.
3. Jasprit Singh, "Semiconductor Devices: Basic Principles", First Edition (Indian Edition), Wiley Publication, 2007.
4. Jasprit Singh, "Semiconductor Optoelectronics: Physics and Technology", First Edition (Indian Edition) Mc-Graw Hill Publication, 2019.
5. G.W. Hanson, "Fundamentals of Nanoelectronics", Indian Standard Edition, Pearson Education, 2009.

REFERENCES

1. R. Balasubramaniam, "Callister's Materials Science and Engineering", Second Edition (Indian Edition), Wiley Publication, 2014.
2. Wendelin Wright and Donald Askeland, "Essentials of Materials Science and Engineering", First Edition, CL Engineering Publishers, 2013.
3. Robert F. Pierret, "Semiconductor Device Fundamentals", Standard Edition, Pearson Education, 2006.
4. Pallab Bhattacharya, "Semiconductor Optoelectronic Devices", First Edition, Pearson Education, 2017.
5. Ben Rogers, Jesse Adams and Sumita Pennathur, "Nanotechnology: Understanding Small Systems", First Edition, CRC Press, 2017.