VELAMMAL COLLEGE OF ENGINEERING & TECHNOLOGY, MADURAI

DEPARTMENT OF PHYSICS

SEMESTER - II

21PH105	PHYSICS FOR ELECTRICAL ENGINEEIRNG	L	T	P	C
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OBJECTIVES:

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

UNIT I	DIELECTRIC MATERIALS AND INSULATION	9

Matter polarization and relative permittivity: definition - Dipole moment and polarization vector Polarization mechanisms: electronic, ionic, orientation, interfacial and total polarization - Frequency dependence - Local field and Causius-Mossotti equation - Dielectric constant and dielectric loss - Gauss's law and boundary conditions - Dielectric strength, introduction to insulation breakdown in gases, liquids and solids - Capacitor materials - Typical capacitor constructions - Piezo and pyroelectric crystals (qualitative).

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 - 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	NANO DEVICES	9

Density of states for solids - Significance between Fermi energy and volume of the material - Quantum confinement - Quantum structures - Density of states for quantum wells, wires and dots - Band gap of nanomaterials - Tunneling - Single electron phenomena - Single electron Transistor. Conductivity of metallic nanowires - Ballistic transport - Quantum resistance and conductance - Carbon nanotubes:

Properties and applications - Spintronic devices and applications - Optics in quantum structures - quantum well laser.

TOTAL: 45 PERIODS

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

CO1: Explain the basics of dielectric materials and insulation.
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 nanotechnology in nano devices.

TEXT BOOKS:

1. S.O. Kasap, "Principles of Electronic Materials and Devices", Fourth Edition (Indian Edition), McGraw Hill Education, 2020.
2. R.F. Pierret, "Semiconductor Device Fundamentals", First Edition (Indian Edition) Pearson, 2006.
3. G.W.Hanson. "Fundamentals of Nanoelectronics", First Edition (Indian Edition) Pearson Education, 2009.

REFERENCES

1. Laszlo Solymar, Walsh, Donald, Syms and Richard R.A., "Electrical Properties of Materials", Indian Edition, Oxford University Press, 2015.
2. Jasprit Singh, "Semiconductor Optoelectronics: Physics and Technology", First Edition (Indian Edition), McGraw-Hill Education, 2019.
3. Charles Kittel, "Introduction to Solid State Physics", Seventh Edition, (Indian Edition), Wiley, 2019.
4. Mark Fox, "Optical Properties of Solids", Standard Edition, Oxford University Press, 2001.
5. Parag K. Lala, "Quantum Computing: A Beginner's Introduction", First Edition (Indian Edition) , McGraw-Hill Education, 2020.