19EPH131: ENGINEERING PHYSICS (ECE, CSE, EEE and IT)

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This course is designed with fundamentals of electromagnetism and properties of materials for advanced courses in their respective engineering branches. It introduces electromagnetic theory with relevant mathematical tools, optical fibers and their propagation characteristics, properties of dielectric and magnetic materials. It also introduces principles of semiconductors and some widely used semiconductor devices for various applications.

Course Objectives:
- To introduce mathematical principles to estimate forces, fields and waves.
- To familiarize students with electromagnetics in modern communication systems.
- To impart knowledge concerning the electrical behaviour of dielectric materials.
- To demonstrate the properties of magnets.
- To introduce semiconductor physics and devices.

Unit-I: Basics of Electromagnetics **9 L**

Electrostatic field: Coulomb's law and Gauss' law, derivation of Coulombs law from Gauss' law, applications of Gauss' law (line charge, thin sheet of charge and solid charged sphere), Gauss' law of electrostatics in dielectric medium, divergence and curl of electric fields, electric potential, relation between potential and force, Poisson's and Laplace equations.

Magnetostatic field: Biot–Savarts' law, divergence and curl of magnetic fields, Faraday's and Ampere's laws in integral and differential form, displacement current, continuity equation, Maxwell's equations.

Learning outcomes:

After completion of this unit, the student will be able to
- apply Coulomb's and Gauss' laws to electric field configurations from charge distributions (L3).
- apply the Biot-Savarts' law to derive magnetostatic field distributions (L3).
- use vector calculus to describe electromagnetic phenomena (L2).
- relate the law of conservation of charge to continuity equation (L3).
- evaluate the Maxwell's equations, Maxwell's displacement current and correction of Ampere's law (L2).

Unit II: Fiber Optics **7 L**

Introduction, advantages of optical fibers, principle and structure, acceptance angle, numerical aperture, modes of propagation, classification of fibers, fiber optic communication, importance of V-number, fiber optic sensors (Temperature, displacement and force), applications.

Learning outcomes:

After completion of this unit, the student will be able to

- apply the principle of propagation of light in optical fibers (L3).
- explain the working and classification of optical fibers (L2).
- analyze propagation of light through optical fibers based on the concept of modes (L4).
- summarize applications of optical fibers in medical, communication and other fields (L2).

Unit III: Dielectric and Magnetic Materials **10 L**

Dielectric materials: Introduction, electric polarization, dielectric polarizability, susceptibility and dielectric constant, types of polarizations (qualitative treatment only), frequency dependence of polarization, Lorentz (internal) field (quantitative), Clausius-Mossotti equation.

Magnetic materials: Introduction, magnetic dipole moment, magnetization, magnetic susceptibility and permeability, origin of permanent magnetic moment, classification of magnetic materials, Weiss theory of ferromagnetism (qualitative), domain theory, hysteresis, soft and hard magnetic materials.

Learning Outcomes:

After completing this unit the students will be able to
- explain the concept of dielectric constant and polarization in dielectric materials (L2).
- interpret dielectric loss, Lorentz field and Claussius- Mosotti relation (L2).
- classify the magnetic materials (L2).
- explain the phenomenon of hysteresis for a ferromagnetic material and summarize the properties of hard and soft magnetic materials (L3).

Unit IV: Semiconductor physics **8 L**

Introduction, origin of energy band, intrinsic and extrinsic semiconductors,mechanism of conduction in intrinsic semiconductors, generation and recombination, carrier concentration in intrinsic semiconductors, variation of intrinsic carrier concentration with temperature, n-type and p-type semiconductors, carrier concentration in n-type and p-type semiconductors.

Learning outcomes:

After completion of this unit, the student will be able to

- outline the properties of semiconductors (L2).
- interpret expressions for carrier concentration in intrinsic and extrinsic semiconductors (L3).
- assess the variation of carrier concentration in semiconductors with temperature (L4).

Unit – V: Semiconductor devices **8 L**

Drift and diffusion currents in semiconductors, Hall effect and its applications, magnetoresistance, p-n junction layer formation and V-I characteristics, direct and indirect band gap semiconductors, construction and working of photodiode, LED, solar cell.

Learning Outcomes:

After completion of this unit, the student will be able to

- explain the drift and diffusion currents and formation of junction layer(L2).
- state Einstein's relations (L1).
- explain Hall effect and its applications (L3).
- illustrate and interpret the V-I characteristics of a p-n junction diode(L2).
- describe applications of p-n junction diodes in photodiodes, LEDs and solar cells (L3).

Text Book(s):

1. David J. Griffiths, "Introduction to Electrodynamics"- 4/e, Pearson Education, 2014.
2. Charles Kittel "Introduction to Solid State Physics", Wiley Publications, 2011.

References:

1. M.N. Avadhanulu, P.G.Kshirsagar "A Text book of Engineering Physics", 11/e, S. Chand Publications, 2019.
2. Gerd Keiser "Optical Fiber Communications"- 4/e, Tata Mc Graw Hill, 2008.
3. S.O. Pillai, "Solid State Physics" 8/e, New Age International, 2018.
4. S.M. Sze, "Semiconductor devices-Physics and Technology" - Wiley, 2008.

Course Outcomes:

After completion of this course, the student will be able to

- apply the fundamental laws of electricity and magnetism to currents and propagation of EM waves (L2).
- identify the mechanisms of polarization in dielectrics and magnetic materials, conduction in semiconductors and propagation of light in optical fibers. (L3).
- explain the principles of physics in dielectrics, magnetic materials and semiconductors useful to engineering applications (L2).
- summarize magnetic hysteresis curve (L2).
- analyze dielectric loss and carrier concentration in semiconductors (L4).
- classify solids and calculate conductivity of semiconductors (L4).
- demonstrate the functioning of solar cell, photodiode and loss mechanisms in optical fibers (L2).

Engineering Physics Laboratory (ECE, CSE, EEE, EIE and IT)

List of Experiments:

1. To determine the magnetic field along the axis of a circular coil carrying current.
2. To determine the numerical aperture of a given optical fiber and hence to find its acceptance angle.
3. To determine magnetic susceptibility by Gouy's method.
4. To determine the Hall coefficient using Hall effect experiment.
5. To determine the resistivity of semiconductor by Four probe method.
6. To determine the energy gap of a semiconductor.
7. To study the characteristics of PN Junction diode.
8. To study magnetic hysteresis loop (B-H curve).
9. To determine the dielectric constant of a substance by resonance method.
10. To determine hysteresis loss by CRO.
11. To study the characteristics of Photodiode.

12. To study the characteristics of Solar Cell.

References:

1. S. Balasubramanian, M.N. Srinivasan " A Text book of Practical Physics"- S Chand Publishers, 2017

Learning Outcomes:

After completion of this unit the student will be able to

- utilize four probe set up and measure resistance (L3).
- determine the susceptibility of a paramagnetic substance (L5).
- understandthe characteristics of photodiode, p-n junction diode and solar cell (L2).
- demonstrate the importance of dielectric material in storage ofelectric field energy in the capacitors (L2).
- assess the intensity of the magnetic field of circular coil carrying current with varying distance (L5).
- evaluate the acceptance angle of an optical fiber and numerical aperture and loss (L5).
- determine hysteresis losses by B-H curve and measure magnetic parameters using hysteresis loop (L5).
- identify the type of semiconductor i.e., n-type or p-type using Hall effect (L3).
- determine the band gap of a given semiconductor (L5).