

ACE R25- BoS Approved Syllabus
ADVANCED ENGINEERING PHYSICS
(PH102BS/PH202BS)

I B. Tech- I/II Semester
Pre-requisites: 10 + 2 Physics

L	T	P	C
3	0	0	3

Course Objectives :

To make the student to

1. Study crystal structures, defects, and material characterization techniques like XRD and SEM.
2. Understand fundamental concepts of quantum mechanics and their applications in solids and nanomaterials.
3. Understand quantum computing principles, quantum gates, and basic quantum algorithms.
4. Learn the properties and applications of magnetic and dielectric materials.
5. Explore the working and applications of lasers and fiber optics in modern technology.

Course Outcomes:

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

1. **CO1:** Analyze crystal structures, identify defects, and apply XRD and SEM techniques for material characterization.
2. **CO2:** Apply quantum mechanical principles to explain particle behaviour and energy band formation in solids.
3. **CO3:** Understand quantum computing concepts, use quantum gates, and explain basic quantum algorithms.
4. **CO4:** Classify magnetic and dielectric materials and explain their properties, synthesis, and applications.
5. **CO5:** Explain the principles of lasers and fiber optics and their applications in communication and sensing.

SYLLABUS:

UNIT - I: Crystallography & Materials Characterization

Introduction: Unit cell, space lattice, basis, lattice parameters; crystal structures, Bravais lattices, packing factor: SC, BCC, FCC; Miller indices, inter-planar distance; defects in crystals (Qualitative): point defects, line defects, surface defects and volume defects. concept of nanomaterials: surface to volume ratio, X-ray diffraction: Bragg's law, powder method, calculation of average crystallite size using Debye Scherrer's formula, scanning electron microscopy (SEM): block diagram, working principle.

UNIT - II: Quantum Mechanics

Introduction, de-Broglie hypothesis, Heisenberg uncertainty principle, physical significance of wave function, postulates of quantum mechanics: operators in quantum mechanics, eigen values and eigen functions, expectation value; Schrödinger's time independent wave equation, particle in a 1D box, Bloch's theorem (qualitative), Kronig-Penney model (qualitative): E-K diagram, effective mass of electron, formation of energy bands, origin of bandgap, classification of solids, concept of discrete energy levels and quantum confinement in nanomaterials.

UNIT - III: Quantum Computing

Introduction, linear algebra for quantum computation, Dirac's Bra and Ket notation and their properties, Hilbert space, Bloch's sphere, concept of quantum computer, classical bits, Qubits, multiple Qubit system, quantum computing system for information processing, evolution of quantum systems, quantum measurements, entanglement, quantum gates, challenges and advantages of quantum computing over classical computation, quantum algorithms: Deutsch-Jozsa, Shor, Grover.

UNIT - IV: Magnetic and Dielectric Materials

Introduction to magnetic materials, origin of magnetic moment-classification of magnetic materials, hysteresis, Weiss domain theory of ferromagnetism, soft and hard magnetic materials, synthesis of ferrimagnetic materials using sol-gel method, applications: magnetic hyperthermia for cancer treatment, magnets for EV, Giant Magneto Resistance (GMR) device.

Introduction to dielectric materials, types of polarization (qualitative): electronics, ionic & orientation; ferroelectric, piezoelectric, pyroelectric materials and their applications: Ferroelectric Random-Access Memory (Fe-RAM), load cell and fire sensor.

UNIT - V: Laser and Fiber Optics

Introduction to laser, characteristics of laser, Einstein coefficients and their relations, metastable state, population inversion, pumping, lasing action, Ruby laser, He-Ne laser, CO₂ laser, semiconductor diode laser, applications: Bar code scanner, LIDAR for autonomous vehicle.

Introduction to fiber optics, total internal reflection, construction of optical fiber, acceptance angle, numerical aperture, classification of optical fibers, losses in optical fiber, applications: optical fiber for communication system, sensor for structural health monitoring.

TEXTBOOKS:

1. Walter Borchardt-Ott, *Crystallography: An Introduction*, Springer.
2. Charles Kittel, *Introduction to Solid State Physics*, John Wiley & Sons, Inc.
3. Thomas G. Wong, *Introduction to Classical and Quantum Computing*, Rooted Grove

REFERENCE BOOKS:

1. Jozef Gruska, *Quantum Computing*, McGraw Hill
2. Michael A. Nielsen & Isaac L. Chuang, *Quantum Computation and Quantum Information*, Cambridge University Press.
3. John M. Senior, *Optical Fiber Communications Principles and Practice*, Pearson Education Limited.

Useful Links:

- <https://shijuinpallotti.wordpress.com/wp-content/uploads/2019/07/optical-fiber-communications-principles-and-pr.pdf>
- https://www.geokniga.org/bookfiles/geokniga-crystallography_0.pdf
- <https://dpbck.ac.in/wp-content/uploads/2022/10/Introduction-to-Solid-State-PhysicsCharles-Kittel.pdf>
- <https://www.thomaswong.net/introduction-to-classical-and-quantum-computing-1e4p.pdf>
- <https://www.fi.muni.cz/usr/gruska/qbook1.pdf> <https://profmcruez.wordpress.com/wp-content/uploads/2017/08/quantum-computation-and-quantum-information-nielsen-chuang.pdf>

ACE R25- BoS Approved Syllabus
ADVANCED ENGINEERING PHYSICS LABORATORY
(25PH107BS/25PH207BS)

I B. Tech- I/II Semester
Pre-requisites: 10 + 2 Physics

L	T	P	C
0	0	3	1

Course Objectives :

1. To provide practical exposure to advanced concepts in solid-state and modern physics.
2. To synthesize and study the physical properties of materials like semiconductors, ferromagnetic, and ferroelectric substances.
3. To perform semiconductor characterization using Hall effect and band gap experiments.
4. To explore the working principles of lasers and optical fibers through hands-on experiments.
5. To develop skills in data analysis, interpretation, and scientific reporting.

Course Outcomes:

1. **CO1:** Synthesize and analyze nanomaterials such as magnetite (Fe_3O_4) using chemical methods.
2. **CO2:** Determine key electrical, magnetic, and optical properties of semiconductors and other functional materials.
3. **CO3:** Characterize semiconductors using Hall effect and energy gap measurement techniques.
4. **CO4:** Demonstrate working knowledge of laser systems and optical fiber parameters through experimental study.
5. **CO5:** Apply scientific methods for accurate data collection, analysis, and technical report writing.

List of Experiments:

1. **Synthesis of magnetite (Fe_3O_4) powder using sol-gel method.**
2. **Determination of energy gap of a semiconductor.**
3. **Determination of Hall coefficient and carrier concentration of a given semiconductor.**
4. **Determination of magnetic field along the axis of the coil using Stewart-Gee's experiment**
5. **Study of B-H curve of a ferro magnetic material.**
6. **Computation of Planck's constant using Photoelectric effect**
7. **Determination of dielectric constant of a given material.**
8. **Determination of Curie's temperature of a given ferroelectric material.**
9. **a. Determination of wavelength of a laser using diffraction grating.**
b. Study of V-I & L-I characteristics of a given laser diode.
10. **a. Determination of numerical aperture of a given optical fiber.**
b. Determination of bending losses of a given optical fiber.

Note: Any 8 experiments are to be performed.