

Engineering Physics
I Year B. Tech. I Semester
(Common to CSE, CSM, CSD, CSC, CSF, IT)

L P T C

3 2 0 4

Course code:

Course outcomes: At the end of the course student is able to

CO1: Analyze semiconductor physics, carrier transport phenomena, and Hall effect principles to design modern optoelectronic devices and integrated circuits.

CO2: Evaluate laser engineering principles and optical fiber characteristics to optimize advanced photonics and high-speed communication links.

CO3: Apply wave-particle duality, Schrödinger's equations, and quantum computing fundamentals to model qubits, quantum gates, and cryptographic protocols.

CO4: Configure automated sensing and actuation systems by selecting appropriate capacitive, piezoelectric, optical, and thermal sensors for specific engineering applications.

CO5: Appraise the fabrication, scale-dependent properties, and biomedical capabilities of nanomaterials, smart materials, and advanced metamaterials.

Unit 1: Semiconductors

9 L

Band theory of solids, electrons in periodic potential and Kronig-Penny model (qualitative), E-K diagram, classification of solids, Fermi level, Fermi-Dirac distribution function, intrinsic and extrinsic semiconductors, wide band gap semiconductors, direct and indirect band gap semiconductors, carrier concentration in intrinsic (quantitative) and extrinsic semiconductor (qualitative), electrical conductivity, Hall effect, applications- solar cell, photodiode, LED, power amplifiers, electronic switching, ICs.

Learning Outcomes

LO1: Explain the band theory of solids, charge carrier distributions, and transport phenomena using energy band diagrams and mathematical models.

LO2: Distinguish between various semiconductor types, bandgap structures, and wide-bandgap materials based on their physical and electronic properties.

LO3: Analyze the operation and engineering applications of semiconductor devices including solar cells, LEDs, and integrated circuits.

Unit 2: Lasers and Fiber Optics

9 L

Spontaneous and stimulated emission, Einstein's co-efficients (qualitative), population inversion, characteristics and components of lasers, Nd:YAG and diode lasers, applications - LIDAR - LASIK - holography - laser additive manufacturing (3D printing).

Propagation of light through optical fiber, acceptance angle, numerical aperture, classification of fibers - step & graded index - single & multimode, fiber losses, optical communication links - LAN - long-haul.

Learning Outcomes

LO1: Evaluate the principles of population inversion, Einstein coefficients, and laser operations for Nd:YAG and semiconductor diode lasers.

LO2: Formulate light propagation characteristics in optical fibers by calculating acceptance angles, numerical apertures, and signal losses.

LO3: Assess the deployment of laser and fiber technologies in advanced applications like LIDAR, LASIK, and optical communication networks.

Unit 3: Quantum Mechanics and Quantum Computing

10 L

De-Broglie hypothesis, Heisenberg uncertainty principle, wave function characteristics and significance, Schrodinger's time-independent wave equation, particle in one-dimensional rigid box.

Qubit vs. classical bit, superposition, Bloch sphere, Pauli spin matrices, single (X-, Y-, Z-, & H) and multi-qubit (CNOT & Toffoli) gates, entanglement, applications - quantum teleportation, cryptography, QKD, AI.

Learning Outcomes

LO1: Solve fundamental quantum mechanical problems using the Schrödinger wave equation for idealized systems like a particle in a rigid box.

LO2: Contrast classical bits with qubits by analyzing quantum states, superposition, the Bloch sphere, and quantum logic gates.

LO3: Explain the underlying physics and advantages of quantum entanglement in applications like cryptography, quantum teleportation, and artificial intelligence.

Unit 4: Sensors

8 L

Sensors, actuators, classification of sensors- active and passive sensors with examples, capacitive sensors - touch sensor, pressure sensor and water level detecting, piezo electric and piezo resistive effects - tactile sensors in robots, piezo resistive strain sensor, photoelectric effect, photo resistors, proximity detection with polarized light, visible, near IR, far IR and PIR motion detectors, rotor gyroscope, Seebeck, Kelvin and Peltier effects, thermocouples and thermistors, pyroelectric effect, pyroelectric detectors.

Learning Outcomes

LO1: Classify active and passive sensors alongside their underlying physical mechanisms like capacitive, piezoelectric, and piezoresistive effects.

LO2: Analyze the operational mechanisms of optical, proximity, motion, and gyroscopic detection technologies.

LO3: Design thermal sensing systems by applying the principles of the Seebeck, Peltier, and pyroelectric effects.

Unit 5: Advanced Materials

9 L

Nanophase materials - Introduction, surface to volume ratio, quantum confinement effect, Synthesis - Sol-gel - CVD, CNTs, applications of nanomaterials - sunscreens and cosmetics, quantum-dot displays, semiconductor manufacturing, drug delivery, biosensors.

Smart and functional materials, shape memory alloys, biomaterials, garnets, MXenes, metamaterials, applications - medical stents, artificial hip and knee implants, surgical instruments, bone and dental repair, supercapacitors, electromagnetic shielding, data storage devices.

Learning Outcomes

LO1: Explain the synthesis and unique physical changes in nanomaterials caused by high surface-to-volume ratios and quantum confinement effects.

LO2: Appraise the engineering and biomedical utility of smart materials, shape memory alloys, MXenes, and metamaterials.

LO3: Identify the commercial applications of advanced materials in semiconductor manufacturing, medical implants, supercapacitors, and electromagnetic shielding.

Text Books

1. Engineering Physics by M.N. Avadhanulu, P.G. Kshirsagar & TVS Arun Murthy, 11th edition, S. Chand Publishing, reprint 2026.
2. Millman Jacob Halkias C Christos, Electronic Devices and Circuits, 2nd Ed., Tata McGraw-Hill Pub, 2015.
3. Lasers: Fundamentals and Applications by K. Thyagarajan and A. Ghatak, Springer, 2nd ed., 2010.
4. Optical Fibre Communications by Gerd Keiser, McGraw Hill, 2017 .
5. P. K. Palanisamy, Applied Physics, 4th Edition, SciTech Publications, Chennai, 2023.
6. Introduction to Classical and Quantum computing by Thomas G. Wong, 2022.
7. I. R. Sinclair, Sensors and Transducers, 3rd Edition, Elsevier (Newnes), 2001.
8. Handbook of Modern Sensors by Jacob Fraden, 3rd Edition, Springer Publishers, 2000.
9. Resistive Capacitive Inductive and Magnetic Sensor Technologies by Winncy Y Du, CRC press, 2014.

Engineering Physics Lab

1. Demonstration of Error Analysis
2. Four probe Apparatus- Determination of Energy Band a gap of a semiconductor Crystal
3. Determination of particle size using diffraction method.
4. Determination of Wavelength of Laser using Plane diffraction grating
5. Determination of Numerical aperture of optical fiber
6. Determination of Coercivity, Retentivity and Energy loss in a Ferromagnetic sample using BH curve.
7. Determination of Dielectric constant of a material by charging and discharging method.
8. Determination of temperature coefficient of resistance using Thermistor.
9. Determination of Strain in a cantilever using Strain Gauge sensor.
10. Determination of Planck's Constant using LED