COURSE CONTENT

ADVANCED ENGINEERING PHYSICS

I Semester: CE / CSD / CSM / ECE / EEE / ME

II Semester: CSE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
25X0008	Basic Science	3	0	0	3	40	60	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 48		
Prerequisites: Intermediate Physics								

Course Overview:

Advanced Engineering Physics bridges fundamental principles with modern technology. It integrates quantum mechanics, crystal structures, and material characterization to explain matter at the atomic scale. This knowledge is essential for designing materials, from semiconductors to quantum computing components. The field applies these principles to functional technologies like dielectrics and magnetic materials for electronics and energy storage. It also harnesses lasers and optical fibers for communication and sensing. This integrated understanding equips engineers to solve complex problems and drive innovation in sectors such as nanotechnology, renewable energy, and environmental systems.

Course Objectives:

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

Course Outcomes: After Completion of the Course, Students should be able to

1. Illustrate the concepts of quantum mechanics for explaining particle behaviour and energy band formation in solids.
2. Understand quantum computing concepts, quantum gates and basic quantum algorithms.
3. Identify crystal structures, defects and XRD and SEM techniques for material characterization.
4. Classify magnetic and dielectric materials and their applicability in engineering contexts.
5. Explain the principles of lasers and fibre optics and their applications across various fields in scientific practices.

UNIT - I: Quantum Mechanics

Introduction to quantum physics, Blackbody radiation (Qualitative), Photoelectric effect, de-Broglie Hypothesis, Matter waves, Heisenberg uncertainty principle, Eigen values and Eigen functions, Schrödinger's time independent wave equation, Physical significance of wave function, Particle in a 1D box, Bloch's theorem (qualitative), Kronig-Penney model (qualitative), Effective mass of electron.

UNIT - II: Quantum Computing

Introduction, Concept of quantum computer, Linear algebra for quantum computation, Dirac's Bra and Ket notation and their properties, Hilbert space, Classical bits, Qubits: single and multiple Qubit system, Bloch's sphere, Entanglement, Quantum gates, Evolution of quantum systems, Quantum measurements, Challenges and advantages of quantum computing over classical computation, Quantum computing system for information processing, Quantum algorithms: Deutsch-Jozsa, Grover.

UNIT - III: 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.

Bock diagram and working principle of X-ray diffraction (XRD), Scanning electron microscopy (SEM).

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, Magneto Resistance, Synthesis of magnetic 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, Pyro electric materials and their applications: Ferroelectric Random-Access Memory (Fe-RAM) and fire sensor..

UNIT - V: Laser and Fibre Optics

Introduction to Laser, three quantum processes - Stimulated Absorption, Spontaneous emission, Stimulated Emission Characteristics of laser, Einstein coefficients and their relations, Meta stable state, Population inversion, Pumping, Lasing action, Ruby laser, He-Ne laser, Semiconductor diode laser, Applications: Bar code scanner.

Introduction to fibre optics, Total internal reflection, Construction of optical fibre, Acceptance angle, Numerical aperture, Classification of optical fibres, Losses in optical fibre, Applications: Optical fibre for communication system, Sensor for structural health monitoring.

TEXT BOOKS:

1. TVS Arun Murthy & MN Avadhanulu," Advanced Engineering Physics", S. Chand Publications.
2. B.K. Pandey and S. Chaturvedi, Engineering Physics, Cengage Learning, 2nd Edition, 2022.
3. Shatendra Sharma and Jyotsna Sharma, "Engineering Physics", Pearson Publication, 2019.
4. A.P. Siva Kumar, Y Subba Reddy, "Introduction to Quantum Technologies and applications".
5. M. N. Avadhanulu, P. G. Kshirsagar& TVS Arun Murthy "A Text book of Engineering Physics", S. Chand Publications, 11th Edition 2019.
6. S O Pillai "Solid State Physics", New Age International Private Limited, 8th Edition, 2018.

REFERENCE BOOKS:

1. Quantum Physics, H.C.Verma, TBS Publication, 2nd Edition 2012.
2. Elementary Solid-State Physics, S.L.Gupta and V.Kumar, PragathiPrakashan, 2019.

3. A.K. Bhandhopadhya -Nano Materials, NewAgeInternational,1st Edition,2007.
4. Engineering Physics, S P Basavaraj, 2005 Edition.
5. Engineering Physics by Gupta and Gour, DhanpatRai Publications, 2016 (Reprint).
6. Vishal Sahani, Quantum Computing, McGraw Hill Education, 2007 Edition

ELECTRONIC RESOURCES:

- 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://profmcruz.wordpress.com/wp-content/uploads/2017/08/quantum-computation-and-quantum-information-nielsen-chuang.pdf
- https://www.youtube.com/watch?v=_hJ71IAWx3o
- https://youtu.be/4CbU_NtQjLg?si=BBd1A4dxxeQE_klA
- https://youtu.be/7mjBVRxaCT0?si=lqRSboepRZl8mTrS
- https://youtu.be/rhw7QDp1scY?si=89-Msq6jBRf51OZf
- https://youtu.be/_NvS9l_8j-w?si=TgfnbfUwbiFOmxRz
- https://youtu.be/RSeMfAoXqQw?si=C5qvwDkF5giq_1f1
- https://youtu.be/nFROY70WbDc?si=87KoX22vuErTIBhY
- https://youtu.be/36UQSzYPTm4?si=LKUsBrP7Kx_0Gaf2

MATERIALS ONLINE:

1. Course template
2. Concept Video topics and Certificate Course in mindluster
3. Assignments
4. Cognitive Assessment Resource Bank
5. Lecture notes
6. E-Learning Readiness Videos (ELRV)