**Rajiv Gandhi University of Knowledge Technologies-AP**

***NUZVID\*\*\*RK VALLEY\*\*\*SRIKAKULAM\*\*\*ONGOLE***



**DEPARTMENT OF PHYSICS**

***COURSE STRUCTURE***

***AND DETAILED SYLLABI OF PHYSICS***

**Effective from the batches admitted in 2023-2024 and onwards**

**Physics BoS 2023-24**

**Members**

1. **Prof. B. Jayarami Reddy, Director of RGUKT Ongole campus (Chairman)**
2. **Prof. N. Harish Kumar, Professor, Department of Physics, IIT Madras, ( Member)**
3. **Prof. K.T. Rama Krishna Reddy, Professor, Department of Physics, Sri Venkateswara University, (Member)**
4. **Prof. V. Venkatramu, Professor, Department of Physics, Krishna University (Member)**
5. **Prof. G. Mohan Rao, Head – Research Cell RGUKT (Member)**
6. **Dr. A. Satish Kumar , Assistant Professor, Nuzvid (Convener)**
7. **Dr. P. Tirupathi, Assistant Professor, RGUKT-RKV (Member)**
8. **Mr. S.K. Muni Chandu, Mentor, RGUKT-Nuzvid (Member)**
9. **Mr. P. Veera Raghava Reddy, Head of the Department, RGUKT- RKV (Member)**
10. **Dr. Tilak, Head of the Department, RGUKT-Ongole (Member)**
11. **Dean of Academics (RGUKT- Nuzvid ) (Member)**
12. **Dean of Academics, (RGUKT-RKV) (Member)**
13. **Dean of Academics (RGUKT- Ongole) (Member)**

***The education offered by the RGUKT-AP consists of a six year integrated course after 10thclass examination leading to a B. Tech degree. The first part of the six-year course is a two-year Pre University Course (equivalent to Board of Intermediate Education, AP) and followed by four-year Engineering Program with the following branches  i.e., Civil Engineering, Mechanical Engineering, Electronics and communication Engineering, Metallurgical and Materials Engineering Chemical Engineering, Computer Science and Engineering and Electrical engineering. In addition to regular degrees, University is offering minor degrees to students. In this connection we divide the physics course into 3 parts i.e.,***

***1) Physics for Pre university students,***

 ***2) Physics for Engineering 1st year students***

***3) Minor physics for physics aspirants.***

**Proposed changes:**

**1. We have adopted the N.C.E.R.T syllabus for the PUC course in the proposed BoS 2023–24.**

**2. The Engineering Physics syllabus of ECE has been adapted for EEE.**

**3. The semiconductor physics topics in the sixth unit of the ECE course have been compressed due to time constraints.**

**4. Due to time constraints, the Superconductivity topic in the sixth unit of the Mechanical Engineering course is being revisited.**

**5. Minor physics was designed to give fundamental concepts of Semiconductor Physics to the engineering students and discus working and applications of basic devices, including fabrication of devices.**

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***Physics Course Structure for***

***Pre University Course (PUC)***

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| **S.No.** | **Year** | **Semester** | **Course** | **Code** | **Credits** |
| **01** | **PUC-I** | **1** | **Physics-I** | **20PPY1101** | **4** |
| **02** | **PUC-I** | **1** | **Physics Lab –I** | **20PPY1210** | **1** |
| **03** | **PUC-I** | **2** | **Physics-II** | **20PPY1201** | **4** |
| **04** | **PUC-I** | **2** | **Physics Lab –II** | **20PPY1211** | **1** |
| **05** | **PUC-II** | **1** | **Physics-III** | **20PPY2101** | **4** |
| **06** | **PUC-II** | **1** | **Physics Lab –III** | **20PPY2210** | **1** |
| **07** | **PUC-II** | **2** | **Physics-IV** | **20PPY2201** | **4** |
| **08** | **PUC-II** | **2** | **Physics Lab –IV** | **20PPY2211** | **1** |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PPY1101** | **Physics Theory-I** | **PUC** | **4-2-0** | **4** |

**Course Learning Objectives:**

1. To enable the students to understand the importance and the usage of units of physical quantities and identification of error percentage in physical quantities.
2. Students will learn the importance of scalar and vector geometry in understanding the kinematic equations of motion.
3. Students will learn concept of projectile motions in a plane and its applications.
4. Students will learn Newton’s law of motion in an inertial and non-inertial frame of references under the influence of forces.
5. Students will learn the basic definition of work, energy and power and its applications in real life besides gravitation field and the phenomenon of conservation of energy with applications of elastic and inelastic collisions.
6. To gain the basic knowledge on the motion of system of particles with concept of center of mass and momentum of inertia.

**Course Content:**

**Unit I: Physical World, Units & Measurement** (08 Hours)

Units and system of units, fundamental units, measurement of Length, mass and time, derived units, Accuracy, Precision of Instruments and errors in measurements, significant figures, , Dimensions of Physical Quantities, Dimensional formulae and dimensional equations, Dimensional Analysis and its Applications.

**Unit-II: Motion in a straight line & Vectors** (12 Hours)

Position, path length and displacement, Average velocity and average speed, Instantaneous velocity and speed, Acceleration, Kinematic equations for uniformly accelerated motion. Scalars and vectors (position and displacement vectors, equality of vectors), multiplication of vectors by real numbers, Addition and subtraction of vectors by graphical method (Triangle law) Proof for Parallelogram law of vector addition, Resolution of vectors,

**Unit-III: Motion in a plane** (08Hours**)**

Position vector and displacement, velocity vector, acceleration vector, Projectile motion (Equation of path of a projectile, time of flight, maximum height, horizontal range), horizontal projectile motion, Uniform circular motion.

**Unit-IV: Laws of motion** (12 Hours)

Newton’s law of motion, momentum, impulse conservation of momentum, equilibrium of a particle, Friction, types of friction, relation between inclined angle and coefficient of friction, acceleration of block moving on inclined plane, block and trolley system, Uniform circular motion, motion of a car on a level road, motion of a car on a banked road (with friction and without friction)

**Unit-V: Work , Energy and Power** (10 Hours)

Scalar product of vectors, work, kinetic energy, work-energy theorem (constant and variable force), potential energy, conservation of mechanical energy with examples, Potential energy of a spring, Energy graph, Power, collisions: elastic and inelastic collisions in one dimension

**Unit- VI: Systems of particles and Rotational motion-I** (12 Hours)

Centre of mass (two particle system and ‘n’ number of particles), Motion of centre of mass, Vector product of vectors, Angular velocity and its relation with linear velocity, Angular acceleration, Torque and Angular momentum for a system of particles, conservation of angular momentum.

**Learning resources**

**Text book:**

1. *‘Physics Part-1, Text Book for Class XI’,* National Council of Educational Research and Training, 2006

**Reference Books:**

1. Sear’s and Zemansky, *‘University Physics’*, Pearson Edition.

2. D. Halliday, R. Resnick and J. Walker ‘*Fundamentals of Physics’*, *6th Edition*, John Wiley and Sons, New York (2001).

3. Concept of Physics part-1, HC Verma, 2017 Edition

**Web resources:**

1. RGUKT course content

# 2. NPTEL physics: IIT-PAL

# URL: <https://www.youtube.com/channel/UCwNr8peMxn8-Nc2V_RZsRvg/videos>

# 3. Ashish Arora, Physicsgalaxy video lectures, 2015

URL: <https://www.youtube.com/user/physicsgalaxy74>

**Course outcomes:** At the end of the course, the student will be able to

|  |  |
| --- | --- |
| CO 1 | understand the importance of units of physical quantities and how the units can be related with dimensional analysis. The student will get adequate knowledge on the difference between accuracy and precision of a measurement and also able to analyze errors in a measurement. |
| CO 2 | understand the concepts of vectors & scalars and properties relating to them.  |
| CO 3 | understand the concept of motion of an object in terms of its position, velocity and acceleration without external force. |
| CO 4 | get adequate knowledge on fundamental laws of motion. Student will able to solve problems related to motion of the objects under the influence of external forces.  |
| CO 5 | understand the concept of work, energy and power and its applications  |
| CO 6 | understand the concept conservation of momentum & energy of a physical body. Student will acquainted with the concept of collision quantitatively. |

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Monthly tests | End Semester Test | Total |
| Weightage (%) | 40% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PPY1210** | **Physics Laboratory -1** | **PUC** | **0-0-2** | **1** |

**Course Learning Objectives:**

The student will gain practical knowledge and basic method/ techniques to measuring small objects lengths/ areas/ volumes. Further, the student will gain basics knowledge on verifying the equation of kinemics in two dimensions.

1. Students will learn how to measure the different Physical quantities such as length, thickness, radius and volume of different objects by using Vernier-caliper, Screw Gauge, Spherometer.

2. Students will learn how to verify the different laws in kinematics and dynamics of physics such as acceleration due to gravity on an inclined plane

3. Students will learn how to measure the weight of a given body using parallelogram law of vector addition.

**Course Content:** Name of the Experiment

1. Error analysis and graphical methods (Theory)
2. Determination of Density of regular body by using Vernier-Calipers.
3. Determine the thickness of a Glass slide and radii of different wires using Screw Gauge.
4. Determination of radius of curvature of the curved surface.
5. Determining the coefficient of friction on an inclined plane.
6. Determine the weight of a given body using parallelogram law of vector addition.

**Web resources:**

URL: http://www.olabs.edu.in/?pg=topMenu&id=40

**Course Outcome:**

1. Students can understand how to measure the different physical quantities such as length, thickness, radius and volume of different objects by using vernier callipers, screw gauge, spherometer.
2. Student will understand the concept of coefficient of friction and how to measure coefficient of friction on an inclined plane.

**For Lab courses only:**

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| **Course Nature** | **Practical** |
| **Assessment Method** |
| Assessment Tool | Experiments | Record | Viva-Voce/ Quiz/MCQ/Lab project | Total |
| Weightage (%) | 25% | 5% | 10% | 40% |
| End Semester Examination weightage (%) | 60% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PPY1201** | **Physics Theory –II** | **PUC** | **4-2-0** | **4** |

**Course Learning Objectives:**

1. To gain the basic knowledge on the motion of system of particles with concept of center of mass, momentum of inertia with rigid body dynamics.
2. To gain the basic knowledge on the universal law of gravitation and its application the motion of the satellites under the gravity.
3. To advance knowledge on the mechanical properties of solids and fluids.
4. To gain the detail knowledge on the heat energy and its behaviour on matter while transfer. In addition the basic fundamental law of thermodynamics and various thermodynamic processes.

**Course Content:**

**Unit-I: Systems of particles and Rotational motion-II** (10 Hours)

Equilibrium of rigid body, centre of gravity, Moment of inertia and kinetic energy of a rotating rigid body, Formulae for moment of inertia of different rigid bodies of regular shape, Perpendicular and parallel axis theorem, kinematics of rotational motion about a fixed axis, work done by a torque, Angular momentum of a rigid body rotating about a fixed axis, conservation of angular momentum.

**UNIT-II: Gravitation** (12 Hours)

Kepler’s laws, Universal law of gravitation, Gravitational constant, Acceleration due to gravity of the earth, Acceleration due to gravity below and above the surface of the earth, Gravitational potential energy, Escape speed, Earth satellites, Energy of an orbiting satellite.

**UNIT-III: Mechanical properties of solids** (08 Hours)

Stress and Strain, Hooke’s law, Stress- Strain curve, Young’s modulus, Determination of young’s modulus of the material of a wire, Shear modulus, Bulk modulus, Elastic potential energy in a stretched wire.

**UNIT-IV: Mechanical Properties of Fluids** (12 Hours)

Concept of Pressure, Pascal’s law, Variation of pressure with depth, Atmospheric pressure and Gauge pressure, Hydraulic machines, Archimedes principle, Streamline flow, Continuity equation, Bernoulli’s Principle, Torricelli’s law, Venturi meter, Dynamic lift, (Ball moving without spin, Ball moving with spin, Aerofoil or lift on aircraft wing), Viscosity, Surface tension: Surface energy, Surface energy and surface tension, Angle of contact, Capillary rise.

**UNIT-V: Thermal properties of matter** (12 Hours)

Temperature and Heat, Measurement of temperature (Different scales of temperature), Ideal gas equation, Thermal expansion (Linear, areal, volume expansion of solids), Anomalous expansion of water, expansion of gases, specific heat capacity, heat capacity, Calorimetry, change of state, latent heat, Heat transfer: conduction, Convection (convection cycles), Radiation: Black body radiation, Radiation laws, Newton’s law of cooling.

**UNIT-VI: Thermodynamics** (12 Hours)

Thermal equilibrium, Zeroth law of thermodynamics, Heat, Internal energy and work, First law of thermodynamics, molar specific heat capacity at constant pressure and constant volume, Different types of thermodynamic process, work done in isothermal process, work done in adiabatic process, Heat engine, Refrigerators and Heat pump, Second law of thermodynamics, Reversible and Irreversible process, Carnot engine.

**Learning resources**

**Text book:**

1. *‘Physics Part-II, Text Book for Class XI’*, National Council of Educational Research and Training, 2006

**Reference Books:**

1. Sear’s and Zemansky, *University Physics’*, Pearson Edition.
2. D. Halliday, R. Resnick and J. Walker, *Fundamentals of Physics*, John Wiley and Sons, 6th Edition*,* New York (2001).
3. H.C. Verma, *Concept of Physics part-1*, 2017 Edition

**Web resources:**

1. RGUKT course content

# 2. NPTEL physics: IIT-PAL

# URL: <https://www.youtube.com/channel/UCwNr8peMxn8-Nc2V_RZsRvg/videos>

# 3. Ashish Arora, Physicsgalaxy video lectures, 2015

URL: <https://www.youtube.com/user/physicsgalaxy74>

**Course outcomes:** At the end of the course, the student will be able to

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| CO 1 | understand the concept of centre of mass and centre of gravity of a body. Students will be able to understand the Concept of Rotational Dynamics and equations of motion for rotating body and the analogy between Kinematics and Rotational Dynamics. |
| CO 2 | understand concept of gravitational force between two bodies and its conservative nature. Students will be able to understand the concept of variationof acceleration due to gravity with height and depth. |
| CO 3 | understand Practicality of different types of Elastic moduli and Relation between stress and strain. Learners will be able to understand Practicality of Fluid dynamics in real life (Pascal’s Law, Bernoulli’s theorem, Magnus Effect) Learners will be able to understand concept of surface Tension and Surface energy and will be able to relate it with a daily life.  |
| CO 4 | understand the Different methods of heat transfer, Concept of thermal expansion and Laws of cooling. |
| CO5 | understand the Concept of Heat, work and Internal energy of the system. Learners will be able to understand the thermodynamic process like isothermal, adiabatic, isochoric, isobaric, heat engines etc |
| CO 6 | understand the basic concept of generation of waves along with its Classification and Mathematical analysis and SHM. Learners will be able to understand the Concept of Different forms of energy possessed by a body executing SHM with its mathematical analysis. Learners will be able to understand the Concept of Resonance, free oscillations.  |

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Monthly tests | End Semester Test | Total |
| Weightage (%) | 40% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PPY1211** | **Physics Laboratory –II** | **PUC** | **0-0-2** | **1** |

**Course Learning Objectives:**

The student will gain practical knowledge on verifying the equation of kinemics in two dimensions and well then mechanical properties of fluids. In addition, student will gain practical knowledge on fundamental laws in waves and oscillations in a periodic motion.

1. . Students will learn how to verify the different laws in kinematics and dynamics of physics such as acceleration due to gravity on an inclined plane, moment of inertia of fly wheel, spring constant, Young’s modulus etc.

2. Students will learn how to measure the mechanical properties of fluids such as viscosity of water, surface tension of water etc.

3. Students will learn how to verify the first law in gases i.e., Boyle’s Law.

4. Students will learn how to verify the laws of transverse waves by using sonometer and the speed of sound in air by using resonance method.

**Course Content:** Name of the Experiment

1. Determine Surface Tension of water by capillary rise method.
2. Verification of the laws of transverse waves using Sonometer.
3. Verification of Boyle’s Law by Quill tube method.
4. Determination of acceleration due to gravity (g) at a place by using simple pendulum.
5. Determining the Spring Constant of given spring.
6. Determination of moment of inertia of Fly Wheel.
7. Determination of Young’s modulus of elasticity of the material of a given wire
8. Determination of speed of sound in air by using resonance phenomenon.
9. Determination of viscosity of water measurement

**Web resources:**

URL: http://www.olabs.edu.in/?pg=topMenu&id=40

**Course Outcome:**

1. Students can understand how to verify the different laws of mechanics such as acceleration due to gravity, inclined plane, moment of inertia fly wheel, spring constant, young’s modulus etc.

2. Students can understand how to measure the different types of fluids properties such as viscosity of water, surface tension of water etc.

3. Students can understand how to verify laws of thermo dynamics such as Boyle’s Law.

4. Students can understand how to verify the laws of transverse waves by using sonometer and the speed of sound in air by using resonance method.

**For Lab courses only:**

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| --- | --- |
| **Course Nature** | **Practical** |
| **Assessment Method** |
| Assessment Tool | Experiments | Record | Viva-Voce/ Quiz/MCQ/Lab project | Total |
| Weightage (%) | 25% | 5% | 10% | 40% |
| End Semester Examination weightage (%) | 60% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PPY2101** | **Physics-III** | **PUC** | **4-2-0** | **4** |

**Course Learning Objectives:**

1. To gain basics on periodic motion and its characteristics as well simple harmonic motion with few examples in real life.
2. Students will learn the wave motion and its classifications in dynamics. In addition, the important terms associated in wave motion and its applications while superposition of waves.
3. Students will learn the origin of electric charges and forces between charges, electric fields associated around charges of different geometries.
4. Students will learn electric potential and potential difference in different geometries. As well, capacitors, combination of capacitors and its working principle in air and dielectric medium.
5. Students will learn flow of electric current by Ohm’s law in metal both qualitatively and quantitatively and analysis of currents in circuits by Kirchhoff’s laws.
6. Students will learn the magnetic force by moving charges and magnetic field properties associated in different geometric bodies due to moving charges. Magnetism associated due to bar magnetic and classification of magnetic material.

**Course Content:**

**UNIT-I: Oscillations** (12 Hours)

Periodic and Oscillatory motions, Period and frequency, Displacement equation, Simple harmonic motion with graphs, Simple harmonic motion and uniform circular motion, velocity and acceleration in SHM, Force law for simple harmonic motion, Energy in SHM, Applications of SHM: Oscillations due to a spring, Simple pendulum, Damped SHM, Forced oscillations and Resonance.

**UNIT-II: Waves** (10 Hours)

Introduction, Transverse and longitudinal waves, Displacement relation in a progressive wave (amplitude, phase, wavelength, Angular wave number, period, angular frequency and frequency),Speed of a travelling wave, Speed of a transverse wave on stretched string, Speed of a longitudinal wave, Principle of superposition of waves, Reflection of waves: Standing waves and Normal modes, Beats, Doppler effect.

**UNIT-III: Electric charges and fields** (12 Hours)

Electric charge, Conductors and insulators, Charging by induction, Basic properties of electric change, Coulomb’s law, Forces between multiple charges, Electric field, Electric field lines, Electric flux, Electric dipole: Field of an electric dipole, Dipole in a Uniform electric field, Continuous charge distribution, Gauss’s law, Applications of Gauss law: Electric field due to an infinitely long straight uniformly charged wire, Infinite plane sheet, thin spherical shell.

**UNIT-IV: Electrostatic potential and capacitance** (12 Hours)

Electrostatic potential, Potential due to a point charge, Potential due to an electric dipole, Potential due to a system of charges, Equipotential surfaces: Relation between field and potential, Potential energy of a system of charges, Potential energy in an external field (for a single charge, system of two charges, for a dipole), Electrostatics of conductors, Dielectrics and Polarization, Capacitors and capacitance, Parallel plate capacitor, Effect of dielectric on capacitance, Combination of capacitors in series and in parallel, Energy stored in a capacitor.

**UNIT-V: Current Electricity** (12 Hours)

Electric current, Electric current in conductors, Ohm’s law, Drift of electrons and the origin of resistivity, Limitations of Ohm’s law, Resistivity of various materials, Temperature dependence of resistivity, Electrical energy and power, Combination of resistors in series and in parallel, Cells, emf, internal resistance, Cells in series and in parallel, kirchhoff’s Rules, Wheatstone Bridge, Meter Bridge.

**UNIT-VI: Moving Charges and Magnetism** (14 Hours)

Magnetic Force (source and fields, magnetic field, Lorentz force, magnetic force on a current carrying conductor), Motion in a magnetic field, Motion in combined electric and magnetic fields (Velocity selector, Cyclotron), Biot- Savart law( magnetic field due to a current element), Magnetic field on the axis of a circular current loop, Ampere’s circuital law, Solenoid and Toroid, Force between two parallel currents, Torque on current loop, magnetic dipole ( torque on a rectangular current loop in a uniform magnetic field, Circular current loop as a magnetic dipole, magnetic dipole moment of a revolving electron), Moving coil Galvanometer.

**Learning resources**

**Text book:**

1. *‘Physics Part-I, Text Book for Class XII’*, National Council of Educational Research and Training, 2006

**Reference Books:**

1. Sear’s and Zemansky, *‘University Physics’*, Pearson Edition.
2. D. Halliday, R. Resnick and J. Walker ‘*Fundamentals of Physics’*, John Wiley and Sons, 6th Edition*,* New York (2001).
3. Concept of Physics part-1, HC Verma, 2017 Edition

**Web resources:**

1. RGUKT course content

# 2. NPTEL physics: IIT-PAL

# URL: <https://www.youtube.com/channel/UCwNr8peMxn8-Nc2V_RZsRvg/videos>

# 3. Ashish Arora, Physicsgalaxy video lectures, 2015

URL: <https://www.youtube.com/user/physicsgalaxy74>

**Course outcomes:** At the end of the course, the student will be able to

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| --- | --- |
| CO 1 | understand the Mathematical analysis of waves along its basic parameters (Amplitude , Frequency and Phase) Learners will be able to understand the concept of reflection of waves along with concept of harmonics. Learners will be able to understand the Practicality in variation in frequency of sound due to relative motion between source and observer (Doppler’s Effect) |
| CO 2 | understand the concept of electric charge and distribution of charges. Student will able to calculate electric field due to charge distribution.  |
| CO 3 | understand the concept of electric potential, potential difference and equipotential surfaces. Student will learn concept of capacitors and dielectrics.  |
| CO 4 | Learn circuit analysis using Kirchhoff’s laws involving resistors and multiple sources. |
| CO 5 | understand magnetic field and its production from electric current. Student also learned the calculation of magnetic field using Ampers Law, BiotSavart law for various systems |
| CO 6 | Understand the concept of emf , Faraday’s laws, Lenz’s law and inductance |

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Monthly tests | End Semester Test | Total |
| Weightage (%) | 40% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PPY2210** | **Physics Laboratory -III** | **PUC** | **0-0-2** | **1** |

**Course Learning Objectives:**

The student will gain practical knowledge and working procedure on optical devices and well then to know how to determine physical quantities like velocity of sound. In addition, student will gain basic practical knowledge on to verify the fundamental laws in electrostatics such as Ohm’s law, kirchhoff’s laws with circuit diagram.

1. Students will learn how to verify the basic fundamental laws in electrostatics such as Ohms law, Kirchhoff’s current and voltage law with circuit designing.
2. Students will learn how plotting magnetic field lines around a bar magnetic and finding null points by Equidistance method. In addition, the student will gain basic properties of magnetic lines of forces by observing practical field lines.

**Course Content-** Name of the Experiment**:**

1. Determine refractive index of a glass slab or water by using travelling microscope.

2. Verification of Ohm’s law by using tangent galvanometer.

3. Verification of ratio of magnetic moments of bar magnets in equidistance method and null method by using Deflection magneto meter.

4. Determination of Specific resistance of given wire using Meter Bridge.

5. Verification of Kirchhoff's Voltage Law.

6. Verification of Kirchhoff's current Law.

7. Draw the magnetic lines of force by placing bar magnet north pole towards geographical north and bar magnet north pole towards geographical south respectively.

**Web resources:**

URL: http://www.olabs.edu.in/?pg=topMenu&id=40

**Course outcomes:**

At the end of the course, the student will be able to understand how to verify the fundamental laws of electricity such as Ohm’s law, Kirchhoff’s laws and have a good acquaintance over them.

1. Students can understand how to verify the principles of electrostatics such as Kirchhoff’s voltage law and Kirchhoff’s current law, Ohm’s law,etc.

2. Students can understand how to verify the principles of magnetism such as null method, equidistance method, magnetic fields of lines etc.

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| --- | --- |
| **Course Nature** | **Practical** |
| **Assessment Method** |
| Assessment Tool | Experiments | Record | Viva-Voce/ Quiz/MCQ/Lab project | Total |
| Weightage (%) | 25% | 5% | 10% | 40% |
| End Semester Examination weightage (%) | 60% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PPY2201** | **Physics Theory-IV** | **PUC** | **4-2-0** | **4** |

**Course Learning Objectives:**

1. Students will learn the basic laws of electromagnetic induction and concepts on eddy currents, self and mutual inductance for better understanding the concept of transformers.
2. To gain the basic knowledge on the properties of electromagnetic spectrum.
3. To gain the detail knowledge on the fundamental laws exhibited by light ray in ray optics and construction and working principles of optical instruments such as Microscopes and astronomical telescopes.
4. To gain the detail knowledge on the optical phenomena exhibited by wave nature of light correlated to interference, diffraction and its characteristics of coherent radiations with an example and their application in specific to optical fibers.
5. To gain the basic knowledge the dual nature of matter waves that embraces the origin of quantum mechanics.
6. To gain detail knowledge on the basic semiconductor physics and basic electronic devices fabricated with semiconductors, i.e. diodes, transistors and its working principle and characteristics

**Course Content:**

**UNIT-I: Electromagnetic Induction & Alternating currents** (10 Hours)

Magnetic flux, Faraday’s law of Induction, Lenz’s law and conservation of energy, Motional emf, Energy Consideration: A quantitative study, Eddy currents, Inductance (mutual inductance, self inductance), AC Generator.

**UNIT-II: Electromagnetic waves**  (10 Hours)

Displacement current, Electromagnetic waves: sources of EM waves, nature of EM waves, Maxwell equations(no derivations), Electromagnetic spectrum ( Radio waves, Microwaves, Infrared waves, Visible rays, Ultra violet rays, X-rays, Gamma rays.

**UNIT-III: Ray Optics and Optical Instruments** (14 Hours)

Introduction, Reflection of light by spherical mirrors (Sign convention, focal length of spherical mirrors, Mirror equation), Refraction, Total Internal Reflection (technological applications), Refraction at spherical surfaces and Lenses (Refraction at spherical surfaces, Refraction by lenses, combination of thin lenses in contact), Refraction through a prism, Phenomenon of Rainbow, Scattering of light, Optical instruments ( Microscope , Telescope.

**UNIT-IV: Wave Optics** (12 Hours)

Huygens principle, Coherent and Incoherent addition of waves, Interference of light waves and Young’s experiment (condition for bright and dark fringes), Diffraction (single slit, single slit Diffraction), Polarization (only Malus law)

**UNIT-V: Quantum Physics**  (14 Hours)

Theory of Photoelectric effect, Einstein’s photoelectric equation: Energy quantum of radiation, Particle nature of light (photon), Wave nature of matter, Davisson and Germer experiment. Atomic nucleus, Size of the nucleus, Mass – energy and nuclear binding energy ( mass- energy, nuclear binding energy), Nuclear force, Radioactivity (law of radioactive decay, Alpha decay, Beta decay, Gamma decay).

**UNIT-VI: Semiconductor Electronics** (14 Hours)

Introduction, Classification of metals, conductors and semiconductors, Intrinsic semiconductor, Extrinsic semiconductor(p type and n-type), p-n junction: junction formation, Semiconductor Diode (forward bias and reverse bias), Diode as a rectifier, Zener diode and zener diode as voltage regulator, photo diode, LED, Solar cell , Transistor PNP, NPN (CE, CB, CC qualitative analysis)

**Learning resources**

**Text book:**

1. *‘Physics Part-1, Text Book for Class XI’,* National Council of Educational Research and Training, 2006

**Reference Books:**

1. Sear’s and Zemansky, *‘University Physics’*, Pearson Edition.

2. D. Halliday, R. Resnick and J. Walker ‘*Fundamentals of Physics’*, *6th Edition*, John Wiley and Sons, New York (2001).

3. Concept of Physics part-1, HC Verma, 2017 Edition

**Course outcomes:** At the end of the course, the student will be able to

|  |  |
| --- | --- |
| CO 1 | The student understand the concept of analyzing circuits involving AC source, resistors, capacitors and inductors along with basic concepts of transformers. |
| CO2 | The student understand the unification of Gauss law, faradays law and ampere’s law with correction done by Maxwell and some basic concepts involvingelectromagnetic waves |
| CO 3 | Understand the concepts of reflection, refraction, dispersion through mirrors, lens by using ray optics |
| CO 4 | The student understand the concepts of wave nature of light like interference, diffraction, polarization |
| CO 5 | Understand the dual nature of matter and interaction of matter with radiation by using photoelectric effect and some basic modern physical concepts like dual nature, uncertainty principle, which is hard to explain by ordinary classical physics |
| CO 6 | Understand the modern electronics concepts of semiconductor, diode and its characteristics, applications in LED’s, solar cells and power regulation. The student also learns the concepts of transistors and its application in amplifiers and logic gates |

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Monthly tests | End Semester Test | Total |
| Weightage (%) | 40% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PPY2211** | **Physics Laboratory -IV** | **PUC** | **0-0-2** | **1** |

**Course Learning Objectives:**

The student will gain practical knowledge and working procedure on optical devices and well then to know how to determine physical quantities like focal length of lenses, refractive index glass, wavelength of laser light etc.

1. Students will learn how to measure basic optical parameters such as focal length and radius of curvature of lenses, refractive index of glass, wave length of LASER light, etc by using different optical constituents.

2. Student will observe propagation of a real practical LASER light in laboratory and then determines the wavelength of the LASER source with help of diffraction phenomenon.

3. Students will learn how to verify the basic I-V characteristics of semiconductor diodes as well working of p-n-p and n-p-n transistors with different mode of connections.

**Course Content-** Name of the Experiment**:**

1. Determination of focal length of concave mirror by U-V method.

2. Determination of focal length of convex lens by U-V method and Conjugate foci- method.

3. Determine the refractive index of prism by plotting i-d curve.

4. Determine the wavelength of light using laser diffraction phenomenon.

5 Study the P-N Junction Diode characteristics in forward and reverse bias condition.

6. Verification of I-V characteristics of Junction Diode and Determination break down voltage of Zener Diode.

7. Verification of Transistor characteristics.

8. Determination of the band gap of a semiconductor material by using two probe methods.

**Web resources:**

URL: http://www.olabs.edu.in/?pg=topMenu&id=40

**Course outcomes:**

At the end of the course, the student will be able to understand the methods to measure various physical quantities like velocity of sound, focal length, refractive index, wavelength of laser etc. As well the student can understand how to verify the fundamental laws of electricity such as Ohm’s law, Kirchhoff’s laws and have a good acquaintance over them.

1. Students can understand how to measure the different physical quantities like focal length, refractive index, wave length of Light, etc by using different optical components.

2. Student will learn the concept of LASER light and calculates the wavelength of the LASER source using the concept of diffraction.

3. Students can understand how to verify the principles of electrostatics such as Kirchhoff’s voltage law and Kirchhoff’s current law, Ohm’s law,etc.

4. Students can understand how to verify the principles of magnetism such as null method, equidistance method, magnetic fields of lines etc.

5. Students can understand how to verify the different characteristics of semiconductor devices like diodes, transistors, band gap of semiconductors.

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| **Course Nature** | **Practical** |
| **Assessment Method** |
| Assessment Tool | Experiments | Record | Viva-Voce/ Quiz/MCQ/Lab project | Total |
| Weightage (%) | 25% | 5% | 10% | 40% |
| End Semester Examination weightage (%) | 60% |

***Physics Course Structure for Engineering first year (E1)***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.No.** | **Branch** | **Semester** | **Course** | **Code** | **Credits** |
| **01** | **ECE&EEE** | **1** | **Engineering physics -Theory** | **20PY1101** | **4** |
| **02** | **ECE&EEE** | **1** | **Engineering physics –Lab** | **20PY1181** | **1.5** |
| **03** | **ME** | **1** | **Engineering physics -Theory** | **20PY1102** | **4** |
| **04** | **ME** | **1** | **Engineering physics –Lab** | **20PY1182** | **1.5** |
| **05** | **MME** | **1** | **Engineering physics -Theory** | **20PY1103** | **3** |
| **06** | **MME** | **1** | **Engineering physics –Lab** | **20PY1183** | **1.5** |
| **07** | **CSE** | **2** | **Engineering physics -Theory** | **20PY1201** | **4** |
| **08** | **CSE** | **2** | **Engineering physics –Lab** | **20PY1281** | **1.5** |
| **09** | **CE** | **2** | **Engineering physics -Theory** | **20PY1202** | **3** |
| **10** | **CE** | **2** | **Engineering physics –Lab** | **20PY1282** | **1.5** |
| **11** | **CHEM** | **2** | **Engineering physics -Theory** | **20PY1203** | **3** |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PY1101** | **Engineering Physics-ECE and EEE** | **BSC** | **3-1-0** | **4** |

**Course Learning Objectives:**

1. To impart basic knowledge on the concept of vector and scalar fields as well its physical significance in all 3D coordinate systems. To integrate knowledge on vector calculus and its applications to transform 1, 2 and 3 dimensions.
2. To enable the student in detailed knowledge on Gauss's Law in electrostatics and it’sapplications how to calculate electric field associated by different symmetrical charge distributions. And also impart basic fundamentals on dielectric materials and induced polarizations associated by the presence of external electric field on dielectrics.
3. To impart basic idea on solving problems by using Poisson’s and Laplace equations of different electrical charged bodies and also create knowledge on boundary conditions of electric fields and potentials.
4. To enhance in detail knowledge on magnetic force due to current carrying charged bodies and Amphere’s law as well its applications. To integrate in detail knowledge on magnetic materials and its properties as well applications.
5. To get physical ideas contained in Maxwell’s equations, and how the symmetry between changing electric andchanging magnetic fields explains Maxwell’s prediction of electromagnetic waves in different medium.
6. To gain fundamentals on band theory of solids, semiconductors materials its classification by Fermi energy level and band gap. To get basic knowledge on electronic devices fabricated with semiconductors, i.e. P-N diode, LED’s, Photo diodes and solar cells and its working principle as well characteristics.

**Course Content:**

**UNIT - I: Introduction (08 Hours)**

Coordinate system: Cartesian, cylindrical and spherical coordinate system transformations, Differential Calculus: Gradient, Divergence, Curl and their physical significance, Integral Calculus: Line, Surface, and Volume Integrals, Integral theorem: Gauss and stokes theorems, Curvilinear Coordinates, second derivatives: Laplacian.

**UNIT-II: Electrostatics -1 (09 Hours)**

Coulomb’s Law and Superposition Principle: Electric filed and electric dipole. Gauss’s Law: Field lines and Electric flux, Applications. Electric Potential: Curl of Electric filed and Potential of localized charges, Gradient relationship between E and V. Laplace’s and Poisson Equations, Electrostatic Boundary conditions, Work and Energy in Electrostatics: The energy of point charge distribution and energy of continuous charge distribution. Basic properties of conductors. Multi pole expansions: The electric Potential and field of a dipole

**UNIT-III: Electrostatics -2 (09 Hours)**

Polarization: The Field of a Polarized object ( bound charges), The electric displacement : Gauss law in the presence of Dielectrics, Linear Dielectrics ( Susceptibility, Permittivity and Dielectric constant), Boundary condition and energy in Dielectric system. Capacitance, Dielectric break down. Image problems: The classical image problem, Induced surface charge

**UNIT-IV: Magnetostatics (10 Hours)**

Magnetic Force in current element : Current in a wire, surface current density, volume current density. Continuity equation ,Biot-Savart Law: Magnetic field due to wire , solenoid and Toroid. Ampere's Law,Magnetic Vector Potentials, Magnetization, magnetic susceptibility and permeability, Para ,Dia, Ferro-Magnetic material properties, Magnetic Energy, boundary conditions, Scalar & vector fields.

**UNIT-V: Time varying fields (10 Hours)**

Faraday’s Law, Lenz’s law, EMF, Displacement current, Maxwell’s equation in vacuum and non-conducting medium and conducting medium, Energy in an electromagnetic field; Flow of energy, Poynting’s theorems and conservation Laws.

**UNIT-VI: Semiconductor physics (14 Hours)**

*Introduction to Quantum Mechanics*: De Broglie matter waves, Uncertainty Principle, Wave function& it’s probability interpretation, Postulates of quantum mechanics, Time independent Schrodinger Equation and its Applications, Particle in a box (1-D and 3-D)

*Semiconductor:* Electron in periodic structures, Band theory of solids, Density of states, Fermi level, Band theory of semiconductors, effective mass, Direct and indirect band gap, carriers in intrinsic and extrinsic semiconductors, Charge densities in intrinsic and extrinsic semiconductor, Law of mass action, Hall Effect.

**Learning resources**

**Text book:**

# David J. Griffiths ‘*Introduction to Electrodynamics’* HPI Publications, 3rd edition

# Elements of electromagnetics by Mathews N.O. Sadiku , 3rd Edition

**Reference Books:**

1. S.L. Kakani, Subhadra Kakani ‘*Engineering Physics’*, CBS Publications, 2nd edition

2.Arunkumar *‘Introduction to solid state physics’* HPI Publications, (30 January 2010)

3. Iswar Singh Tyagi *‘Principles of quantum mechanics’* Pearson Publications; 1st edition (25 September 2012)

4. Donald Neamen *‘Semiconductor devices’* McGraw Hill Education; 3ed edition (25 August 2006)

**Web resources:**

1. Prof V. Ravi Shakar, NPTEL-IIT Kanpur, ‘*Engineering Physics-II*’

URL: <https://nptel.ac.in/courses/122104016/>

2. Prof. D. K. Ghosh, NPTEL-IIT Bombay, ‘*Engineering Physics-II’*

URL: <https://nptel.ac.in/courses/122101002/>

**Course outcomes:** At the end of the course, the student will be able to

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| CO 1 | The student will have capacity to integrate knowledge on vector and scalar fields using mathematical del operators, and also solve the problems in integral calculus.  |
| CO 2 | Student will have capacity to describe the electric field and potentials associated various symmetric charged bodies by using Gauss Law. And also understand the applications of dielectric materials in real life. |
| CO 3 | Student will be able understand different electrical charged body fields, potentials, energy density and boundary conditions by solving Poisson’s and Laplace equations. |
| CO 4 | Student will have capacity to distinguish different magnetic materials such as Dia, para and ferro (Ferri) materials and its applications. |
| CO 5 | Student will have capacity to describe Maxwell’s equation in vacuum and conducting and non-conducting media. |
| CO 6 | Student will have capacity to describe classification of solid state materials in band theory, semiconducting materials and its significance in basic electronic devices. |

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (%) | 10% | 30% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PY1181** | **E1 Physics Laboratory –ECE and EEE** | **BSC** | **0-0-3** | **1.5** |

**Course Learning Objectives:**

1. Hall Effect: To determine the hall coefficient, carrier density and carrier mobility of a given semiconducting materials.
2. Frank Hertz: To verify the postulates of Bohr’s theory and discrete (quantized) energy levels in atoms.
3. Photo electric Effect: To understand phenomenon of the photoelectric effect and Determine the value of Plank’s constant.
4. Energy gap of Semiconductor: Determine the energy gap of a given semiconducting material by four probe method.
5. Susceptibility of Para Magnetic Materials: To determine the susceptibility of a given paramagnetic by Gouy’s method.
6. Magnetic hysteresis curve tracer: Determine the Coercivity, Saturation magnetization and retentivity of a given Ferro magnetic material using a Hysteresis loop tracer.
7. Dielectric Constant measurement: Determine the Dielectric constant of a given dielectric material.
8. Viscosity of water Measurement: Determine the co-efficient of viscosity of given oil by falling sphere method.
9. Zener Diode experiment: Verification of I-V characteristics of Zener Diode and Determination break down voltage of Zener Diode.
10. Transition characteristic experiment: Determine different input and output parameters in common emitter configuration of both p-n-p and n-p-n Transistor.
11. Solar cell experiment: Determine the efficiency of a given Solar cell.

**Experiments list**

Exp-1: Hall Effect

Exp-2: Frank Hertz

Exp-3: Photo electric Effect

Exp-4: Energy gap of Semiconductor

Exp-5: Susceptibility of Para Magnetic Materials

Exp-6: Magnetic hysteresis curve tracer

Exp-7: Dielectric Constant measurement

Exp-8**:**  Viscosity of water Measurement

Exp-9: Verification of I-V characteristics of Zener Junction Diode and Determination break down voltage of Zener Diode.

Exp-10: ***p-n-p*** and ***n-p-n*** Transistor parameters in common emitter configuration

EXP-11: Calculating the efficiency of Solar cell

**Course outcomes:** At the end of the course, the student will be able to

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| CO 1 | Student will have capacity to measure hall coefficient of given semiconductor. Further, students can calculate carrier density and carrier mobility of a given semiconductor.  |
| CO 2 | Student will have capacity to describe discrete (Quantized) energy levels of atoms.  |
| CO 3 | Student will able to understand the photoelectric effect phenomena and then calculate Plank’s constant value by using photoelectric equation.  |
| CO 4 | Student will have ability to describe the relation between conductivity and temperature in semiconductor materials and then calculate the energy gap of material.  |
| CO 5 | Student will have capable to calculate magnetic susceptibility of a given paramagnetic solution by Quinck’s tube method. |
| CO 6 | Student will able to differentiate between hard and soft ferromagnetic materials by observing B-H loops and then calculate Ms, Mr and Hc of a given ferromagnetic materials.  |
| CO 7 | Student will able to differentiate different type of dielectric mediums by calculate the dielectric constant.  |
| CO 8 | Student will have capable to calculate the co-efficient of viscosity of given oil by falling sphere method |
| CO 9 | Student will able to understand (nonohmic) nature of I-V characteristic of Zener diode. And then calculate breakdown voltage.  |
| CO 10 | Student will able to calculate input resistance, output resistance, out the values of current and voltage gain parameters for given transistor. And also Identify the active, Saturation and cutoff regions of a given Transistors by drawing I-V characteristics.  |
| CO11 | Student will able to calculate the efficiency of solar cell.  |

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| **Course Nature** | **Practical** |
| **Assessment Method** |
| Assessment Tool | Experiments | Record | Viva-Voce/ Quiz/MCQ/Lab project | Total |
| Weightage (%) | 25% | 5% | 10% | 40% |
| End Semester Examination weightage (%) | 60% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PY1102** | **Engineering physics-ME** | **BSC** | **3-1-0** | **4** |

**Course Learning Objectives:**

1.    To gain the basic knowledge in the areas of Differential calculus and Integral Calculus.

2.   To gain basic knowledge on the oscillatory motion of a system under certain conditions and its impact on the amplitude and energy of an oscillator.

3.    To gain the basic knowledge on Wave motion in solid media with the special focus on ultrasonic frequency range and its applications.

4.      To learn the basic knowledge about Electromagnetic wave equations vividly.

5.   To gain basic knowledge on Wave phenomena of Light such as Interference, Diffraction, Polarization. Basics of laser theory and its applications.

6.      To learn the detail knowledge about structural, Thermal and Electrical Properties of Solids

**Unit I: Mathematical Physics (10 Hours)**

Coordinate system: Cartesian, cylindrical and spherical coordinate system transformations, Differential Calculus: Gradient, Divergence, Curl and their physical significance, Integral Calculus: Line, Surface, and Volume Integrals, Integral theorem: Gauss and stokes theorems, Curvilinear Coordinates.

**Unit II: Oscillations (10 Hours)**

Oscillations**:** Simple Harmonic Oscillator (SHO), Damped Oscillations, Forced Oscillations, Amplitude and Velocity Resonance, Quality Factor, Coupled Oscillations &Normal modes, Coupled Pendulums & energy.

**Unit III: Ultrasonic Waves (10 Hours)**

 Waves, Phase of wave. Phase Velocity and Group Velocity with specific examples, Ultrasonic waves and its production: Magnetostriction and piezoelectric methods. detection of ultrasound: acoustic grating, ultrasonic interferometer, industrial applications, Non-destructive testing methods using ultrasonic waves (scan mode )

**Unit IV: Electromagnetic Waves (6 Hours)**

Maxwell’s Equations (integral and differential forms), Poynting theorem and conservation Laws, Wave Equation, Electromagnetic waves in vacuum and in Matter, its boundary conditions.

**Unit V: Optics (12 Hours)**

Theory of Diffraction, Fraunhoffer diffraction Single slit and multiple slits, Diffraction Grating, Rayleigh criterion for resolving power, Production of Plane polarized light & double refraction, Quarter & Half -wave plates, elliptical & circular polarized lights, Theory of Laser, Einstein coefficients, Types of Lasers: Three level Lasers (Ruby Laser) Gas Laser (He-Ne Laser) and four level laser (Nd-YAG laser )and semiconductors lasers, applications of lasers.

**Unit VI: Solid state Physics (12 Hours)**

(i) Basic Quantum mechanics: Wave function & probability interpretation, Time independent Schrodinger Equation and its Applications, Particle in a box (1D &3D) (ii) Solid State Physics :Crystallography, Defects in crystals (qualitatively), Thermal Properties: Lattice heat capacity, Einstein’s theory of lattice specific heat, Deby”s theory of specific heat- T3 law, Thermal expansion and Thermal conductivity.

**Learning resources**

**TEXT BOOKS**

1. Md. N. Khan, S. Panigrahi, ‘*Principles of Engineering Physics 1*’ Cambridge University press 2016

2. Suresh Garg, C.K.Ghosh, Sanjay Gupta ‘*Oscillations and Waves*’PHI Learning, 10th edition.

**REFERENCES**

1. Hitendra K. Malik and A.K. Singh ‘[*Engineering Physic*s’](https://www.amazon.in/Engineering-Physics-Hitendra-K-Malik/dp/9352606957/ref%3Dsr_1_fkmr1_2?ie=UTF8&qid=1544720456&sr=8-2-fkmr1&keywords=1.%09Engineering+Physics+by+Gaur+and+Gupta%2C+Dhanpathrai+Publications) by , 3 August 2017
2. [Dr. M.N Avadhanulu](https://www.amazon.in/s/ref%3Ddp_byline_sr_book_1?ie=UTF8&field-author=Dr.+M.N+Avadhanulu&search-alias=stripbooks), [Dr. P.G shirsagar](https://www.amazon.in/s/ref%3Ddp_byline_sr_book_2?ie=UTF8&field-author=Dr.+P.G+Kshirsagar&search-alias=stripbooks)  Jan ‘*A Textbook of Engineering Physics’*

S. Chand publications, old edition

1. David J Griffiths ‘*Introduction to Introduction to electrodynamics’*PHI Learning 3ed edition
2. 4. H.J. Pain ‘*The Physics of Vibrations and Waves’*Willey Student Edition,6th edition

**5.** Sear’s and Zemansky *‘University Physics’*, Pearson Edition.

**Course outcomes:** At the end of the course, the student will be able to

|  |  |
| --- | --- |
| CO1 | The student will be able to differentiate the Del, Gradient, Divergence, and Curl, and also Relations among them. |
| CO2 | The student will be able to understand the oscillatory motion of a single and coupled system and transfer of energy in between particles. |
| CO3 | Students will be able to understand the uses of ultrasonics in various fields. |
| CO4 | Student will be able to understand the EM waves in different media like Vacuum, Matter and Conductor. |
| CO5 | Students will be able to understand the phenomena of interference, diffraction and polarization exhibited by light waves and the characteristics of lasers. |
| CO6 | The student will get a clear idea of crystal physics, Bragg’s law of X-ray diffraction, Thermal and Electrical Conductivity of solids. |

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (%) | 10% | 30% | 60% | 100% |

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| **Course code** | **Course Name** | **Course Category** | **L-T-P** | **Credits** |
| **20PY1182** | **E1 Physics Laboratory -ME** | **BSC** | **0-0-3** | **1.5** |

**Course Objectives:**

**1.**    The goal of this experiment is to learn the concept of semiconductors and motion of charged particle in presence of magnetic field.

2.    The goal of this experiment is to learn how to determine the wavelength of given laser light using diffraction phenomenon and understand the applications of diffraction phenomenon.

3.    The goal of this experiment is to demonstrate the effect which varying thermal conductivities on the heat flow through a given material. This will provide a better understanding of both thermal conductivity and thermal resistance

4.    The goal of this experiment is to understand the concept of the normal mode frequency and beat frequency using coupled pendulum

5.    The goal of this experiment is to determine the acceleration due to gravity (g) and radius of gyration about an axis through the center of gravity by means of a compound pendulum.

6. The goal of this experiment is to calculate the radius of curvature of a Plano convex lens by Newton’s Ring experiment.

**Experiments list**

1. Study of Hall effect and calculation of hall coefficient and concentration of charge carriers
2. Determination of wavelength of laser light using diffraction grating
3. Determination of thermal and electrical conductivity of metals
4. To determine the degree of coupling by using normal modes of coupled oscillations
5. To measure the acceleration due to gravity (g) and radius of gyration about an axis through the center of gravity
6. Determination of the radius of curvature of a Plano convex lens by Newton’s Ring experiment

**Course outcomes:** At the end of the course, the student will be able to

**1**. calculate the hall coefficient, carrier density and carrier mobility of a given semiconductor. Student enrich with sound knowledge on concept of behavior of semiconductors in magnetic field.

2. determine the wavelength of given laser light using diffraction phenomenon and understand the applications of diffraction in day today life.

3. calculate thermal conductivities and electrical conductivity of given metal in laboratory.

4. determine normal mode frequency and beat frequency using coupled pendulum. Student will also understand the concept of coupling and energy transform from one system to other through oscillation.

5. determine the acceleration due to gravity (g) and radius of gyration about an axis through the center of gravity by means of a compound pendulum.

 6. calculate the radius of curvature of a Plano convex lens by Newton’s Ring experiment

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| **Course Nature** | **Practical** |
| **Assessment Method** |
| Assessment Tool | Experiments | Record | Viva-Voce/ Quiz/MCQ/Lab project | Total |
| Weightage (%) | 25% | 5% | 10% | 40% |
| End Semester Examination weightage (%) | 60% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PY1103** | **Engineering Physics-MME** | **BSC** | **2-1-0** | **3** |

**Course Learning Objectives:**

1.    To learn different optical phenomena shown by light waves related to interference, diffraction and polarisation.

2.   To gain the basic knowledge of characteristics of coherent radiations and the basic knowledge in domain of Lasers, Optical fibers and its applications.

3.     To gain the detailed knowledge in production of Ultrasonic waves and its applications.

4.     To learn the detailed knowledge regarding the phenomenon of Thermal effects on Electricity.

5.   To learn the detailed knowledge about Properties of Magnetic materials and its classifications.

6.  To give knowledge about semiconductor physics and discus working and application of  p-n junction diodes.

**Unit I: Wave Optics (8 Hours)**

Introduction- Coherent sources- Interference in thin parallel film by reflection- Newton’s rings- Fraunhofer diffraction due to single slit and multiple slits – Diffraction grating - Rayleigh criterion for resolving power- Resolving power of grating- Resolving power of Microscopes, Polarization- Brewster’s law, Malus law, Double refraction- Half and Quarter wave plate.

**UNIT-II: Lasers and Fibers (8 Hours)**

Lasers – principle and applications – Einstein’s coefficients, Types of Lasers: three level lasers and four level lasers, Co2 laser, Nd:YAG laser, - semiconductor lasers: construction and working – applications.

Optical fibres - classification (index & mode based) - principle and propagation of light in optical fibres - acceptance angle and numerical aperture - fibre optic communication system - active and passive sensors.

**Unit III: Ultrasonics (8 Hours)**

Introduction to ultrasonic waves, production – magnetostriction and piezoelectric methods - detection of ultrasound - acoustic grating – ultrasonic interferometer - industrial applications – Non-destructive testing - ultrasonic method: scan modes and practice.

**Unit IV: Thermoelectricity (08 Hours)**

Seebeck effect, thermoelectric power, thermoelectric series, Peltier effect, Thomoson effect, measurement of temperature using thermocouple, law of successive temperature, law of intermediate metal, application of thermodynamics to thermocouples.

**Unit V: Magnetic Materials (8 Hours)**

Concepts of magnetic dipole, magnetic moment, Magnetic quantities -types of magnetic materials: Dia, Para, ferro, antiferro and ferrimagnetic materials. Domain and Heisenberg exchange interaction theory-Hysteresis-hard and soft materials.

**Unit VI: Semiconductors (8 Hours)**

Formation of energy bands-Band theory of solids: metals, semiconductors and insulators (qualitatively)-intrinsic and extrinsic semiconductors- Fermi energy levels for doped, undoped semiconductors. Hall effect- Hall sensors. Physics of PN junction, solar cell and LED.

**Course outcomes:**At the end of the course, the student will be able to

1. Students will be able to understand the phenomena of interference, diffraction and polarization exhibited by light waves.

2.Students will be able to understand the characteristics of lasers with an example and its application in specific to optic fiber. The principle and functioning of a few types of lasers: Solid, Gas & semiconductor and core properties of Optical fibers.

3. Students will acquire knowledge on production and application of ultrasonic waves in field of engineering.

4.Student will learn the physics behind the energy harvesting through the concept of thermo electric effects: Seebeck, Peltier and Thomoson in detailed manner.

5.Student will learn concept of magnetism and different Properties exhibited by all Magnetic materials.

6.Students will achieve the ability to explain the basic properties of semiconductors including the band gap and describe the working and design considerations for the various photonic devices like, solar-cells and LEDs

**Learning resources**

**TEXT BOOKS**

1. Md. N. Khan, S. Panigrahi, ‘*Principles of Engineering Physics 1*’ Cambridge University press 2016

2. [Dr. M.N Avadhanulu](https://www.amazon.in/s/ref%3Ddp_byline_sr_book_1?ie=UTF8&field-author=Dr.+M.N+Avadhanulu&search-alias=stripbooks), [Dr. P.G shirsagar](https://www.amazon.in/s/ref%3Ddp_byline_sr_book_2?ie=UTF8&field-author=Dr.+P.G+Kshirsagar&search-alias=stripbooks) ‘*A Textbook of Engineering Physics’* S.ChandPublications, 2014

3. M.A. Wahab, ‘*Solid State Physics: Structure and Properties of Materials’*, Narosa Publications, 3rd Edition

**REFERENCES**

1. Gaur and Gupta ‘Engineering Physics’, Dhanpathrai Publications,1st edition

2. Hitendra K. Malik and A.K. Singh ‘[Engineering Physics’](https://www.amazon.in/Engineering-Physics-Hitendra-K-Malik/dp/9352606957/ref%3Dsr_1_fkmr1_2?ie=UTF8&qid=1544720456&sr=8-2-fkmr1&keywords=1.%09Engineering+Physics+by+Gaur+and+Gupta%2C+Dhanpathrai+Publications) , 3 August 2017

3. Sear’s and Zemansky ‘University Physics’, Pearson Publications, 8th Edition.

4. Serway, Jetwett, ‘Physics for Scientists and Engineers with Modern Physics’ Pearson Publications, 8th Edition

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (%) | 10% | 30% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PY1183** | **E1 Physics Laboratory MME** | **BSC** | **0-0-3** | **1.5** |

**Course Learning Objectives:**

1. To study the Hall Effect and to calculate:-(i) The Hall Coefficient (RH)  (ii) The concentration of charge carriers.

2.  To determine the wavelength of laser light using Diffraction Grating.

3.  To determine the Energy Band Gap of a Semiconductor by using a Junction Diode / Four Probe method

4.   Magnetic Hysteresis Loop B-H loop

5.   Measurement of velocity of ultrasonic waves

6.   To verify the Bohr’s postulates and quantization of energy levels

7.   To determine the dispersive power of grating using mercury light with the help of a spectrometer.

8.   To determine the dielectric constant of given material using capacitance method

9.   To verify Stefan’s law by electrical method

10.  Study of I-V Characteristic of a solar cell illuminated by an incandescent lamp, at different frequencies

11.  To determine the thermo electric coefficient of a given metals using Seebeck effect

12.  Determination of thermal and electrical conductivity of metals

13.  Determination of acceptance angle and numerical aperture using fiber optic cable

**Experiments list**

1. Hall Effect
2. Laser Diffraction
3. Four Probe Method - Energy Band Gap of a Semiconductor
4. Magnetic Hysteresis Loop
5. Ultrasonic interferometer
6. Frank Hertz
7. Spectrometer
8. Dielectric Constant
9. Stefan’s Law
10. Solar Cells
11. Thermo electric coefficient of a given metals
12. Thermal and electrical conductivity of metals
13. Optical Fiber.

**Course outcomes:** At the end of the course, the student will be able to

1. Student will able to calculate the Hall coefficient, carrier density and carrier mobility of a given semiconductor.
2. Student will able to understand the concept of diffraction of grating with this experiment.
3. Student will able to understand how to calculate the energy gap of a semiconductor.
4. Student will able to understand the magnetic properties of the material with B-H loop.
5. Student will able to understand how the velocity of ultrasonic waves varies in different media.
6. Student will able to verify the concept of quantization through this experiment.
7. Student will able to understand the dispersion of light through prism using spectrometer and measure their wavelengths
8. Student will able to understand how to calculate the dielectric constant of the given material.
9. Student will able to understand and verify the Stefan’s law radiations.
10. Student will able to understand the I-V characteristic of Solar cells.
11. Student will able to understand thermo electric coefficient of a given metals.
12. Student will able to understand Thermal and Electrical conductivity of Metals.
13. Student will able to calculate the acceptance angle and numerical aperture using fiber optic cable.

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| **Course Nature** | **Practical** |
| **Assessment Method** |
| Assessment Tool | Experiments | Record | Viva-Voce/ Quiz/MCQ/Lab project | Total |
| Weightage (%) | 25% | 5% | 10% | 40% |
| End Semester Examination weightage (%) | 60% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PY1201** | **E1 Engineering Physics-CSE** | **BSC** | **3-1-0** | **4** |

**Course Learning Objectives:**

1. To enhance the knowledge on waves & oscillation with an emphasis on different type of oscillations and its resonance conditions.
2. To distinguish vividly the Optical phenomena’s such as Interference, Diffraction and their applications through experimental point of view like Michelson Interferometer, Newton Rings and Plane Diffraction Grating.
3. To pursue the in-depth knowledge on Polarization with emphasis on Laurent’s half-shade Polarimeter and also to learn all the basic necessary concepts regarding the LASERs including basic important types of LASERs.
4. To pull the student attention towards the difference between Photography and Holography and also the basic knowledge regarding Optical fibers along with its applications.
5. To identify the necessity of origin of Quantum mechanics over the grand old Classical mechanics and also to learn the knowledge on postulates of Quantum mechanics.
6. To get knowledge about the band theory of solids by the assumption of movement of an electron in the periodic potential well only and hence distinguishes the materials classification, phenomena of Hall Effect exhibited by semiconductors and its applications.

**Course Content:**

**Unit I: Oscillations (9 Hours)**

Oscillations**:** Simple Harmonic Oscillator (SHO), Damped Oscillations, Forced Oscillations, Amplitude and Velocity Resonance, Quality Factor, Coupled Oscillations &Normal modes, Coupled Pendulums & energy.

**Unit – II: Wave Optics (10Hours)**

Interference**:** Superposition principle, Division of amplitude and wave front division, Interferometers (Michelson), Newton’s Rings due to Reflected waves, Applications; Diffraction:Fraunhoffer diffraction (single & multiple slits),Plane Diffraction Grating,Rayleigh criterion for resolving power, Dispersive power, Applications.

**Unit – III: Polarization and LASERS (9 Hours)**

Polarization:Classification of Polarized light: Linear, Circular, Elliptical; Production & detection of polarized light;Retardationwave plates: Quarter & Half wave plates;Optical activity: Laurent Half shade Polarimeter; Basic principles of Lasers, Theory of Lasers, and Types of Lasers: Three level and four level lasers, Ruby Laser, He-Ne Laser, and Semiconductor laser: P-N Junction Diode Laser, applications of lasers.

**Unit – IV: Holography, and Optical fibers (8Hours)**

Basic principles of Holography, types of holograms, difference between photography and holography, holographic NDT &applications of holography; Optical fibers: Basic principles, types and applications for communication and sensing, Acceptance angle &Numerical Aperture NA.

**Unit V: Quantum Mechanics (12 Hours)**

Photo electric effect, Compton effect;De-Brogliematter waves, properties of matter waves, Uncertainty Principle, Wave function& it’s probability interpretation, Operators, Expectation values, Postulates of quantum mechanics, Time independent Schrodinger Equation and its Applications, Particle in a box (1-D and 3-D).

**Unit VI: Semiconductor Physics (12 Hours)**

Electron in periodic structures, Band theory of solids, E-K curve, effective mass, Density of states, Fermi levels. Intrinsic and extrinsic semiconductors, dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carriertransport: diffusion and drift, Hall effect- Hall sensors,Physics of p-n junction, Metal-semiconductor junction (Ohmic and Schottky)

**Text Books:**

1. Dr. N. Subrahmanyam, Brijalal, [Dr. M.N Avadhanulu](https://www.amazon.in/s/ref%3Ddp_byline_sr_book_1?ie=UTF8&field-author=Dr.+M.N+Avadhanulu&search-alias=stripbooks)“A Text Book of Optics” S. chand Publication

2. Md. N. Khan & S. Panigrahi “Principals of Engineering Physics” Volume I, Volume II, Cambridge University Press

3. Hitendra K. Malik and A.K. Singh, ‘[*Engineering Physics*’](https://www.amazon.in/Engineering-Physics-Hitendra-K-Malik/dp/9352606957/ref%3Dsr_1_fkmr1_2?ie=UTF8&qid=1544720456&sr=8-2-fkmr1&keywords=1.%09Engineering+Physics+by+Gaur+and+Gupta%2C+Dhanpathrai+Publications)Tata McGraw Hill, 2nd Edition, 2017

4. Gaur and Gupta “*Engineering Physics*, Dhanpathrai Publications, 6th edition

**References:**

1. AjoyGhatak‘*Optics*’ Tata McGraw Hill, 6th Edition

2. M. Armugam, Anuradha‘*Engineering Physics*’, Agencies publishers, 2003

3. [David McMahon](https://www.amazon.in/David-McMahon/e/B001H6O0UW/ref%3Ddp_byline_cont_book_1), ‘*Quantum Computing Explained’*, Wiley, 2016

**Course outcomes:** At the end of the course, the student will be able to

1: Student will be able to distinguish the phenomena’s of interference & diffraction exhibited by light waves theoretically through Michelson Interferometer, Newton’s Rings and Plane Diffraction Grating.

2: Student will have capable to understand the lengths and breadths of Concept called Polarization as well as working nature and construction of LASERs rather closely along with its applications in various fields.

3: Students will have capable to discriminate the merits and de-merits of Holography over the Photography besides of that they can purse the knowledge about optical fibers and their applications.

4: Student will be able to differentiate all type of oscillations like Simple Harmonic, Forced, Damped & Coupled and also implications governed by Amplitude & Velocity Resonance.

5: Student will be able to construct a quantum mechanical model to explain the behavior of a system at microscopic level and solve engineering problems using the laws of quantum mechanics.

6: Student will acquire the capacity to describe classification of solid state materials by the band theory of solids and semiconducting materials along with its significance.

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (%) | 10% | 30% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PY1281** | **Engineering Physics Laboratory** | **BSC** | **0-0-3** | **1.5** |

**Course Learning Objectives:**

1. To determine the wavelength of laser light using Diffraction Grating.
2. To determine the radius of curvature of a Plano convex lens by Newton’s Ring experiment.
3. To determine the specific rotation of cane sugar solution with the help of Polarimeter.
4. To calculate the velocity of ultrasonic sound waves in different liquid media by interferometer.
5. To study the phenomena of Hall Effect in given semiconductors and to calculate:-(i) The Hall Coefficient (RH) (ii) the concentration of charge carriers of given semiconductor material.
6. To verify the postulates of Bohr’s theory and discrete (quantized) energy level of atoms.
7. To study the photoelectric effect and determine the value of Plank’s constant.
8. To determine the Energy Band Gap of a Semiconductor by using a Junction Diode / Four Probe method
9. Study of I-V Characteristic of a solar cell illuminated by an incandescent lamp at different fixed frequencies.
10. Determination of Acceptance angle and Numerical Aperture using fiber optic cable

**Experiments list**

1. Laser Diffraction
2. Newton’s Ring expt
3. Polarimeter.
4. Ultrasonic interferometer
5. Hall Effect
6. Frank Hertz
7. Photo electric Effect
8. Energy Band Gap of a Semiconductor
9. Solar cells
10. Optical fiber

**Course outcomes:** At the end of the course, the student will be able to

1. Student will able to recognize the diffraction phenomena exhibited by different grating elements and then capable to calculate wavelength of given laser light.
2. Student will able to recognize the interference phenomena exhibited by division of amplitude using Newton’s Ring experiment. And capable of calculate the radius of curvature by given Plano-convex lens by ring pattern.
3. Student will able to distinguish the purity of sugar cane by measuring polarization and specific rotation of given sugar solution with the help of Polarimeter. The higher the polarization purer will more in sugar; and lesser the polarization impurity will be more.
4. Student will able to understand the generation of ultrasonic sound waves by piezoelectric effect in different liquid media and to know how the velocity of sound wave varies with adiabatic compressibility of medium.
5. Student will have capable to distinguish the nature of semiconductors by measuringHall coefficient, carrier density and carrier mobility of a given semiconductor.
6. Students will able to understand quantization of energy in atoms.
7. Student will able to understand physical characteristics of photoelectric effect and how to calculation of Plank’s constant value by Einstein particle radiation concept.
8. Student will have ability to describe the relation between conductivity and temperature in semiconductor materials and then calculate the energy gap ofgiven material.
9. Student will have skillful to draw I-V characteristic of solar cells.
10. Student will able to calculate the acceptance angle and numerical aperture using fiber optic cable.
11. Student will able to understand how recording and reconstruction of holograms under Laser light.

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| **Course Nature** | **Practical** |
| **Assessment Method** |
| Assessment Tool | Experiments | Record | Viva-Voce/ Quiz/MCQ/Lab project | Total |
| Weightage (%) | 25% | 5% | 10% | 40% |
| End Semester Examination weightage (%) | 60% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PY1202** | **E1 Engineering Physics- CE** | **BSC** | **2-1-0** | **3** |

**Course Learning Objectives:**

1. To pursue the in-depth knowledge on waves and oscillations as well ultrasonic waves and seismic waves, its implications.
2. To know properties of matter and their utilization in civil engineering.
3. To know the concept of acoustic and its effect on civil constructions.
4. To get adequate knowledge on the use of functional materials

5. To get adequate knowledge on different techniques used in processing of ceramic materials.

6. To learn about effect of natural calamity on structure

**Unit I: Oscillations (7 Hours)**

Oscillations**:** Essential Mathematics, Simple Harmonic Oscillator (SHO), Damped Oscillations, Forced Oscillations, Amplitude Resonance, Quality Factor, Coupled Oscillations, Coupled pendulum and beats.

**Unit II: Waves (7 Hours)**

Ultrasonic waves: Magnetostriction and Piezoelectric methods, detection of ultrasound: acoustic grating and ultrasonic interferometer, industrial applications. Seismology and Seismic waves - Earth quake ground motion

**UNIT III: Properties of Matter (8 Hours)**

Elasticity – Stress-strain diagram and its uses - factors affecting elastic modulus and tensile strength – torsional stress and deformations – twisting couple - torsion pendulum: theory and experiment – bending of beams - bending moment – cantilever: theory and experiment – uniformand non-uniform bending: theory and experiment - I-shaped girders - stress due to bending inbeams.

**UNIT IV: Acoustics (8 Hours)**

Classification of sound- decibel- Weber–Fechner law – Sabine’s formula- derivation using growthand decay method – Absorption Coefficient and its determination –factors affecting acoustics ofbuildings and their remedies. Methods of sound absorptions - absorbing materials - noise and itsmeasurements, sound insulation and its measurements.

**UNIT V: New Engineering Materials-I (6 Hours)**

Composites - definition and classification - Fiber reinforced plastics (FRP) and fiber reinforcedmetals (FRM) - Metallic glasses - Shape memory alloys.

**UNIT VI: New Engineering Materials-II (Ceramics) (7 Hours)**

Ceramics - Classification - Crystalline -Non Crystalline - Bonded ceramics, Manufacturing methods - Slip casting - Isostatic pressing -Gas pressure bonding - Properties - thermal, mechanical, electrical and chemical ceramic fiber -ferroelectric and ferromagnetic ceramics - High aluminium ceramics.

OUTCOMES:

Upon completion of this course,

1. The student will gain knowledge on oscillation and it importance in building design.
2. the students will have knowledge on the thermal performance of buildings,
3. the students will acquire knowledge on the acoustic properties of buildings,
4. the students will gain knowledge on the properties and performance of engineering materials
5. the students will gain knowledge on the ceramics materials preparation techniques use in civil engineering

TEXT BOOKS:

1. Md. N. Khan, S. Panigrahi, ‘*Principles of Engineering Physics 1*’ Cambridge University press 2016
2. Alexander, D. “Natural disaster”, Springer (1993).
3. Budinski, K.G. & Budinski, M.K. “Engineering Materials Properties and Selection”, Prentice Hall, 2009.
4. Severns, W.H. & Fellows, J.R. “Air conditioning and Refrigeration”, John Wiley and Sons, London, 1988.
5. Stevens, W.R., “Building Physics: Lighting: Seeing in the Artificial Environment, Pergaman Press, 2013.

REFERENCES:

1. Gaur R.K. and Gupta S.L., Engineering Physics. Dhanpat Rai publishers, 2012.
2. Reiter, L. “Earthquake hazard analysis - Issues and insights”, Columbia University Press,1991.
3. Shearer, P.M. “Introduction to Seismology”, Cambridge University Press, 1999.

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (Marks) | 10 | 30 | 60 | 100 |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PY1282** | **Engineering Physics Laboratory** | **BSC** | **0-0-3** | **1.5** |

**Course Learning Objectives**:

1. The goal of this experiment is to determine the acceleration due to gravity (g) and radius of gyration about an axis through the center of gravity by means of a compound pendulum.

2. The goal of this experiment is to determine momentum of inertia of given Flywheel.

3. The goal of this experiment is to determine dielectric constant of given material by capacitance method.

4. The goal of this experiment is to determine the radius of curvature of a Plano convex lens by Newton’s Ring experiment.

5. The goal of this experiment is to determine the wavelength of laser light using Diffraction Grating

6. The goal of this experiment is to determine the Magnetic Hysteresis Loop (B-H loop) of given magnetic materials

7. The goal of this experiment is to determine the acceptance angle and Numerical Aperture of given fiber optic cable

8. The goal of this experiment is to determine the magnetic susceptibility of given paramagnetic sample

9. The goal of this experiment is to study the Hall Effect and to calculate:-(i) The Hall Coefficient (RH) (ii) The concentration of charge carriers

10. The goal of this experiment is to determine the electrical resistivity of a given Semiconductor using Four Probe method

11. The goal of this experiment is to determine the Energy Band Gap of a given Semiconductor using Four Probe method

12. The goal of this experiment is to understand the concept of the normal mode frequency and beat frequency using coupled pendulum

**List of the experiments**

1. Determination of ‘g’ by compound pendulum
2. Moment of inertia by Flywheel
3. Dielectric constant and dipole moment of molecules
4. Determination of the radius of curvature of a Plano convex lens by Newton’s Ring experiment
5. Determination of the wavelength of laser light using Diffraction Grating
6. B-H Curve tracer
7. To determine the numerical aperture of a given optical fiber and hence to find its acceptance angle
8. Measurement of magnetic susceptibility by Gouy’s method
9. Hall effect
10. To determine the resistivity of semiconductor by Four probe method
11. To determine the energy gap of a semiconductor
12. To determine the degree of coupling by using normal modes of coupled oscillations

**Course outcomes:** At the end of the course, the student will be able to

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| CO 1 | How to determine the acceleration due to gravity (g) and radius of gyration about an axis through the center of gravity using compound pendulum. |
| CO 2 | Learn the concept of momentum of inertial and he will able to calculate momentum of inertia of given Flywheel |
| CO 3 | learn how to determine the dielectric constant of given material by capacitance method |
| CO 4 | Calculate the radius of curvature of a Plano convex lens by Newton’s Ring experiment |
| CO 5 | Calculate the wavelength of laser light using Diffraction Grating and get knowledge over the phenomena of diffraction.  |
| CO 6 | learn the concept of magnetism and student will able to determine the Magnetic Hysteresis Loop (B-H loop) of given magnetic materials |
| CO 7 | Calculate the acceptance angle and Numerical Aperture of given fiber optic cable |
| CO 8 | learn how to calculate the magnetic susceptibility of given sample |
| CO 9  | understand the concept of Hall effect and he/she will able to calculate the hall coefficient, carrier density and carrier mobility of a given semiconductor |
| CO 10 | Learn the four probe method and its applications in determination of electrical resistivity of given semiconductor. |
| CO11 |  determine the Energy Band Gap of a given Semiconductor  |
| CO12 | learn how to determine normal mode frequency and beat frequency using coupled pendulum. Student will also understand the concept of coupling and energy transform from one system to other through oscillation.  |

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| **Course Nature** | **Practical** |
| **Assessment Method** |
| Assessment Tool | Experiments | Record | Viva-Voce/ Quiz/MCQ/Lab project | Total |
| Weightage (%) | 25% | 5% | 10% | 40% |
| End Semester Examination weightage (%) | 60% |
| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PY1203** | **E1 Engineering physics-Chemical Engineering** | **BSC** | **3-0-0** | **3** |

**Course Learning Objectives:**

1. To purse the in-depth knowledgeon waves and different types of oscillations, its production and applications.
2. To distinguish vividly the Optical phenomena’s exhibited by light waves i.e.interference, diffractionand polarization. And to understand the in depth knowledge of its characteristics of coherent radiations with an example and their applications in real life.
3. To learn all the basic necessary concepts regarding the LASERs production as well basic important types of LASERs. And also enhance the basic knowledge towards optical fibers.
4. To gain knowledge on the foundation principles of crystallography in specific to crystal systems, unit cell and related parameters and to understand the concept of X-ray diffraction to determine the crystal systems.
5. To enhance knowledge on the dielectric, ferroelectric and magnetic materials and its properties, applications. To get basic knowledge on superconducting materials.
6. To gain knowledge on the nano materials and its synthesis process from top down to bottom up approach towards few practical methods.

**Unit 1: Oscillations (8 Hours)**

Oscillations**:** Simple Harmonic Oscillator (SHO), Damped Oscillations, Forced Oscillations, Amplitude and Velocity Resonance, Quality Factor, Coupled Oscillations &Normal modes, Coupled Pendulums & energy and Oscillation on N coupled modes

**UNIT-2: Wave Optics (8 Hours)**

Introduction- Coherent sources- Interference in thin parallel film by reflection- Newton’s rings- Fraunhofer diffraction due to single slit – Diffraction grating (Qualitative)- Resolving power of grating- Rayleigh criterion for resolving power- Polarization- Double refraction- Half wave plate –Quarter wave plate.

**UNIT-3: Laser and Fiber Optics (8 Hours)**

LASER:Introduction- Characteristics of lasers- Absorption, Spontaneous and stimulated emission of radiation - Population inversion- Semiconductor laser.Fiber Optics:Introduction- Principle of optical fiber- Acceptance angle- Acceptance cone- Numerical Aperture.

**UNIT-III: Crystallography (8 Hours)**

Introduction- space lattice- basis- unit cell- lattice parameters- Crystal systems- Bravais lattices- Packing fractions, Directions and Planes in crystals, Miller indices, Interplanar spacing, Bragg’s Law of X-Ray diffraction. Structure factor calculations and X-ray diffraction methods to determine crystal structure determination.

**UNIT-IV: Magnetic and Dielectric Properties of Material (10 Hours)**

Dielectrics: Introduction- Dielectric constant- Electronic, ionic and orientation polarization mechanisms (qualitative) - Internal field- Clausius-Mossotti relation, Piezo, Pyro and Ferroelectric materials and its applications (qualitative)

Concepts of magnetic dipole, magnetic moment, Magnetic quantities -types of magnetic materials: Dia, Para, ferro, antiferro and ferrimagnetic materials(qualitative). Hysteresis: Soft and hard magnetic materials.

Superconductivity: Introduction- Transition temperature, Critical magnetic field, persistent currents, Meissner effect), Type I and Type II superconductors, Applications of superconductors.

.**Unit-VI: Introduction to nanoscience (8 hours)**

History and importance of nanotechnology, difference between bulk and nanoscale materials and their significance, Classification of nanostructures: zero, one, two and three dimensional nanostructures, size dependency in nanostructures, preparation of nano materials: bottom up methods : Sol- gel method and Chemical vapor deposition method top down method: Ball milling.

**Learning resources**

**TEXT BOOKS**

1. 1. Md. N. Khan, S. Panigrahi, ‘*Principles of Engineering Physics 1 and 2*’ Cambridge University press 2016

2. [Dr. M.N Avadhanulu](https://www.amazon.in/s/ref%3Ddp_byline_sr_book_1?ie=UTF8&field-author=Dr.+M.N+Avadhanulu&search-alias=stripbooks), [Dr. P.G shirsagar](https://www.amazon.in/s/ref%3Ddp_byline_sr_book_2?ie=UTF8&field-author=Dr.+P.G+Kshirsagar&search-alias=stripbooks)  Jan ‘*A Textbook of Engineering Physics’*  S. Chand publications, old edition

3. Gaur and Gupta “*Engineering Physics*, Dhanpathrai Publications, 6th edition.

**REFERENCES**

1. Hitendra K. Malik and A.K. Singh ‘[*Engineering Physic*s’](https://www.amazon.in/Engineering-Physics-Hitendra-K-Malik/dp/9352606957/ref%3Dsr_1_fkmr1_2?ie=UTF8&qid=1544720456&sr=8-2-fkmr1&keywords=1.%09Engineering+Physics+by+Gaur+and+Gupta%2C+Dhanpathrai+Publications) by , 3 August 2017
2. H.J. Pain ‘*The Physics of Vibrations and Waves’* Willey Student Edition, 6th edition

3. Sear’s and Zemansky *‘University Physics’*, Pearson Edition.

**Course outcomes:** At the end of the course, the student will be able to

1. Student will acquire in-depth knowledge on waves and oscillations as well ultrasonic waves, its production and applications.
2. Student will be able to distinguish the phenomena’s of interference & diffraction exhibited by light waves theoretically through Young’s double slit, Newton’s Rings and Plane Diffraction Grating.
3. Student will have skillful in construction and working principles of LASERs and optical Fibers rather closely along with its applications in various fields.
4. Student will have knowledge on the foundation principles of crystallography in specific to crystal systems and basic concept of X-ray diffraction to determine the crystal systems.
5. Student will have capacity to identify, dielectric, ferroelectric, magnetic and superconducting materials by characterizing it properties
6. Student will acquire the capability to prepare nano particles with different synthesis process.

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (%) | 10% | 30% | 60% | 100% |

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***Course Structure for***

**Minor in Semiconductor Devices**

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| ***S.No*** | **Course Code** | **Subject Category** | **Name of the subject** | **L-T-P** | **Credits** |
| **1** | **20PYM201** | **PCC** | **Quantum physics** | **3-1-0** | **4** |
| **2** | **20PYM202** | **PCC** | **Semiconductor Physics** | **3-1-0** | **4** |
| **3** | **20PYM301** | **PCC** | **Integrated Solid State Devices** | **3-1-0** | **4** |
| **4** | **20PYM302** | **PCC/PEC** | **Microelectronic devices – Fabrication techniques** | **3-1-0** | **4** |
| **5** | **20PYM401** | **PCC** | **Characterization techniques** | **3-1-0** | **4** |
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**Open electives:**

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| **S. No** | **Course Code** | **Subject Category** | **Name of the subject** | **L-T-P** | **Credits** |
| **1** | **20PYM303** | **PEC** | **Elementary Solid State Physics** | **3-0-0** | **3** |
| **2** | **20PYM304** | **PEC** | **Electrodynamics** | **3-0-0** | **3** |
| **3** | **20PYM305** | **PEC** | **Introduction to Fiber Optics** | **3-0-0** | **3** |
| **4** | **20PYM306** | **PEC** | **Nano Science and Technology** | **3-0-0** | **3** |
| **5** | **20PYM307** | **PEC** | **Optoelectronics** | **3-0-0** | **3** |
| **6** | **20PYM308** | **PEC** | **Thermodynamics & Statistical****Mechanics** | **3-0-0** | **3** |
| **7** | **20PYM402** | **PEC** | **Introduction to Nuclear and Particle Physics** | **3-0-0** | **3** |
| **8** | **20PYM403** | **PEC** | **Thin Film Technology** | **3-0-0** | **3** |
| **9** | **20PYM404** | **PEC** | **Semiconductor devices and Embedded Systems** | **3-0-0** | **3** |
| **10** | **20PYM405** | **PEC** | **Atmospheric Physics** | **3-0-0** | **3** |
| **11** | **20PYM406** | **PEC** | **Wind and Solar energy** | **3-0-0** | **3** |
| **12** | **20PYM407** | **PEC** | **Renewable Energy** | **3-0-0** | **3** |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PYM201** | **Quantum Physics** | **PCC** | **3-1-0** | **4** |

**Course Learning Objectives:**

The course is aimed at equipping the undergraduate Engineering and Physics students with the basic understanding of quantum mechanics and solid state physic.

1. This Unit covers the limitations of Classical physics and importance of quantum theory.

2. This Unit covers wave formulation in quantum mechanics like phase velocity, group velocity and probability density.

3. This Unit covers the Schrodinger wave equation and its application in solving problems like particle in a box, steps, barriers, well, bound states, delta function potential, and liner harmonic oscillator

4. This Unit provides knowledge of Crystal Structure, determination of crystal structure and diffraction techniques used to identify the crystal structure of the matter.

5. This Unit provides knowledge of Crystal defects and determination of crystal defect density.

6. This Unit gives an introduction to electron theory of solids and motion of electron in a periodic lattice. This Unit also aims at electrical properties of matter.

**PART-A**

**UNIT I: Origin of the Quantum mechanics (08 Hours)**

Limitations of Classical physics, Plank’s Quantum Hypothesis, Blackbody Radiation, Einstein’s Theory of Photoelectric Effect, Compton Effect, Pair production, Wave particle duality, De-Broglie matter waves, Experimental confirmation of De-Broglie hypothesis, Matter waves for macroscopic objects, Heisenberg’s uncertainty principle, Inadequacy of Quantum theory.

**UNIT II: Wave formulation in quantum mechanics (10 Hours)**

Wave function as a complete description of the state, Relation to measurable quantities, Probability density, Principle of superposition of waves, Phase velocity, Group velocity, Operators corresponding to measurable quantities, Expectation values of dynamic variables, wave packets, wave equations, wave packet description of particles.,

**UNIT III: Schrodinger Equation in 1-dimension problems (14Hours)**

Time-dependent Schrodinger Equation to get energy Eigen values and Eigen functions, Time-independent Schrodinger Equation, Potential step, The infinite Square well potential, Finite Square well potential, The potential barrier, Tunneling effect, Linear Harmonic Oscillator: Schrodinger method, Three dimension problems in Cartesian coordinates: Box potential, density of states, three dimension problems in spherical coordinates: Central potential, Spherical Harmonics.

**PART-B**

**UNIT IV: Crystal Structure: (10 Hours)**

Crystal lattice, Unit cell, Bravais lattices, X-ray diffraction, Bragg’s law, Reciprocal lattice, Crystal structures, Atomic scattering factor, Geometrical structure factor, Neutron diffraction, Electron diffraction, Crystal structure determination by Powder crystal methods.

**UNIT V : Crystal defects: (08 Hours)**

Defect classification; Defect equilibrium; Point defects in metallic, ionic and covalent crystals; Overview of grain boundaries, inter-phase boundaries, stacking faults; Volume defects; Defects in non-crystalline materials.

**UNIT VI: Electron theory of solids (10 Hours)**

Failure of free electron theory, Sommerfield modification, Particle in a box, Fermi Dirac statistics and electronic distribution in solid, density of states and Fermi energy, Fermi distribution function, Motion of electron in a periodic lattice: Bloch theorem, Kronig-Penney model and origin of bands in solids, Brillouin zones for simple lattices, Crystal momentum, Effective mass of electrons and holes.

**Text Books**:

1. NouredineZettili ‘*Quantum Mechanics: Concepts and Application’* Wiley; 2nd edition (23 January 2009)

2. M. A. Omar, *Elementary Solid State Physics*, Pearson publisher, 4th ed.( 2004).

Recommended Books:

1) L.I. Schiff, [JayendraBandhyopadhyay](https://www.amazon.in/s/ref%3Ddp_byline_sr_book_2?ie=UTF8&field-author=Jayendra+Bandhyopadhyay&search-alias=stripbooks) ‘*Quantum Mechanics*’ McGraw Hill Education; 4th edition

2) A. K. Ghatak, S. Lokanathan ‘*Quantum Mechanics: Theory and Applications’*, Trinity publications, 5th edition

3) P. A. M. Dirac ‘*The Principles of Quantum Mechanics*’, Oxford University Press.

4) N.W. Ashcroft, N.D. Mermin , ‘*Solid State Physics’*, Harcourt Asia, 2001.

5) Charles Kittel, ‘*Introduction to Solid State Physics’* Wiley Eastern Limited, 7th ed.

6) H.V. Keer, ‘*Principles of the Solid State*’ Wiley Eastern Limited, 1994.

7) J. P. Srivastava, ‘*Elements of Solid State Physics’,* Prentice Hall of India, 2006.

Web source:

1. Prof. AjoyGhatak, NPTEL-IIT Delhi, *Basic quantum mechanics*,

URL: <http://nptel.ac.in/courses/115102023/>,

2. Dr. S.LakshmiBala, NPTEL-IIT Madras, *Quantum mechanics-1’*, <http://nptel.ac.in/courses/115106066/>

3. Prof. G. Rangarajan, IIT-Madras-NPTEL, *Condensed matter physics*, 2013, <https://nptel.ac.in/courses/115106061/>

**Course outcomes:** At the end of the course, the student will be able to

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| CO 1 | Students will able to understand the differences between classical and quantum mechanics and importance of evolution of Quantum mechanics. |
| CO 2 | Students will know the wave formulation in quantum mechanics and understand the wave nature of particles.  |
| CO 3 | Students will able to understand the Schrodinger wave equation and its application in solving problems like particle in a box, steps, barriers, well, bound states, delta function potential, and liner harmonic oscillator. |
| CO 4 | learn crystal Structures and how to determination of crystal structure. Student also learns different diffraction techniques used to identify the crystal structure of the matter. |
| CO 5 | learn about different defects present in the crystal and how to calculate the defect density. |
| CO 6 | learn Band theory of electrons i.e., motion of electron in a periodic lattice. |

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (%) | 10% | 30% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PYM202** | **Semiconductor Physics**  | **PCC** | **3-1-0** | **4** |

Course Objectives: The main objective of this course is to give fundamental concepts of Semiconductor Physics to the engineering students and discus working and applications of basic devices, including p-n junctions, BJTs and FETs.

**Unit 1: Semiconductors**: Energy Band and Charge Carriers: Energy bands in semiconductors, Types of semiconductors, Charge carriers, Intrinsic and extrinsic materials. Carrier concentration: Fermi Level, Electron and hole concentration equilibrium, Temperature dependence of carrier concentration, Compensation and charge neutrality. Conductivity and mobility, Effect of temperature, Doping and high electric field.

**Unit 2: Optical Excitation in Semiconductor**: Optical absorption, carrier generation, Carrier life time, diffusion length and photo conductivity, Direct and indirect recombination and trapping, Photoconductive devices. Diffusion of carriers, Einstein relation, Continuity equation, Carrier injection, Diffusion length. Haynes-Shockley experiment.

**Unit 3: Junctions:** p-n junction and contact potential, Fermi levels, Space charge, Reverse and Forward bias, Zener and Avalanche breakdown. Capacitance of p-n junction, Schottky barriers; Schottky barrier height, C-V characteristics, current flow across Schottky barrier: thermionic emission, Rectifying contact and Ohmic contact.

**Unit 4: Field Effect Transistors:** JEFT amplifying and switching, Pinch off and saturation, Gate control, I-V characteristics. MOSFET, Operation, MOS capacitor, Debye screening length, Effect of real surfaces; Work function difference, Interface charge, Threshold voltage and its control, MOS C-V analysis and time dependent capacitance. Output and transfer characteristics of MOSFET.

**Unit 5: Bipolar Junction Transistors (BJT):** Fundamentals of BJT operation. Minority carrier distribution, Solution of diffusion equation in base region, Terminal current, Current transfer ratio, Ebers-Moll equations, Charge control analysis. BJT switching: Cut off, Saturation, Switching cycle.

**Unit 6: Photonics: LED:** Radiative transition, Emission spectra, Luminous efficiency and LED materials, Solar cell and photodetectors: Ideal conversion efficiency, Fill factor, Equivalent circuit, Voc, Isc and Load resistance, Spectral response. Reverse saturation current in photodetector.

Course learning outcomes: Students will have achieved the ability to:

1. explain the basic properties of semiconductors including the band gap, charge carrier concentration, doping and charge carrier injection/excitation.

2. explain the working, design considerations and applications of various semiconducting devices including p-n junctions, BJTs and FETs.

3. describe the working and design considerations for the various photonic devices like photodetectors, solar-cells and LEDs

Recommended Books

1. Streetman, B. and Banerjee, S., Solid State Electronics, Prentice Hall India, (2006).

2. Sze, S.M., Physics of Semiconductor Devices, John Wiley, (1981)

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (%) | 10% | 30% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PYM301** | **Integrated Solid State Devices** | **PCC** | **3-1-0** | **4** |

Course Objectives: 1. The main objective of this course is to inculcate the concepts of VLSI technology to the students and discus fabrication of basic devices.

2. To impart knowledge about the miniaturization of Electronic Systems.

3. To introduce the fundamental concepts relevant to VLSI fabrication.

4. To enable the students to understand the various VLSI fabrication techniques

**UNIT-1:** (10 Hours)

Semiconductor Fundamentals – Poisson and continuity equations – Recombination (direct, Auger, trap-assisted) – Equilibrium carrier concentrations (electron statistics, density of states, effective mass, bandgap narrowing) – Diffusion mechanisms; diffusion reactor; diffusion profile; diffusion kinetics; parameters affecting diffusion profile; Dopants and their behavior, choice of dopants; Ion Implantation- reactor design, impurity distribution profile, properties of ion implantation, low energy and high energy ion implantation;

**UNIT-2:** (10 Hours)

**PN junctions :** Contact potential, Electrical Field, Potential and Charge distribution at the junction, Biasing and Energy band diagrams, Ideal diode equation. Metal Semiconductor contacts, Electron affinity and work function, Ohmic and Rectifying Contacts, current voltage characteristics. Bipolar junction transistor, current components, Transistor action, Base width modulation

**UNIT-3:** (10 Hours)

Ideal MOS capacitor, band diagrams at equilibrium, accumulation, depletion and inversion,threshold voltage, body effect, MOSFET-structure, types, Drain current equation (derive)-linear and saturation region, Drain characteristics, transfer characteristics.MOSFET scaling – need for scaling, constant voltage scaling and constant field scaling.

**UNIT-4:** (10 Hours)

Sub threshold conduction in MOS. Short channel effects- Channel length modulation, Drain Induced Barrier Lowering, Velocity Saturation, Threshold Voltage Variations and Hot Carrier Effects. Non-Planar MOSFETs: Fin FET –Structure, operation and advantages. CMOS Testing, Need for testing, Test Principles, Design Strategies for test, Chip level Test Techniques, System-level Test Techniques, Layout Design for improved Testability

**UNIT-5:** (10 Hours)

VLSI CIRCUIT DESIGN PROCESSES: VLSI Design Flow, MOS Layers, Stick Diagrams, Design Rules and Layout, 2 \_m CMOS Design rules for wires, Contacts and Transistors Layout Diagrams for NMOS and CMOS Inverters and Gates, Scaling of MOS circuits, Limitations of Scaling. Hardware description Language (HDL) Lexical Conventions, Ports and Modules, Gate Level Modeling, Operators, Data Flow Modeling, Behavioral level Modeling, Testbench

**UNIT-6:** (10 Hours)

Advanced Device Technology – SOI – SiGe, strained Si – Alternative oxide/gate materials – Alternative geometries (raised source/drain, dual gate, vertical, FinFET) – Tunnel FETs – Memory Devices (DRAM, Flash). Prototype fabrication of Diodes, npn BJT, pnp BJT, MOSFETs (Enhancement and depletion mode), n-MOS, p-MOS, CMOS, Resistors and Capacitors. Isolation techniques in Diodes, BJT and MOSFETs (Enhancement and depletion mode).

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Identify the various design limits material used for fabrication.

CO2: Describe the Performance of technology scaling.

CO3: Understand the complexities involved in the integrated circuits.

CO4: Apply principles to Identify and Analyze the various steps for the fabrication of various components

 CO5:Assess the various reliability issues in VLSI technology

**Books and References**

1. VLSI Technology by S.M. Sze, TMH.

2. VLSI Fabrication Principles by S.K. Gandhi, John Willey& Sons.

3. Micromachined transducer by G.T.A. Kovacs, McGraw Hill.

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| **Course Code** | **Course Name** | **Course Category** | **L-T-P** | **Credits** |
| **20PYM302** | **Microelectronic devices – Fabrication techniques** | **PCC** | **4-0-0** | **4** |

**Objectives of the course:** This is a comprehensive course encompassing the basics of micro and nano electronic devices starting from wafer level, covering various stages of the process, leading to final packaging of the device. Students of ECE and EEE would have studied about semiconductor devices, VLSI etc., in their curriculam. However, the methodology used in realization of these devices is lacking. This is oriented towards practical aspects of the technology.

Course will be useful to students of ECE, EEE, MME

**UNIT I**: Growth of Silicon crystals - Difference between electronic grade and terestrial grade wafers- Oxidation–oxidation kinetics - Epitaxial growth - compound semiconductors – Chemical mechanical polishing - wafer level characterization – Rapid Thermal Processing (10 hours)

**UNIT II**: Need for Vacuum in microelectronic laboratory – production of vacuum – Rotary, Diffusion and Turbo molecular pumps, cryo sorption pumps –Measurement of low pressures – manometers – pirani and penning gauges – fabrication of vacuum system and components – Leak detection techniques (10 hours)

**UNIT III**: **Thin film techniques** –Electro and Electroless plating – Chemical vapor deposition – Thermal and electron beam evaporation – sputtering, DC, RF and magnetron sputtering – Ion beam techniqeus – Molecular beam epitaxy Thickness measurement – Growth and structure of thin films – Electron microscopy and XPS techniques for characterization (10 hours)

**UNIT IV**:– **Photo resists (positive and negative)** – hydrophilic and hydrophobic surfaces - spin coating – Optical and ebeam lithography – wet etching – isotropic and anisotropic etching – ion beam etching – Reactive ion beam etching –Ion milling - Radiation damage (10 hours)

**UNIT V**: **MEMS devices** – Micromachining - Device isolation – contacts – yield production - packaging – polymer and ceramic packaging - wire bonding –soldering – Vacuum/hermetic sealing, Anodic Bonding and Eutectic bonding, Dicing, die-attach, Perylene coating, clean room practices – maintenance –– particle control (10 hours)

**SEMINAR/PROJECT**– Each student is expected to make a presentation/submit a project report on the topic relevant to the course (10 hours)

**Text books:**

***Science and Engineering of Microelectronic Fabrication*** – Stephen A Campbell – Oxford University Press (2001)

**Fundamentals of Microsystems packaging**, Rao Tummala – McGraw Hill (2001)

***Materials Science of Thin films*** – Milton Ohring (Academic Press)

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| **Course nature** | **Theory** |
| Assessment Tool | Monthly tests | Seminar/Project | End Semester Test | Total |
| Weightage  | 30% | 10% | 60% | 100% |

**Course Outcomes:**Atthe end ofthecourse,studentwillbe ableto:

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| CO1 | Appreciate the processes involved in the fabrication of microelectronic devices |
| CO2 | Understand the interdisciplinary approach in the processes |
| CO3 | Gain knowledge about the equipment used in a microelectronic device Fab |
| CO4 | Gain confidence to work in a foundry of microelectronic devices |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PYM302** | **Materials Characterization techniques** | **PCC** | **3-1-0** | **4** |

**Course Objective:** To familiarize students with Spectroscopic, Electrical, Thermal and Magnetic characterization techniques and interpretation of results including standards etc.

1. The course explains characterization of electrical measurements like hall measurement, impedance, advanced equipment like EBIC
2. The course explains the principles of thermal and magnetic measurements like DTA, TGA, DSC, VSM, SQUID etc.
3. Experimental techniques involving diffraction methods like XRD, neutron to study the crystal structure of various samples are explained.
4. Experimental methods used to optically image the topography of a given sample are studied.
5. Experimental methods used to study the surface morphology of the sample by probing the surface currents are studied
6. Experimental setups that are used to identify the chemical state of atom/molecules are studied.

**Unit-I: Electrical Characterization Techniques (10 Hours)**

Measurement of resistivity by 4-prob method, Hall measurement, impedance measurements, Sebecek coefficient measurements, Basics of Nano indentation techniques.

**Unit-II: Thermal and Magnetic Characterization (10 Hours)**

Thermal analysis, Principle, Working and application of DTA, TGA, and DSC. Vibrating Sample Magnetometer (VSM), SQUID magnetometer.

**Unit-III: Diffraction Techniques (10 Hours)**

Properties of x-rays, the directions of diffracted beams, Atomic scattering factor, Crystal structure factor, Debye-Scherrer method, crystal size, Electron and Neutron diffraction.

**Unit-IV: Microscopic Techniques (10 Hours)**

Optical Microscopes, Light Microscopy, Electron Microscope, Scanning Electron Microscopy (SEM), Transmission Electron Microscope (TEM), Scanning Transmission Electron Microscopy (STEM).

**Unit-V: Probe Microscopic Techniques (10 Hours)**

Scanning Probe Microscope (SPM), Scanning Tunneling Microscope (STM), Atomic Force Microscope (AFM), Scanning Near Field Optical Microscope (SNOM),Magnetic Force Microscope (MFM).

**Unit-VI: Elemental and Advanced Surface analysis Techniques (10 Hours)**

Electron probe microanalysis (EPMA). Energy Dispersive X-ray analysis (EDAX), XPS, ELEM, AES, LEEM, DLS, PSA and Zeta potential, BET: pore size and distribution, Mossbauer Spectroscopic techniques, Electron spin resonance, Nuclear magnetic resonance

**Textbooks:**

1. T.Pradeep ‘*Nano: The Essentials -Understanding Nano Scinece and Nanotechnology*’, Tata Mc.Graw Hill

2. Charles. P. Poole Jr and Frank J. Owens ‘*Introduction to Nano Technology’*,

3. Z.L. Wang ‘*Characterization of nanostructured materials*’

4. C.Suryanarayana ‘*A practical approach to X-Ray diffraction analysis*’

5. J.I. Goldstein ‘*Scanning electron microscopy and x-ray microanalysis*’

**Reference Books:**

1. Sulabha K. Kulkarni ‘*Nanotechnology: Principles and Practices*’ Capital Publishing Comany.

2. JHD Eland ‘*Photoelectron spectroscopy*’, Butterworth & Co. publishers, 2nd education.

3. H.S. Nalwa ‘*Encyclopedia of Nanotechnology*’

**4.** C. Richard Brundle and Charles A. Evans, Jr ‘*Encyclopedia of materials Characterization’*.

**Outcome of the study:** At the end of the course, the student will be able to

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| CO 1 | Gain knowledge over methods which are used to measure the electrical properties like mobility, carrier concentration, band gap etc.  |
| CO 2 | Gain knowledge over methods involving thermal and magnetic measurement. |
| CO 3 | Gain knowledge over various diffraction techniques and various techniques used to measure the crystal structure and lattice constant |
| CO 4 | Gain knowledge over different microscopic techniques to image the topography of very minute structures. |
| CO 5 | Gain knowledge over techniques that gives information of surface morphology by probing |
| CO 6 | Gain knowledge over techniques that gives information of oxidation states of various combinations in molecules. |

***Open electives***

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PYM303** | **Elementary Solid State Physics** | **PEC** | **3-0-0** | **3** |

**Course Learning Objectives:**

The course is aimed at equipping the undergraduate Engineering and Physics students with the basic understanding of solid state physic.

1. This unit provides knowledge of Crystal Structure, determination of crystal structure and diffraction techniques used to identify the crystal structure of the matter.

2. This unit gives an introduction to electron theory of solids and motion of electron in a periodic lattice. This Unit also aims at electrical properties of matter.

3. This Unit explains theory and properties of Semiconductor materials with practical applications.

4. This Unit explains the concept of Dielectrics. Dielectric in an alternating field, the complex dielectric function, dielectric constant and dielectric loss, etc., has been discussed. Various loss mechanisms have been explained.

5. This Unit explains the theory of Diamagnetism, Paramagnetism and Ferromagnetism. This unit also explains applications of ferromagnetic materials.

6. This Unit explains the theory of Superconductivity.

**UNIT I: Crystal Structure and Crystal defects: (10 Hours)**

Crystal lattice, Unit cell, Bravais lattices, X-ray diffraction, Bragg’s law, Reciprocal lattice, Crystal structures, Atomic scattering factor, Geometrical structure factor, Neutron diffraction, Electron diffraction, Crystal structure determination by Powder crystal methods. Defect classification; Defect equilibrium; Point defects in metallic, ionic and covalent crystals; Overview of grain boundaries, inter-phase boundaries, stacking faults; Volume defects; Defects in non-crystalline materials.

**UNIT II: Electron theory of solids (10 Hours)**

Failure of free electron theory, Sommerfield modification, Particle in a box, Fermi Dirac statistics and electronic distribution in solid, density of states and Fermi energy, Fermi distribution function, Motion of electron in a periodic lattice: Bloch theorem, Kronig-Penney model and origin of bands in solids, Brillouin zones for simple lattices, Crystal momentum, Effective mass of electrons and holes.

**UNIT III: Physics of Semiconductors (10 Hours)**

Intrinsic and Extrinsic Semiconductor, Carrier concentration in intrinsic and extrinsic semiconductor, Fermi levels, Recombination process, Rectifier equation, Continuity equation, I-V Characteristics of p-n junction, Hall effect, Application of Hall Effect.

**Unit IV: Dielectrics (10 Hours)**

Static dielectric constant of solids, dielectric polarization, polarizability and dielectric constant, various contributions to the Polarizability. The local electric field – Clausius Mossotti relation. Dielectric response of an ionic crystal – difference between static and high frequency dielectric constants. Dielectric in an alternating field, the complex dielectric function, dielectric constantand dielectric loss, Debye’s equations, dielectric dispersion, electronic Polarizability and optical absorption, Ionic polarization and infrared absorption

**Unit V: Magnetism (10 Hours)**

Laugeuin’s theory of Diamagnetism. Quantum theory of paramagnetism, the rare-earth ions, iron group ions; quenching of orbital angular momentum. Ferromagnetism – characteristic behavior of ferromagnetic materials, spontaneous magnetization, Curie-Weiss law and hysteresis, interpretation in terms of the exchange integral, temperature dependence of spontaneous magnetization. Saturation magnetization at absolute zero. Ferromagnetic domains, anisotropy energy, transition between domains .Origin of domains, coercive force and hysteresis, concept of magnons.

**UNIT VI: Superconductivity (10 Hours)**

Type I and Type II superconductors, Meissner effect, London-Equations, Thermodynamics of Superconductors, BCS Theory, Quantum tunnelling, Josephson effect, High temperature superconductivity.

**Text Books**:

1. M. A. Omar, *Elementary Solid State Physics*, Pearson publisher, 4th ed.( 2004).

Reference Books:

1. N.W. Ashcroft, N.D. Mermin , ‘*Solid State Physics’*, Harcourt Asia, 2001.

2. Charles Kittel, ‘*Introduction to Solid State Physics’* Wiley Eastern Limited, 7th ed.

3. H.V. Keer, ‘*Principles of the Solid State*’ Wiley Eastern Limited, 1994.

4. J. P. Srivastava, ‘*Elements of Solid State Physics’,* Prentice Hall of India, 2006.

Web-source:

1. Prof. G. Rangarajan, IIT-Madras-NPTEL, *Condensed matter physics*, 2013, <https://nptel.ac.in/courses/115106061/>

**Course outcomes:** At the end of the course, the student will be able to

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| CO 1 | learn crystal Structures and how to determination of crystal structure. Student also learns different diffraction techniques used to identify the crystal structure of the matter. |
| CO 2 | learn Band theory of electrons i.e., motion of electron in a periodic lattice.  |
| CO 3 | learn the properties of Semiconductor materials and application of semiconductors |
| CO 4 | Understand the theory of dielectric polarization, dielectric constant and various contributions to the Polarizability. Student also learn optical absorption, Ionic polarization and infrared absorption |
| CO 5 | Understand the theory of Diamagnetism, Paramagnetism and Ferromagnetism. Students also learn the applications of ferromagnetic materials.  |
| CO 6 | Understand the theory of Superconductivity and applications. |

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (%) | 10% | 30% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PYM304** | **Electrodynamics** | **PEC** | **3-0-0** | **3** |

**Course learning objectives**

1. To impart knowledge about Faraday’s law, Maxwell’s equations and boundary conditions to the students.
2. To make the students aware about the conservation laws valid in electrodynamics. Also to help them measure the charge on a surface and find the energy crossing through a point in Electromagnetic field.
3. To make the students knowledgeable about the Electromagnetic wave equation, its propagation in free space, boundary conditions that they obey. Similarly, to make the students knowledgeable about the wave propagation in linear media and boundary conditions.
4. To make the students understand the propagation of EM waves in rectangular cross-section wave guides and to make them follow about transmission lines.
5. To make the students understand the concept of potential and field due to a point charge, dipole and continuous distribution of charges.
6. To make the students learn about radiation from electric and magnetic dipole, point charges and radiation reaction.

**UNIT-1: Electrodynamics (10 Hours)**

Electromotive Force: Ohm’s Law, Electromotive Force, Motional emf, Electromagnetic induction: Faraday’s Law, The induced Electric Field, Inductance, Energy in Magnetic Fields, Maxwell's Equations: Electrodynamics before Maxwell’s, How Maxwell fixed Ampere’s Law, Maxwell Equations, Magnetic Charge, Maxwell Equations and Matter, Boundary conditions

**UNIT-II: Conservation Laws (10 Hours)**

Charge and Energy: Continuity Equation, Pointing Theorem, Momentum: Newton's third Law in Electrodynamics, Maxwell's Stress Tensor, Conservation of Momentum, Angular Momentum

**UNIT-III: Electromagnetic Waves (10 Hours)**

Waves in One Dimension: The Wave Equation, Sinusoidal Equation Wave, Boundary Conditions: Reflection and Transmission, Polarization, Electromagnetic Wave in Vacuum: The Wave Equation for E and B, Monochromatic Plane Waves, Energy and momentum in Electromagnetic Waves, Electromagnetic Waves in Matter: Propagation in Linear Media, Reflection and Transmission at Normal Incidence, Reflection and Transition’s at Oblique Incidence

**UNIT-IV: Waves Guides (6 Hours)**

Wave Guides, TE Waves in Rectangular Wave Guides, the Coaxial Transmission Lines

**UNIT-V: Potentials and Fields (10 Hours)**

The potential Formulation, Scalar and Vector potentials, Guage Transformations, Coulomb Gauge and Lorentz -Gauge, Cotinuous Distributions: Retarded Potentials, Jefimenko's Equations, Point Charges: Lienard-Wiechert Potentials, The Fields of a Moving Point Charge

**UNIT-VI: Radiation (10 Hours)**

Dipole Radiation: What is Radiation, Electric Dipole radiation, Magnetic Dipole Radiation, Radiation from an Arbitrary Source, Point Charges: Power Radiated by a Point Charge, Radiation Reaction The Physical Basis of the Radiation Reaction

**COURSE OUTCOMES**

1. The student will be able to calculate the motional EMF, Maxwell’s equations and its application. The student will also be able to understand the Boundary conditions and its applications to Maxwell’s equations
2. The student should be able to measure the charge on a surface, calculate the energy stored in a Electromagnetic field and intensity of energy crossing a point in EM field. He would also know about the momentum conservation laws.
3. The student would be able to understand the propagation of EM waves in free space and in linear dielectric media. He would also be able to understand the laws of reflection and transmission at normal and oblique incidence from a boundary.
4. The student will be able to find out the modes propagating in rectangular wave guides. He will be able to understand about the transmission lines.
5. The student will be able to calculate the scalar and vector potential due to a point charge, continuous distribution of charges, moving point charge. He would also be able to calculate the field due to a moving point charge.
6. The student would be able to calculate the theoretical equation due to a dipole radiation, radiation from any arbitrary source and physical basis of radiation.

Reference Books

1. Introduction toelectrodynamics, J. Griffiths (Prentice Hall).
2. Introduction toElectrodynamics, A, Z. Capri and P. V. Panat(Narosa)
3. Classical Electricity andMagnetism, W.K.H. Panofsky and M. Phillips (Addison-Wesley).
4. ClassicalElectrodynamics, J. D. Jackson (John Wiley).

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (%) | 10% | 30% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PYM305** | **Introduction to Fiber Optics** | **PEC** | **3-0-0** | **3** |

**Course Learning Objectives:**

1. The course is aimed at equipping the undergraduate Engineering and Physics students with the basic understanding of optical fibers and optical fiber communication. The course provides knowledge of optical fiber waveguide at fundamental level, essentials of an optical fiber communication system and understanding of various components of an optical fiber telecommunication system.

2. This course gives an introduction of optical fibers, their applications in our lives and some interesting facts associated with optical fibers. This unit explains the need for optical telecommunication and outlines the advantages of a fiber optic communication system.

3. This course explains various mechanisms of optical signal attenuation in an optical fiber and Pulse broadening through intermodal dispersion in an optical fiber is explained. Electromagnetic wave analysis of light propagation in an infinitely extended dielectric medium has been carried out. Electric and magnetic field associated with a light wave is explained.

4. Concept of TE/TM and EH/HE modes of an optical fiber has been explained. Scalar wave equation of LP modes of the fiber is formed and is implementation in a step-index fiber has been discussed. Various loss mechanisms at the joint of two fibers have been explained.

5. Total dispersion in a single mode fiber and waveguide dispersion in various types of graded index fibers have been discussed. In this lecture we introduce components and devices based on optical fibers. Working of directional coupler and its applications as a switch and as a power splitter have been explained

6. Optical Sources and Detectors were explained

**Course Content:**

**Unit – I: Introduction to fibers (10 hours)**

Introduction, need for optical communication, salient features of optical fibers, ray theory of light guidance, numerical aperture, modes of a fiber, single and multimode fibers, step-index and graded-index fibers.

**Unit – II: Fiber fabrication techniques (10 hours)**

Fiber fabrication techniques, Transmission characteristics of optical fibers, attenuation, pulse broadening mechanism, intermodal dispersion, bit rate - length product, material dispersion

**Unit – II: Electromagnetic analysis (10 hours)**

Electromagnetic wave analysis of light propagation in an infinitely extended medium, em waves in dielectrics, boundary conditions Electromagnetic analysis of planar optical waveguides, TE and TM modes, planar mirror waveguide, dielectric symmetric step-index, planar waveguide, symmetric and anti-symmetric modes, b-V curves,

**Unit – III: Waveguides (10 hours)**

Power associated with modes of dielectric symmetric planar waveguide, asymmetric planar waveguide, single polarization single mode waveguide, excitation of guided modes by prism coupling technique, radiation modes, optical fiber waveguide, EH and HE modes

**Unit – IV: Optical fiber modes (10 hours)**

Optical fiber modes, field patterns, fractional power in the core, single mode fiber, cut-off wavelength, mode field diameter, bend loss, splice loss, waveguide dispersion, group delay, Total chromatic dispersion, dispersion in graded-index and multilayer fibers, optical fiber components and devices, directional coupler, power splitter, WDM coupler, polarization controllers, fiber Bragg gratings

**Unit – VI: Optical communication (10 hours)**

Detectors for optical communication, p-i-n Photodetector, APD, System design, dispersion and attenuation limited systems, BER, power budgeting of fiber link, recent advances

**Learning resources**

**Text book:**

1. A. K. Ghatak and K.Thyagarajan, ‘Introduction to Fiber Optics’, Cambridge University Press

**Reference Books:**

1. B. E. A. Saleh and M. C. Teich, ‘*Fundamentals of Photonics*,’ Wiley-Interscience
2. G.P. Agrawal, ‘*Optical Fiber Communication System*’ Wiley-Interscience
3. G. Keiser, ‘*Optical Fiber Communications*’, McGraw Hill
4. A. Snyder and J Love, ‘*Optical Waveguide Theory*’, Chapmann and Hall
5. J. M. Senior, ‘*Optical Fiber Communications*,’ Pearson Prentice Hall

**Web resources:**Dr. Vipul Rastogi*,*Indian Institute of Technology, Roorkee *, NPTL video lectures*, URL: [https://nptel.ac.in/courses/115107095/33#](https://nptel.ac.in/courses/115107095/33)

**Course outcomes:** At the end of the course, the student will be able to

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| CO 1 | ‘Know about optical fibers, their applications in telecommunication and outlines the advantages of a fiber optic communication system.  |
| CO 2 | Gain knowledge about various mechanisms of optical signal attenuation in an optical fiber and Pulse broadening through intermodal dispersion in an optical fiber. Understand the electromagnetic wave analysis of light propagation in an infinitely extended dielectric medium.  |
| CO 3 | Gain knowledge about Concept of TE/TM and EH/HE modes of an optical fiber. Scalar wave equation of LP modes of the fiber is formed and is implementation in a step-index fiber. |
| CO 4 | Know about various loss mechanisms at the joint of two fibers  |
| CO 5 | Understand total dispersion in a single mode fiber and waveguide dispersion in various types of graded index fibers. Gain knowledge about working of directional coupler and its applications as a switch and as a power splitter. |
| CO 6 | Optical Sources and Detectors were explained |

**For Theory courses only:**

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (%) | 10% | 30% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PYM306** | **Nano Science and Technology** | **PEC** | **3-0-0** | **3** |

**Course Learning Objectives:**

1. The course is aimed at equipping the undergraduate Engineering and Physics students the basic concepts of nano science and its application in the real world

2. It explains the various classification of nanostructures and the effect of size on certain properties

3. This course explains the synthesis of various nano particles by using various methods

4. Synthesis methods of 1D nanostructures are explained.

5. Physical properties like electrical, optical and magnetic properties are explained.

6. Applications of nano materials in real life are discussed.

**Unit-I: Introduction to nanoscience (10 hours)**

History and importance of nanotechnology, length and time scale in structures, difference between bulk and nanoscale materials and their significance, properties at nanoscale, optical, electronic, magnetic and chemical. surface to volume ration, design of 4 vectors, reduction of dimensionality.

**Unit-II: Nanostructures and dimensions (10 hours)**

Classification of nanostructures: zero, one, two and three dimensional nanostructures, size dependency in nanostructures, quantum size effects in nanostructures, quantum dots, nanowells and nanowires.

**Unit-III: Synthesis of nanomaterials and 0D nanostructures (10 hours)**

Synthesis of metallic, semiconductor and oxide nano-particles. Solid state phase segregation, Fundamentals of heterogeneous nucleation, nano-particles through Heterogeneous Nucleation, Synthesis inside micelles or using microemulsions, Spray pyrolysis, Template-based synthesis, Epitaxial Core-Shell nano-particles.

**Unit IV: Synthesis of 1D nanostructures (10 hours)**

Introduction Spontaneous Growth, Fundamentals of evaporation, Evaporation and Dissolution condensation growth, Vapor (or solution)-liquid-solid, (VLS or SLS) growth, Electrochemical deposition, Template filling, Template-Based Synthesis

**Unit V: Physical Properties of Nanomaterials (10 hours)**

Melting points and lattice constants, Mechanical properties, Optical properties, Electrical conductivity, Surface scattering, Change of electronic structure, Effect of microstructure, Ferroelectrics and dielectrics, Superparamagnetism

**Unit-VI: Applications of nanomaterials (10 hours)**

Nanotechnology in energy systems, textiles, food and health care, agriculture, automotive industry, solar technology, pharmaceutical and drugs, nanoelectronics, nanosensors and devices.

**Course outcomes:** At the end of the course, the student will be able to

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| CO 1 | Gain knowledge over possible extent to which the field of Nano technology is used  |
| CO 2 | Gain knowledge over classification of Nano materials basing on dimensions |
| CO 3 | Gain knowledge about various synthesis methods of nano particles of semiconductors, oxides etc. |
| CO 4 | Gain knowledge about various synthesis methods of nano particles , rods by advanced techniques likes VLS etc. |
| CO 5 | To understand various physical properties of like optical, mechanical, electrical and various effects involving nano scale |
| CO 6 | Gain knowledge over applications of nano materials in the fields of agriculture, electronics, medicine etc. |

**Text books :**

1. P. Charles, Poole Jr & J. Frank, Owens, ‘*Introduction to Nano Technology’*. Wiley India Pvt. Ltd.

**Reference books**

1. WR Fahrner, ‘*Nano Technology and Nano Electronics – Materials, devices and measurement Techniques’*– Springer

2. M.Balakrishna Rao, K.Krishna Reddy, ‘*Encyclopedia of Nano Technology’*, Vol I to X Campus books.

3. Lynn E. Foster, Prentice Hall, ‘*Nano Technology - Science, innovation and opportunity’* , Pearson education.

4. Hari Nalwa, *Hand book of Nano structured materials Vol I &V,*Academic Press, 1st edition, 18th October 1999

# 5. H.S.Nalwa, ‘*Encyclopedia of Nano Technology* (Volumes 11-25)’, American Scientific Publishers, March 2011

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (%) | 10% | 30% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PYM307** | **Optoelectronics** | **PEC** | **3-0-0** | **3** |

**Course Learning Objectives:**

1. This unit emphasis the importance of Quantum mechanics in semiconductors.
2. This unit gives an introduction to electron theory of solids and motion of electron in a periodic lattice. This Unit also aims at electrical properties of matter.
3. This unit emphasis the types of semiconductors and construction and working of semiconductors in terms of carrier statistics.
4. This unit enlighten about the interaction of light with different types of semiconductor materials. This unit also focuses on the optoelectronic properties of semiconductors.
5. These unit emphasis measurement techniques employed to study the semiconductor parameters.
6. This unit focuses on the design and fabrication of various types of semiconducting materials.

**Course Content:**

**Module 1: Wave nature of particles and the Schrodinger equation (10 Hours)**

Introduction to Quantum mechanics, Wave nature of Particles, Time-dependent and time independent Schrodinger equation for wave function, Born interpretation, probability current, Expectation values, Free-particle wave function and wave-packets, Uncertainty principle. Solution of stationary-state, Schrodinger equation for one dimensional problems (particle in a box), linear harmonic oscillator.

**Module 2: Electronic materials (10 Hours)**

Free electron theory, Density of states and energy band diagrams, Kronig-Penny model (to introduce origin of band gap), Energy bands in solids, E-k diagram, Direct and indirect band gaps, Types of electronic materials: metals, semiconductors, and insulators.

**Module 3: Semiconductors (10 Hours)**

Density of states, Occupation probability, Fermi level, Effective mass, Intrinsic and extrinsic semiconductors, Dependence of Fermi level on carrier-concentration and temperature (equilibrium carrier statistics), Carrier generation and recombination, Carrier transport: diffusion and drift, p-n junction.

**Module 4: Light-semiconductor interaction (10 Hours)**

Semiconductor materials of interest for optoelectronic devices, Optical transitions in bulk semiconductors: absorption, spontaneous emission, and stimulated, Emission; Optical loss and gain; Photovoltaic effect, Exciton, Drude model.

**Module 5: Measurements (10 Hours)**

Four-point probe and van der Pauw measurements for carrier density, resistivity, and Hall mobility; Hot-point probe measurement, capacitance-voltage measurements, parameter extraction from diode I-V characteristics, DLTS, band gap by UV-Vis spectroscopy, absorption/transmission.

**Module 6: Engineered semiconductor materials (10 Hours)**

Density of states in 2D, 1D and 0D (qualitatively). Practical examples of low-dimensional systems such as quantum wells, wires, and dots: design, fabrication, and characterization techniques.

**Learning resources:**

**Text Book**

1. J. Singh, ‘*Semiconductor Optoelectronics: Physics and Technology’*, McGraw-Hill Inc. (1995).

**References:**

1. B. E. A. Saleh and M. C. Teich, ‘*Fundamentals of Photonics’*, John Wiley & Sons, Inc., (2007).

2. S. M. Sze, ‘*Semiconductor Devices: Physics and Technology’*, Wiley (2008).

3. A. Yariv and P. Yeh, *Photonics: Optical Electronics in Modern Communications*, Oxford University Press, New York (2007).

4. P. Bhattacharya, *Semiconductor Optoelectronic Devices*, Prentice Hall of India (1997).

Online course:

1. M R Shenoy NPTEL -IITD, “Semiconductor Optoelectronics”,

URL: <https://nptel.ac.in/courses/115102026/>

2. Monica Katiyar and Deepak Guptaon NPTEL- IITD "Optoelectronic Materials and Devices" URL: <https://nptel.ac.in/syllabus/113104012/>

**Course outcomes:** At the end of the course, the student will be able to

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| CO 1 | Student will able to understand the importance of Quantum mechanics in semiconductors |
| CO 2 | Student will able to understand the electron theory of solids in terms of motion of electron in a periodic lattice and electrical properties of matter. |
| CO 3 | Student will able to understand the different types of semiconductors and construction and working of semiconductors in terms of carrier statistics |
| CO 4 | Student will able to understand the Optical transitions in semiconductors and photovoltaic effect. |
| CO 5 | Student will able to understand the how to measure the semiconductor electronic parameters using different techniques. |
| CO 6 | Student will able to understand design and fabrication of various semiconducting material. |
| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (%) | 10% | 30% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PYM308** | **Thermodynamics– Statistical****Mechanics** |  **PEC** | **4-0-0** | **4** |

Course Learning Objectives:

1. To gain the basic knowledge about thermal equilibrium, laws involved in thermodynamics and its applications.
2. To gain the basic knowledge about thermal properties of materials.
3. To learn how to explain the micro, macrostates, phase space, quantum states, energy states &amp; energy levels, statistical interpretation of entropy and types of statistics.
4. To gain knowledge about MB statistics and its approach to explain the thermal behavior of solids.
5. To gain knowledge about types of ensembles.
6. To gain the basic knowledge about BE and FD statistics and its applications in quantum level.

**Unit-I: Introduction to Thermodynamics -1 (08 Hours)**

Concept of temperature, Absolute temperature, Zeroth law of thermodynamics and the concept of thermal equilibrium. Concepts of heat and work. Quasi-static, reversible and irreversible processes. First law of thermodynamics and its applications. Conversion of work into heat and vice versa.

**Unit-II: Introduction to Thermodynamics -1 (08 Hours)**

Heat engines. Carnot cycle. Entropy. Second law of thermodynamics (different statements). Applications of second law. Equations of state (ideal gas example). Van-der wall equation. Thermal properties of materials: heat capacity, thermal conductivity, thermal compressibility etc

**Unit-III statistical mechanics: Ensemble theory-1 (10Hours)**

Elements of ensemble theory, Microcanonical ensemble, Macroscopic and microscopic tates, Classical phase space, Statistical distribution function, Liouville’s theorem, Statistical origin of entropy. Application to the ideal gas, Gibbs paradox and Gibbs correction term, Quantum states and the phase space.

**Unit-IV: statistical mechanics: Ensemble theory-2 (10 Hours)**

Canonical ensemble, Partition function and thermodynamic variables, Energy fluctuations, Boltzmann distribution, Applications to the thermodynamics of an ideal gas, Specific heat of solids (classical and Einstein models),), Equipartition and virial theorem. Thermodynamics of interacting systems.

**Unit-V: Quantum statistics (10 Hours)**

Grand canonical ensemble, Partition function and thermodynamical variables, Density and energy fluctuations, Application to the problem of adsorption. First order and second order phase transitions, Phase equilibria Quantum statistics: microcanonical, canonical and grand canonical ensembles. Representation of density matrices in energy, coordinate and momentum bases, with suitable examples.

**Unit-VI: Advanced Quantum statistics (10Hours)**

Ideal Bose gas: Bose-Einstein statistics, Partition function, Thermodynamic behaviour, Bose-Einstein condensation in ideal Bose gas. Applications: Black body radiation, Planck’s law and its limiting cases (Rayleigh-Jeans law, Wien’s displacement law). Phonon gas. Specific heat of solids (Einstein and Debye models).Ideal Fermi gas: Fermi-Dirac statistics, Partition function,

Books:

1. Statistical Mechanics, Pathria and Beale (Academic Press).

2. Statistical Mechanics, Reif

3. Statistical and Thermal Physics, Gould &amp; Tobochnik (Princeton University Press).

4. Statistical Physics of Particles, Kardar (Cambridge University Press)

5. Statistical Mechanics, Huang (Wiley)

6. Thermodynamics and Statistical Mechanics, Greiner, Neise, Stocker, Springer, 2010.

7. Statistical Physics (Part 1), L.D. Landau and E.Lifhsitz (Elsevier)

Course outcomes: At the end of the course, the student will be able to

1. understand the concepts of thermodynamics and different thermodynamic process and able to derive planck’s law for blackbody radiation.

2. understand the thermal behavior of different materials and their properties in engineering physics student also understand the importance of probability in statistical mechanics.

3. learn the thermodynamic functions for a classical system in terms of partition function and explain gibbs paradox. discuss Einstein and debye’s theories of the heat capacity of solids.

4. understand the concept of Canonical ensemble, Partition function and thermodynamic variables, Energy fluctuations and Boltzmann distribution.

5. discuss the various classical ensembles and quantum ensembles, solve the statistical mechanics problems using ensemble theory, explain the connection between classical statistical mechanics and quantum, statistical mechanics, explain the concept of density matrix

6. acquire the knowledge on expressions for thermodynamic function of a strongly degenerate BE system and apply BE statistics to an assembly of photons and to solids.

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (%) | 10% | 30% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PYM402** | **Introduction to Nuclear and Particle Physics** |  **PEC** | **3-0-0** | **3** |

**Course Learning Objectives:**

1. To enhance the knowledge on all the basic properties of atomic nucleus concurrently and vividly, including Proton-Electron, Proton-Neutron hypothesis, Yukawa theory and Mass Spectroscopy.

2. To identify and understand the scientific methodology behind the developments of all Nuclear Models such as Liquid Drop Model and Shell Model after knowing the detailed properties of atomic nucleus.

3. To acquire the theoretical skills while studying the Fundamental Laws of Radioactivity including α- Emission, β- Decay, γ-Decay as well as Artificial Radioactivity and Radioactive Dating.

4. To purse the in-depth knowledge on both controlled and un-controlled Nuclear Reactions along with the Laws are being conserved and applying the same knowledge to understand the burning Sun.

5. To measure and percept the effects produced by radioactive elements through Particle Accelerators such as Cyclotron, Betatron and Synchrocyclotron and Particle Detectors such as Proportional and GM Counters.

6. To get the brief and immense scientific knowledgeable expose on the chart of all Elementary Particles or the building blocks of Universe through Standard Model including Quarks and it’s Symmetries.

**Course Content:**

**Unit-1: Nuclear Phenomenology (15 Hours)**

Introduction, 1) Scattering of α- particles: Rutherford’s Scattering formula and it’s experimental verification; 2) Constituents of the Nucleus: Proton-Electron hypothesis, Proton-Neutron hypothesis; 3) Terms associated with Nucleus: Isotopes, Isobars, Isotones, Mirror Nuclei..etc; 4) Basic properties of the Nucleus: Mass, Charge, Radius, Density, Spin, Magnetic dipole moment, Electric quardupole moment; 5) Binding Energy: Binding energy per nucleon, Mass defect, Packing fraction, B.E. of Deuteron;6) Nature of Nuclear Forces: Yukawa theory of Nuclear forces; 7) Mass Spectroscopy: Bainbridge and Jordan Mass Spectroscopy;

**Unit-2: Nuclear Models (10 Hours)**

1) Fermi Gas Model;2) Liquid Drop Models: Semi-empirical mass formula, Mass of the most stable Isobar, Predictions, Achievements, Failures; 3) Shell Model: Magic numbers, Order to fill nucleons into the shells, Predictions, Achievements, Failures; 4) Collective Model;

**Unit-3: Radio Activity (10 Hours)**

1) Fundamentals Laws of Radioactivity: Soddy Fajan’s Displacement law, 2) Laws of Radioactive Disintegration, Activity, Decay constants, Half-life, Mean life, 3) Laws of Successive Transformation, Radioactive Equilibrium; 4) α- Emission, Geiger-Nuttal law, Gamow theory of α-decay, β- decay, γ-decay 5) Dosimetry, Induced Radioactivity and it’s applications, Radioactive Dating: Age of the earth;

**Unit-4: Nuclear Reactions (10 Hours)**

1) Kinds of Nuclear Reactions: Elastic & In-elastic scattering, Disintegration, Photo disintegration, Radiative capture, Direct, Heavy Ion, Spallation & High energy Reactions, Spontaneous decay; 2) Conservation Laws: Energy, Momentum, Angular Momentum, Charge, Nucleons, Spin, Parity, Isotopic Spin; 3) Nuclear Reaction Kinematics: Exothermic & Endothermic, Q- Equation; 4) Compound Nucleus: Nuclear Fission, Nuclear Fusion, Helium Burning in Stars 5) Nuclear Cross Section, Partial and Differential Cross Section (qualitative);

**Unit-5: Particle Accelerators and Radiation Detectors (10 Hours)**

1) Van de Graff Accelerator: Principle, Construction, Working, Advantages and Limitations2) Magnetic Resonance Acceleratorsor Cyclotrons 3) Betatron 4) Synchrocyclotrons 5) Proportional Counter 6) Geiger-Muller Counter 7) Solid state detector: Principle, Construction, Working, Advantages and Limitations;

**Unit-6: Introduction to Particle Physics (10 Hours)**

1) Classification of Elementary Particles: Bosons & Fermions, Hadrons & Leptons, Mesons & Baryons; 2) Particle Interactions: Gravitational, Electromagnetic, Strong and Weak; 3) Quantum Numbers and Conservation Laws: Spin S, Charge Q, Parity P, Lepton Number L, Baryon Number B, Isospin I, Strangeness S, Hyper Charge Y, Gell-Mann-Nishijima Scheme, Charge Conjugation Parity C, Time Reversal symmetry T, CPT theorem; 4) Particle Symmetries: SU(2) & SU(3) and Higher symmetries; 5) Qualitative Description of Quark model;

**Reference Books:**

1) “Nuclear Physics" by **D.C. Tayal**; Himalaya Publishing House

2) “Introduction Nuclear and Particle Physics” by **V.K. Mittal, R.C. Verma, and S.C. Gupta**; PHI Learning Private Limited

3) “Concepts of Modern Physics” by **Arthur Beiser**; McGraw-Hill Publications

4) “Nuclear and Particle Physics - An Introduction” by **B.R. Martin**; Wiley Publications

5) “Introduction to Elementary Particles” by **David Griffiths**; Wiley Publications

6) “Introduction to Nuclear Physics” by **Kenneth S. Krane**; Wiley publications

7) “Introduction to Nuclear physics” by **Harald A. Enge, Robert P. Redwine**

**Course Outcomes:**  After completion of this NPP course, any disciplined Student will be able to

CO1. Answer the questions like whether Nuclear forces are Charge independent or Spin dependent and how can we measure quantities like B.E., B.E. per nucleon and Mass of the given nucleus.

CO2. Understand the facts like why some of the Nucleuses are more stable while the rest is unstable through magic and double magic numbers and also the energy order in which shells of the nucleus to be occupied by nucleons.

CO3. Balance the any kind of Nuclear Reactions after alpha emission, beta decay and gamma decay by knowing the laws behind the nuclear reactions and also measure the age of the earth by radioactive dating.

CO4. Learn the mechanisms that deploy behind both controlled and uncontrolled nuclear chain reactions through nuclear fission and fusion process like atomic bomb.

CO5. Get the detailed knowledge on Particle accelerators and Particle detectors like working principle, construction, advantages and limitations in both pictorial and theoretical sense.

CO6. Distinguish thedifferent kind elementary particles like bosons and fermions and its properties and also identifies the quantum numbers are being conserved and laws of symmetries lies among them.

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PYM403** | **Thin Film Technology** | **PEC** | **3-0-0** | **3** |

**Course Learning Objectives:**

1. The course is aimed at equipping the undergraduate Engineering and Physics students with the basic understanding of how thin films are fabricated, characterized and their applications.

2. This course gives an introduction to vacuum technology which plays a key role in the dynamics of nucleation and growth of a thin film.

3. This course explains various mechanical and chemical ways of depositing methods for thin film fabrication

4. Dynamics of nucleation and growth of a thin film during fabrication are explained.

5. Various characterization methods of the grown thin films are explained.

6. Optical and electrical Properties and applications of thin films in the field of solar cells are covered.

**Course Content**

**UNIT–I: Vacuum technology (10 Hours)**

Fundamentals of vacuum, basic definition and pressure regions of vacuum, kinetic theory of gases mean free path, vacuum pumps and systems, rotary mechanical pump, diffusion pump, turbo molecular pump, sputter ion pump, measurement of vacuum, concept of different gauges, Pirani gauge, ionization gauge and penning gauge.

**UNIT-II: Physical methods of thin film deposition (10 Hours)**

Thermal evaporation, resistive heating, flash evaporation, rf-heating, co-evaporation, sputtering plasma, sputtering variants, sputtering yield low pressure sputtering, rf-sputtering, reactive sputtering, magnetron sputtering, evaporation versus sputtering, Epitaxy (MBE), pulsar laser deposition (PLD), Atomic layer deposition (ALD), cryogenic polymer thin film foam techniques, charcoal carbon foam film techniques

**UNIT–III: Chemical methods of thin film deposition (10 Hours)**

Electro-deposition, electrolytic deposition, electro less deposition, anodic oxidation, spray pyrolysis, spin and dip coating, chemical vapor deposition (CVD), homogenous and heterogeneous process, CVD reactions, pyrolysis, hydrogen reduction, transfer reactions, CVD processes and systems, low pressure CVD.

**UNIT–IV: Growth of thin films (10 Hours)**

Introduction: nucleation and early stages of film growth, thermodynamic aspects of nucleation, capillary theory, thin film growth modes, Volmert Weber (VW) growth, Frank-van der Merwe (FM) growth, Stranski-Krastanov growth

**UNIT V: Characterization methods of thin films (10 Hours)**

Thickness measurement, electrical methods, microbalance monitors, quartz crystal monitor, mechanical method (stylus), optical interference methods, ellipsometry, interference fringes.

**UNIT–VI: Properties of thin films (10 Hours)**

Mechanical, electrical and optical properties of thin films, Application to Renewable energy technology – Thin film solar cells, Quantum well and Quantum dot solar cells, dye – sensitized solar cells.

**Text Books**:

## Milton Ohring ‘*Materials Science of Thin Films’* Academic Press, 2nd Edition

**REFERENCES**:

1. K. L. Chopra ‘*Thin Film Phenomenon’*, McGraw-Hill, 2nd Edition

**Course outcomes:** At the end of the course, the student will be able to

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| CO 1 | Gain knowledge over Vacuum technology and principle of vacuum pumps- various types of vacuum pumps and their corresponding ranges. |
| CO 2 | Gain knowledge about various physical fabrication methods of thin films like thermal evaporation, Pulsed laser deposition, Sputtering, Epitaxy etc. |
| CO 3 | Gain knowledge about various Chemical methods of fabrication like Oxidation, pyrolysis, Various methods of chemical Vapour Deposition.  |
| CO 4 | Know about growth kinetics and nucleation of thin films along with their measurement  |
| CO 5 | Characterization methods of electron microscopy, ellipsometry, and spectroscopy are covered.  |
| CO 6 | Mechanical, optical and electric Properties of thin films are covered and various applications in the field of solar cells are covered. |

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (%) | 10% | 30% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PYM404** | **Semiconductor devices and Embedded Systems** | **PEC** | **3-0-0** | **3** |

**Objective:**

This course is intended to cover basics of Semiconductor devices and Embedded Systems application in present technology.

1. The course is intended to cover different types of semiconductor devices.
2. The course is intended to cover Digital electronic logic devices.
3. The course explains about the combinational logic circuits.
4. The course explains about the Sequential logic circuits.
5. The course is intended to cover the basics of embedded system using TI MSP430G2553 Microcontroller.
6. The course is intended to cover the interface of sensors and actuators to TI MSP430G2553 Microcontroller.

**UNIT-I: Basic Semiconductor devices used in Electronics (8 Hours)**

Resister, capacitor, inductor and their different types - Diodes - Light Emitting diode (LED), Photo diode - Zener diode, Transistors, BJT, UJT, Phototransistor, FET, MOSFET, TRIAC, SCR - LCD - solar cell - LDR - Semiconductor LASER diode and its application

**UNIT-II: Digital Electronics (8 Hours)**

Analog and digital signals - Digital circuits - Binary number system - conversion of Binary to decimal - decimal to binary - logic gates - OR gate - AND gate - NOT gate - Combination of Logic gates - NAND and NOR as universal building blocks.

**UNIT-III: Combinational Digital Circuits(8 Hours)**

 Arithmetic building blocks, Basic Adders and Subtractors, BCD adders - Data processing circuits, multiplexers, de-multiplexers, encoders, decoders - TTL, CMOS digital logic families.

**UNIT-IV: Sequential Digital Circuits(8 Hours)**

 Flip - Flops, RS, clocked SR, JK, D, T, master-slave types - shift registers, ring counters-ripple counters - Design of counters - modulus of counters - timer IC 555, applications.

**UNIT-V: Introduction and fundamentals of MSP430 Launchpad (8 Hours)**

Embedded systems, How to choose a microcontroller for Embedded system application, Introduction to TI MSP430G2553 Microcontroller, TI MSP430G2553 Launch Pad: An overview, Getting started with Launchpad using Energia IDE, First Energia code: LED blinking program.

**UNIT-VI: Interfacing to Digital I/O Pins on MSP430 Launch Pad(8 Hours)**

Push Button, LED control using buttons, Interfacing Relay, DC Motor interface, PIR Motion sensor, Serial plotter in Energia IDE, Temperature monitor, 16X2 LCD interface, IoT applications.

**Text Books:**

1. Embedded Systems: with TI MSP430G2553 launchpad by Dr. Umesh Dutta, Vikas Sharma
2. Digital Principles and Applications - *A.P.Malvino&D.P.Leach*, 4/e, Tata McGraw Hill Publishing Co. Ltd.
3. Digital Integrated Electronics - *H. Taub & D. Schilling*, McGraw-Hill Book Company.

**Reference Books:**

1. Basic Electronics - B.L. Theraja - S.Chan publication, New Delhi
2. Electronic Devices and Circuits (Applied Electronics Vol. I) - *G.K. Mithal*, Khanna Publishers.
3. Principles of Electronics - *V.K. Metha*, S. Chand & Co., 1991.
4. Programmable Microcontrollers with Applications: MSP430 LaunchPad with CCS and Grace by CemUnsalan, H. Deniz Gurhan.

**Outcome of the study:** At the end of the course, the student will be able to

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| CO 1 | Learn semiconductor devices used in circuits. |
| CO 2 | Learn to understand the importance of various logic gates and binary number systems. |
| CO 3 | Learn the combinational logic circuits to design and solve the complex logic functions. |
| CO 4 | Learn the sequential logic circuits for memory storage and logic applications. |
| CO 5 | Learn the Microcontrollers used in designing embedded systems with TI MSP430G2553 Microcontroller. |
| CO 6 | Learn to interface sensors and actuators to TI MSP430G2553 Microcontroller for embedded system designing. |

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (%) | 10% | 30% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PYM405** | **Atmospheric Physics** | **PEC** | **3-0-0** | **3** |

**Objective:**

This course is intended to cover basics of Atmospheric observations, motions, waves and Modelling.

1. The course is intended to cover different types of measurements of atmospheric parameters like Temperature, Pressure, Humidity and Winds.
2. The course is intended to cover Atmospheric Radiation phenomenon.
3. The course explains about the laws of atmospheric motion and their equations.
4. The course explains about the variations of atmospheric motion in three dimensional.
5. The course is intended to cover the basics of Atmospheric boundary layer and Atmospheric waves.
6. The course is intended to cover the Numerical Modelling of the atmosphere.

**Unit-1 Atmospheric Observations** (10 Hours)

Overview and importance of the Meteorology Observations; Measurement of temperature and Humidity; Measurement of wind and pressure; measurement of precipitation; Modern Meteorological instruments; Surface Observatory Network; Radar Network; Upper air Observational Network; Satellite Observations.

**Unit-2 Radiation** (10 Hours)

Spectrum of radiation; Black body radiation; Atmospheric observation of solar radiation: Absorption; Emissivity; Reflectivity; Transmittivity; vertical profile of absorption; Absorption of solar radiation by atmosphere; Atmospheric absorption of solar radiation and emission of infrared radiation; Scattering of Solar radiation: Ralyeigh and Mie scattering.

**Unit 3: Governing Laws of Atmospheric motion**  (10Hours)

Equation in rotating coordinate system: Centripetal and coriolis acceleration; Gravity and Pressure gradient forces; Total, Local and convective gradient; Continuity equation: Eulerian Approach; Lagrangian Approach; Equations of motion and equations for horizontal flow: Equations of motion in spherical coordinates, scale analysis of the equations of motion; Thermal wind; Thermodynamic energy equation.

**Unit-4 Atmospheric motion** (10 Hours)

Circulation and vorticity; Isobaric coordinate system; vorticity and divergence equations; Absolute and potential vorticity.

**Unit-5 Atmospheric boundary layer and waves** (10 Hours)

Viscosity; expression for viscosity from kinetic energy; viscous force in the equation of motion; turbulence and diffusion; equations of mean motion in turbulence flow; Mixing length; surface and ekman layers; Secondary circulations and spin down in atmosphere &Teacup.Waves: Rossby waves; gravity waves in shallow water; orographic and sound waves; internal gravity waves; equatorial waves.

**Unit-6 Numerical Modelling of the Atmosphere** (10 Hours)

Basics; The finite difference method; partial difference equations: Modern numerical weather prediction; Data Assimilation; Spectral and finite element methods: Galerkin, Spectral and finite element method; Challenge in weather and climate forecasts.

**Text books:**

1. J.M. Wallace and P.V. Hobbs *Atmospheric Sciences: An introductory Survey,* Academic Press.
2. A. Chandrasekar, *Basics of Atmospheric Science,* PHI learning PVT. Delhi.

**Reference books:**

1. R.J. Barry and R.G. Chorley, *Atmosphere; Weather and Climate,* Methuen Publication.
2. Aguado, E. and J.E. Burt (2007): Understanding Weather and Climate, 4th ed., Pearson/Prentice Hall.
3. Dutton, J.A.(1976): The ceaseless wind: An Introduction to the theory of atmospheric motion, McGraw Hill.
4. Hougthon, J.T (2006): The Physics of Atmospheres, 3rd ed., Cambridge University press.
5. Haltiner, G.J and R.T. Williams (1980): Numerical weather prediction and dynamic Meteorology, 2nd ed., Wiley.
6. MIntosh, D. H. and A. S.Thom (1983) essentials of meteorology, Taylor and Francis.

**Outcome of the study:** At the end of the course; the student will be able to

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| CO 1 | Learn about the measurements of different types of parameters in the Atmosphere. |
| CO 2 | Understand the importance of radiation and their effects on the earth Atmosphere. |
| CO 3 | Learn about the laws of the atmospheric motions and their equations. |
| CO 4 | Learn about the Atmospheric motion in three dimensions space. |
| CO 5 | Learn about various types of waves present in the atmospheric layers and their characteristics. |
| CO 6 | Learn about various types of Numerical Modelling methods for data analysis. |

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (%) | 10% | 30% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PYM406** | **Wind and Solar Energy** | **PEC** | **3-0-0** | **3** |

**Course Learning Objectives:**

1. To learn basics of energy resources available on the Earth’s Surface.
2. To learn measurement techniques of renewable resources such as wind energy and solar energy.
3. To learn the variations of wind and solar parameters daily, seasonally and annually.
4. To learn the concepts of conversion of one form of Wind energy into another form of useful energy (electric).
5. To learn the concepts of conversion of one form of solar energy into another form of useful energy (electric).
6. To learn the practical applications and their utilization for real world usage.

**Unit - I: Fundamentals of energy systems (10 Hours)**

Energy Sources, World Energy Present Situation, Availability of Conventional & Non-Conventional Energy Resources.

*Conventional energy sources***:** Fossil Fuel, Hydro Resources, Nuclear Resources, Coal, Oil, Gas, Thermal Power Stations. Advantages and disadvantages of Conventional Energy Sources.

*Non-conventional energy sources***:** Solar energy (Principle of photovoltaic conversion of solar energy), Wind energy (Wind energy conversion principles), Biomass Energy (Classification of biomass and Physicochemical characteristics of biomass as fuel), Hydropower (Principles of Wave and Tidal energy conversion), Geothermal energy (Type of geothermal energy deposits), Types of fuel cells. Advantages & limitations of on conventional energy sources.

**Unit - II: Wind measurement techniques (10 Hours)**

Introduction: Wind energy technology, Characteristics of wind: Nature of atmospheric winds; wind resource characteristics and assessment, anemometry, wind statistics; speed frequency distribution, effect of height, wind rose, Weibull distribution and effect of topography.

**Unit – III: Wind energy conversion (10 Hours)**

Basic components of Wind Mill Conversion System. Types of Wind Mills – Based on: Application, Wind Flow Direction, Tower Type & Height, Rotor, Controls, Axis, Number &Types of Blades, Wind Turbine Terminology, Tip Speed Ratio, Co-efficient of Performance, Efficiency. Wind Turbine Performance Analysis. Wind turbine design, Control Mechanisms: Wind turbine dynamics.

**Unit - IV: Solar measurement techniques (10 Hours)**

Solar Radiation: Sun as Solar radiation. Earth and solar constant. Extra Terrestrial at Earth’s Surface – Horizontal, Tilted Surface. Estimation of Radiation, Alternation of Solar Radiation by Atmosphere, Effect of Orientation of Receiving Surface.

Estimation: Monthly Average, Daily Total Radiation & Diffuse Radiation on
Horizontal Surface. Monthly Average, Daily Global Radiation on Tilted Surface.

Measurements: Pyranometer, Pyrheliometer, Sunshine Recorder. Radiation Characteristics of Opaque Materials. Radiation Transmission through covers and Absorption of Collectors

 **Unit V: Solar photovoltaic energy conversion (10 Hours)**

Solar Cell Fundamentals: Semiconductors, p-n Junction, Generation of Electron-Hole Pair by Photon Absorption, Photoconduction.

Solar Cell Characteristics: I-V Characteristics, Effect of Variation of Insolation and Temperature, Energy Losses and Efficiency, Maximizing the Performances, Cell size, Energy Payback Period (EPP).

Classification of Solar Cell:

Single Crystal Silicon Solar Cell, Multi-crystalline Silicon Solar Cell.Thin film solar cells (CdTe and CIGS), Emerging technologies in solar cells.

**Unit –VI: Real-world application (10 Hours)**

Wind power: Wind turbines, Home, domestic, Agriculture water pump setsand wind energy storage options. Solar power: Solar cells, Home lighting systems, solar lanterns, Solar PV pumps, solar energy storage options.

TEXT-BOOKS:

1. Garg & Prakash, H. P. Garg, *Solar Energy, Fundamentals and Applications*,Tata McGraw Hill.
2. D.P. Kothari, K.C. Signal, Rakesh Ranjan, *Renewable Energy Sources and Emerging Technologies*, Prentice-Hall of India
3. B. H. Khan’, *Non-Conventional Energy Resources*, Mc Graw Hill Publications.

REFERENCES:

1. F Kreith and J. F. Kreider, ‘*Principles of Solar Engi*neering’, McGrawhill Book Co.
2. G.D. Ray, *Non-Conventional Energy Sources*, Khanna Publications.
3. S. P. Sukhatme and J.K. Nayak, *Solar Energy – Principles of Thermal Collection and Storage*, Tata McGraw-Hill, New Delhi.
4. C.S. Solanki, *Solar Photovoltaics: Fundamental, Technologies and Applications*, Prentice Hall of India, 2011.
5. Solar Energy, G. N. Tiwari, Narosa Publishing House

**Course outcomes:** At the end of the course, students able to

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| --- | --- |
| CO1 | Understand the types of energy resources (Conventional and Non-conventional) available on the Earth’s Surface. |
| CO2 | Understand the variations of wind and solar parameters daily, seasonally and annually. |
| CO3 | Understand the measurement techniques followed to extract the wind energy from the environment parameters. |
| CO4 | Understand the measurement techniques followed to extract the solar energy from the environment parameters. |
| CO5 | Understand the principle of conversion of one-form of energy (wind and solar) to electric energy.  |
| CO6 | Get clear idea how to utilize these energy resources efficiently for the real-time applications. |

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (%) | 10% | 30% | 60% | 100% |

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| **Course code** | **Course name** | **Course Category** | **L-T-P** | **Credits** |
| **20PYM407** | **Renewable Energy** |  **PEC** | **3-0-0** | **3** |

**Course Learning Objectives:**

1. To learn the basics of energy resources available on the Earth’s Surface and impact of conventional energy sources on environment and climate change.
2. To learn the global energy consumption and local energy consumption and to know the need of sustainable energy for the global demands
3. To learn the basics principles & types of solar PV & thermal energy systems and their applications.
4. To learn the basics principle & types of wind energy systems and their applications.
5. To learn the basics principles & types of biomass & biogas energy systems and their applications
6. To learn the basics of ocean, tidal & hydrogen energy systems and their applications

**UNIT I: Introduction to Energy and Environmental Effects (8 Hours)**

Definition and units of energy, power, Forms of energy, Conservation of energy, second law of thermodynamics, Energy flow diagram to the earth. Origin and time scale of fossil fuels, Conventional energy sources, Role of energy in economic development and social transformation. Environmental degradation due to energy production and utilization, air and water pollution, depletion of ozone layer, global warming, biological damage due to environmental degradation. Effect of pollution due to thermal power station, nuclear power generation, hydroelectric power stations on ecology and environment.

**UNIT II: Energy Scenario: India and Global (8 Hours)**

Energy consumption in various sectors, projected energy consumption for the next century, exponential increase in energy consumption, energy resources, coal, oil, natural gas, nuclear and hydroelectric power, impact of exponential rise in energy usage on global economy. Energy resources available in India, urban and rural energy consumption, energy consumption pattern and its variation as a function of time, nuclear energy - promise and future, energy as a factor limiting growth, need for use of new and renewable energy sources

**UNIT III: Renewable Energy-I (12 Hours)**

Solar energy: Solar energy, Spectral distribution of radiation, Flat plate collector, solar water heating system, Applications, Solar cooker. Solar cell, Types of solar cells, Solar module and array, Components of PV system, Applications of solar PV systems.

**UNIT IV: Renewable Energy-II (12 Hours)**

Wind Energy**:** Introduction, Principle of wind energy conversion, Components of wind turbines, Operation and characteristics of a wind turbine, Advantages and disadvantages of wind mills, Applications of windenergy.

**UNIT V: Renewable Energy-III (10 Hours)**

Biomass: Energy from biomass – Sources of biomass – Different species – Conversion of biomass into fuels – Energy through fermentation – Pyrolysis, gasification and combustion – Aerobic and anaerobic bio-conversion – Properties of biomass – Biogas plants – Types of plants – Design and operation – Properties and characteristics of biogas.

**UNIT VI: Renewable Energy-IV (10 Hours )**

Ocean Energy: Introduction, Principle of ocean thermal energy conversion, Tidal power generation, Tidal energy technologies, Energy from waves, Wave energy conversion, Wave energy technologies, advantages and disadvantages.

Hydrogen Energy: History of hydrogen energy - Hydrogen production methods - Electrolysis of water, Hydrogen storage options – Compressed and liquefied gas tanks, Metal hydrides; Hydrogen safety - Problems of hydrogen transport and distribution - Uses of hydrogen as fuel.

### References

1. Fundamentals of Renewable Energy Resources by G.N.Tiwari, M.K.Ghosal, Narosa Pub., 2007
2. Solar Energy Principles, Thermal Collection & Storage, S.P. Sukhatme: Tata McGraw Hill Pub., NewDelhi.
3. Non-Conventional Energy Sources, G.D. Rai, NewDelhi.
4. Renewable Energy, power for a sustainable future, Godfrey Boyle,2004,
5. The Generation of electricity by wind, E.W.Golding.
6. Hydrogen and Fuel Cells: A comprehensive guide, Rebecca Busby, Pennwell corporation (2005)
7. Hydrogen and Fuel Cells: Emerging Technologies and Applications, B.Sorensen, Academic Press(2012).
8. Non-Conventional Energy Resources by B.H. Khan, Tata McGraw HillPub

**Course outcomes:** At the end of the course, students are able to

|  |  |
| --- | --- |
| CO1 | Understand the types of energy resources (Conventional and Non-conventional) available on the Earth’s Surface and impact of conventional energy sources on environment& climate change |
| CO2 | Understand the global energy consumption and local energy consumption particularly in India and students can understand the need of sustainable energy for the global demands  |
| CO3 | Understand the basics principles & types of solar PV & thermal energy systems and their applications. |
| CO4 | Understand the basics principle & types of wind energy systems and their applications. |
| CO5 | Understand the principles& types of biomass & biogas energy systems and their applications. |
| CO6 | Understand the basics of ocean, tidal & hydrogen energy systems and their applications |

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| **Course Nature** | **Theory** |
| **Assessment Method** |
| Assessment Tool | Weekly tests | Monthly tests | End Semester Test | Total |
| Weightage (%) | 10% | 30% | 60% | 100% |