CBCS SYLLABUS
FOR

THREE YEARS UNDER-GRADUATE COURSE
IN

PHYSICS (PROGRAMME)
(w.e.f. 2022-2023)

PROGRAMME OUTCOME

The Undergraduate (UG) programme of Physics is constructed of UG (programme). The syllabus is based on the CBCS system which covers almost all the fields of Physics. The students will be enriched with plenty of knowledge after the completion of the course. The complete syllabus is compatible with the competitive examination of various streams. The project work is included in the new syllabus which will motivate students. In this programme there are various inter- and multidisciplinary courses. The students will acquire inter- and multidisciplinary skills which will be of tremendous value to them. The programme will make the students industry-ready. The programme will make the students able to achieve goals in job oriented directions.

SEMESTER-I

T1 – Physics I (4 Credits)

1. Vector Analysis

Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter.

Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

2. Laws of Motion

Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of

Mass.

3. Momentum and Energy

Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.

4. Rotational Motion

Angular velocity and angular momentum. Torque. Conservation of angular momentum.

5. Gravitation

Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). Satellite in circular orbit and applications.

6. Elasticity

Hooke's law –stress-strain diagram, Elastic moduli- relation between elastic constants, poisson's ratio expression for Poisson's ratio in terms of elastic constants- work done in stretching and work done in twisting a wire – twisting couple on a cylinder –Determination of Rigidity modulus by static torsion- Torsional pendulum- Determination of Rigidity modulus and moment of inertia by Searles method.

7. Special Theory of Relativity

Postulate of special theory of relativity. Lorentz transformations. Simultaneity and order of events. lorentz contraction. Time dilation, relativistic transformation of velocity, relativistic addition of velocities.

8. Sound

Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Linearity & Superposition Principle.

(1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats). Graphical and APnalytical Methods. Lissajous Figures with equal an unequal frequency and their uses. Damped oscillations. Forced vibrations and resonance.

Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria.

9. Electrostatics

Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Parallel plate capacitor completely filled with dielectric.

Reference Books

► University Physics. F.W. Sears, M.W. Zemansky and H.D. Young, 13/e, 1986. Addison-Wesley

► Mechanics Berkeley Physics, v.1: Charles Kittel, et.al. 2007, Tata McGraw-Hill.

► Physics – Resnick, Halliday& Walker 9/e, 2010, Wiley

► Engineering Mechanics, Basudeb Bhattacharya, 2nd edn., 2015, Oxford University Press

► University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Course Outcomes:

1. Students will learn and develop the concepts of vector and basic knowledge of the vector differential operator Del and understand the operation on the scalar and vector field.
2. Students will Learn and realize about vector theorems like Divergence and Green theorem etc.
3. Students will develop the concepts on classical mechanics and enhance the basic knowledge of the non-inertial and inertial frame of reference, variable mass, rocket motion, special theory of relativity.
4. They will acquire knowledge about the elasticity of the material and the streamline and turbulent motion.
5. Enhance the capability to prepare and organize a presentation on the application of fundamental dynamics.
6. They can understand the relation between electrical charge, electrical field, electrical potential
7. They can understand and realize the superposition of SHM collinearly and

perpendicularly and can study the Beat ant Lissajous figures.

P1 – Physics I Lab (2 Credits)
List of Practical

1. Measurements of length (or diameter) using verniercaliper, screw gauge and travelling microscope.

2. To determine the Moment of Inertia of a Flywheel.

3. To determine the Young's Modulus of a Wire by Optical Lever Method.

4. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.

5. To determine the Elastic Constants of a Wire by Searle's method.

6. To determine g by Kater's Pendulum.

7. To study the Motion of a Spring and calculate (a) Spring Constant, (b) g.

8. To investigate the motion of coupled oscillators

9. To study Lissajous Figures

10. To determine the Moment of Inertia of cylindrical body about an axis passing through its centre of gravity.

11. Frequency f vs 1/l curve for a sonometer- wire and hence unknown frequency of a tuning fork.

12. To determine the Modulus of Rigidity of a Wire by dynamical method.

Reference Books

► Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.

► Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.

► Engineering Practical Physics, S.Panigrahi&B.Mallick, 2015, Cengage Learning India Pvt. Ltd.

► A Text Book of Practical Physics, InduPrakash and Ramakrishna, 11th Edition, 2011, KitabMahal, New Delhi.

Course Outcomes:

1. Students will learn how can use the screw gauge, slide callipers, microscope, telescope.

2. They are able know how experimentally measure the Young's modulus, coefficient of viscosity of liquid, acceleration due to gravity, spring constant.

3. They will acquire knowledge about Lissajous figures, coupled oscillations.

4. They can realize about the moment of inertia of body about the axis of rotation.

SEMESTER-II

T2-Physics II (4 Credits)
1. Magnetism

Magnetostatics: Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law.

Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para-and ferro- magnetic materials.

Electromagnetic Induction

Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

2. Maxwell`s equations and Electromagnetic wave propagation

Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves.

3. Kinetic Theory of Gases

Mean free path (zeroth order), Law of equipartion of energy (no derivation) and its applications to specific heat of gases, mono-atomic and diatomic gases.

4. Theory of Radiation

Blackbody radiation, Plank's distribution law (statement only), Stefan Boltzmann Law and

Wien's displacement law (statement only and graphical explanation)

5. Laws of Thermodynamics

Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law and Entropy, Carnot's cycle & theorem, Entropy

changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

6. Statistical Mechanics

Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law Quantum statistics - Fermi-Dirac distribution law - electron gas - Bose- Einstein distribution law (Only distribution formula with explanation) comparison of three statistics.

Reference Books

► Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education

► Electricity & Magnetism, J.H. Fewkes&J.Yarwood. Vol. I, 1991, Oxford Univ. Press

► Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.

► University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

► D.J.Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.

► Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.

► A Treatise on Heat, MeghnadSaha, and B.N. Srivastava, 1969, Indian Press.

► Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.

► Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill

► Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears and

► G.L. Salinger. 1988, Narosa

► University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

► Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. chand Publications

P2 –Physics II Lab (2 Credits)
List of Practical

1. Measurement of Planck's constant using black body radiation.

2. To determine Stefan's Constant.

3. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.

4. To use a Multimeter for measuring

   a. Resistances

   b. AC and DC Voltages

c. DC Current

d. Checking electrical fuses.

5. Ballistic Galvanometer:

a. Measurement of charge and current sensitivity

b. Measurement of CDR

c. Determine a high resistance by Leakage Method

6. To study the Characteristics of a Series RC Circuit.

7. To study a series LCR circuit LCR circuit and determine its

a. Resonant frequency

b. Quality factor

8. To determine a Low Resistance by Carey Foster's Bridge.

9. To verify the Thevenin and Norton theorems

10. To verify the Maximum Power Transfer Theorems

11. Resistance of suspended coil galvanometer by half deflection method and hence the current sensitivity of the galvanometer.

12. Potential difference across a low resistance and hence the current through it with the help of a meter bridge (without end correction)

13. To determine the coefficient of linear expansion of the material of a rod using Optical Lever Method

Reference Books

► Advanced Practical Physics for students, B.L.Flint&H.T.Worsnop, 1971, Asia Publishing House.

► Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.

► A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed.2011, KitabMahal

SEMESTER-III

T3 Physics III (4 Credits)

1. Wave Optics

Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.

2. Interference

Interference: Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes);

Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index.

Diffraction: Fraunhofer diffraction- Single slit; Double Slit. Multiple slits and Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate.

3. Polarization

Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization.

4. Crystal Structure

Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Diffraction of X-rays by Crystals. Bragg's Law.

5. Quantum Mechanics

Wave-particle duality, Heisenberg uncertainty principle- impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle**.**

Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum & Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle

6. Nuclear Physics

General properties of atomic nucleus. Packing fraction, mass defect, binding energy, systematics of stable nuclei.

Radioactivity. Law of radioactive decay; Mean life and half-life. Transient and secular

equilibrium.

Fission and fusion. Mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with U^{235}; Fusion and thermonuclear reactions.

Reference Books

► A Text book of Quantum Mechanics, P.M. Mathews & K. Venkatesan, 2nd Ed., 2010, McGraw Hill

► Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.

► Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.

► Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.

► Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.

► Quantum Mechanics for Scientists and Engineers, D.A.B. Miller, 2008, Cambridge University Press

► Quantum Mechanics, EugenMerzbacher, 2004, John Wiley and Sons, Inc

► Introduction to Quantum Mechanics, David J. Griffith, 2nd Ed. 2005, Pearson Education

► Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer

► Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).

► Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).

► Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004)

► Introduction to Elementary Particles, D. Griffith, John Wiley & Sons

► Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi

► Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).

► Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).

► Theoretical Nuclear Physics, J.M. Blatt &V.F.Weisskopf (Dover Pub.Inc., 1991)

► Fundamentals of Optics, F.A Jenkins and H.E White, 1976, McGraw-Hill

► Principles of Optics, B.K. Mathur, 1995, Gopal Printing

► Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publications

► University Physics. F.W. Sears, M.W. Zemansky and H.D. Young. 13/e, 1986. Addison-Wesley

Course Outcomes:

1. Students will Develop an understanding of the principles of optics.
2. To build connections between mathematical development and conceptual understanding.
3. Develop explicit problem-solving strategies that emphasize qualitative analysis steps to describe and clarify the problem
4. They will understand the relationship between observation and theory and their use in building the basic concepts of modern physics.
5. They will understand how major concepts developed and changed over time.
6. They will Capable of analyzing and solving problems using oral and written reasoning skills based on the concepts of modern physics.

P3 - Physics Lab III (2 Credits)
List of Practical

1. Familiarization with Schuster`s focussing; determination of angle of prism.
2. To determine the Refractive Index of the Material of a Prism using Sodium Light.
3. To determine Dispersive Power of the Material of a Prism using Mercury Light
4. To determine the Resolving Power of a Prism.
5. To determine wavelength of sodium light using Newton's Rings
6. To determine the Resolving Power of a Plane Diffraction Grating.
7. To determine value of Boltzmann constant using V-I characteristic of PN diode.
8. To determine work function of material of filament of directly heated vacuum diode.
9. To determine value of Planck's constant using LEDs of at least 4 different colours.
10. Refractive index of water by travelling microscope.
11. Refractive index of the material of a lens by lens mirror method.
12. Refractive index of the liquid by lens- mirror method.
13. Focal length of a convex lens by combination method and calculation of its power.

Course Outcomes:

1. There is scope to learn how use spectrometer to study the spectrum of helium, sodium vapour.
2. They will acquire clear knowledge about prism, grating , single slit

3. They will learn experimentally about Newton's ring.
4. Students will also realize about the resolving power of lens.
5. They can learn to handle the travelling microscope and using this they will able to measure the refractive index of liquid.
6. They will understand about the power of the lens.

SEMESTER-IV

T4 –Physics IV (4 Credits)

1. Elementary band theory

Band Gaps. Conductors, Semiconductors and insulators. P and N type Semiconductors. Conductivity of Semiconductors, mobility, Hall Effect (only statement), Hall coefficient.

2. Semiconductor Devices and Amplifiers

Semiconductor Diodes: P and N type semiconductors. Barrier Formation in PN Junction Diode. Qualitative Idea of Current Flow Mechanism in Forward and Reverse Biased Diode. PN junction and its characteristics. Static and Dynamic Resistance. Principle and structure of

(1) LEDs, (2) Photodiode, (3) Solar Cell

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Active, Cutoff& Saturation regions Current gains α and β. Relations between α and β. Load Line analysis of Transistors. DC Load line & Q- point. Voltage Divider Bias Circuit for CE Amplifier. H-parameter, Equivalent Circuit. Analysis of single-stage CE amplifier using hybrid Model. Input & output Impedance. Current, Voltage and Power gains. Class A, B & C Amplifiers.

3. Operational Amplifiers (Black Box approach)

Characteristics of an Ideal and Practical Op-Amp (IC 741), Open-loop and closed- loop Gain. CMRR, concept of Virtual ground. Applications of Op-Amps: (1) Inverting and non- inverting Amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator.

4. Digital Electronics

Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion, AND, OR and NOT Gates (Realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates.

De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Minterms and Maxterms. Conversion of a Truth Table into an

Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map

Binary Addition. Binary Subtraction using 2's Complement Method). Half Adders and Full Adders and Subtractors, 4-bit binary Adder-Subtractor.

5. Instrumentations

Power Supply: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers Calculation of Ripple Factor and Rectification Efficiency, Basic idea about capacitor filter, Zener Diode and Voltage Regulation.

Reference Books

► Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.

► Electronic devices & circuits, S. Salivahanan& N.S. Kumar, 2012, Tata Mc-Graw Hill

► Microelectronic Circuits, M.H. Rashid, 2nd Edn., 2011, Cengage Learning.

► Modern Electronic Instrumentation and Measurement Tech., Helfrick and Cooper, 1990, PHI Learning

► Digital Principles and Applications, A.P. Malvino, D.P. Leach and Saha, 7th Ed., 2011, Tata McGraw Hill

► Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.

► Fundamentals of Digital Circuits, A. Anand Kumar, 2nd Edition, 2009, PHI Learning Pvt. Ltd.

► OP-AMP & Linear Digital Circuits, R.A. Gayakwad, 2000, PHI Learning Pvt. Ltd.

Course Outcomes:

This course will provide some ideas of Electronics and instrumentation to the students. They will come to know about the elementary band theory, Semiconductor Devices including amplifiers and operational amplifiers. Students will also be able to acquire some basic knowledge of digital electronics.

P4 – Physics IV Lab. (2 Credits)

List of Practical

1. To verify and design AND, OR, NOT and XOR gates using NAND gates.

2. To minimize a given logic circuit.

3. Adder-Subtractor using Full Adder I.C.

4. Study of zener diode characteristics and its application as voltage regulator.

5. To study the characteristics of a Transistor in CE configuration.

6. To design a CE amplifier of given gain (mid-gain) using voltage divider bias.

7. To design an inverting amplifier of given gain using Op-amp 741 and study its frequency response.

8. To design a non-inverting amplifier of given gain using Op-amp 741 and study its Frequency Response.

9. Band gap measurement of for thermistor.

10.To draw the I-V characteristics of a suitable resistance and that of a junction diode within specified limit on a graph, and hence to find d.c. and a.c. resistance of both the elements at the point of intersection.

Department Specific Electives Subjects Syllabus

SEMESTER-V

4.1 DSE T1 - Advanced Mathematical Physics (6 Credits)

1. Cartesian Tensors

Transformation of Co-ordinates. Einstein's Summation Convention. Relation between Direction Cosines. Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti- symmetric Tensors. Invariant Tensors: Kronecker and Alternating Tensors. Association of Antisymmetric Tensor of Order Two and Vectors. Vector Algebra and Calculus using Cartesian Tensors: Scalar and Vector Products, Scalar and Vector Triple Products. Differentiation. Gradient, Divergence and Curl of Tensor Fields. Vector Identities. Tensorial Formulation of Analytical Solid Geometry: Equation of a Line. Angle Between Lines .

Projection of a Line on another Line. Condition for Two Lines to be Coplanar. Foot of the Perpendicular from a Point on a Line. Rotation Tensor (No Derivation). Isotropic Tensors. Tensorial Character of Physical Quantities. Moment of Inertia Tensor. Stress and Strain Tensors: Symmetric Nature. Elasticity Tensor. Generalized Hooke's Law.

2. General Tensors

Transformation of Co-ordinates. Minkowski Space. Contravariant& Covariant Vectors. Contravariant, Covariant and Mixed Tensors. Kronecker Delta and Permutation Tensors. Algebra of Tensors. Sum, Difference & Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Metric Tensor.

3. Group Theory

Review of sets, Mapping and Binary Operations, Relation, Types of Relations.

Groups: Elementary properties of groups, uniqueness of solution, Subgroup, Centre of a group, Co-sets of a subgroup, cyclic group, Permutation/Transformation. Homomorphism and Isomorphism of group. Normal and conjugate subgroups, Completeness and Kernel.

Some special groups with operators. Matrix Representations: Reducible and Irreducible representations. Schur's lemma. Orthogonality theorems. Character tables and their uses. Application to small vibrations.

4. Advanced Probability Theory:

Fundamental Probability Theorems. Conditional Probability, Bayes' Theorem, Repeated

Trials, Binomial and Multinomial expansions. Random Variables and probability distributions, Expectation and Variance, Special Probability distributions: The binomial distribution, The Poisson distribution, Continuous distribution: The Gaussian (or normal) distribution, The principle of least squares.

Reference Books

► A student's Guide to Vectors and Tensors, Daniel Fleisch, S.Chand,2012

► Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications

Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press

► Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books

► Mathematical Physics, P. K. Chattopadhyay, 2014, New Academic Science.

- MATRICES AND TENSORS IN PHYSICS,A.W.Joshi, 4th Edition, New Age International.
- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Mathematical Physics, H.K. DAAS & DR. RAMA VERMA,2019, S Chand.
- Group Theory for Physicists, Pichai Ramadevi & Varun Dubey, Cambridge University Press
- Elements of Group Theory for Physicists, A W Joshi, New Age International.
- Probability and Statistics for Engineering and the Sciences, Jay L. Devore, 2020, Cengage India Private Limited.
- Lectures on Advanced Mathematical Methods for Physicists TRiPS 9, 2014, Sunil Mukhi & N. Mukunda, Hindustan Book Agency.

Course Outcomes:

Transformation of Co-ordinates in 10+2 level to Isotropic Tensor in support of calculaus and vectors helps the students to understand Cartesian Tensors and application in physical properties like elasticity as a different essence of physics. The General Tensor, Group Theory and Probability theory to the advance level will help in penetrating into the higher studies as well as to appear in Grade-1 competitive examinations.

DSE T2 - Classical Dynamics (6 Credits)

1. Classical Mechanics of Point Particles

Review of Newtonian Mechanics; Application to the motion of a charge particle in external electric and magnetic fields- motion in uniform electric field, magnetic field- gyroradius and gyrofrequency, motion in crossed electric and magnetic fields. Generalized coordinates and velocities,

Recap of Lagrangian and Hamiltonian mechanics. Applications: Hamiltonian for a harmonic oscillator, solution of Hamilton's equation for Simple Harmonic Oscillations; particle in a central force field- conservation of angular momentum and energy. Effective potential. The Laplace-Runge-Lenz vector.

2. Small Amplitude Oscillations

Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) -identical springs.

3. Special Theory of Relativity

Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction and twin paradox. Four-vectors: space-like, time-like and light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy-momentum relation. Doppler effect from a four-vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle.

4. Fluid Dynamics

Fluid, an element of fluid and its velocity, Navier-Stokes equation, qualitative description of turbulence, Reynolds number.

Reference Books

► Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications

Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press

► Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books

► Mathematical Physics, P. K. Chattopadhyay, 2014, New Academic Science.

- MATRICES AND TENSORS IN PHYSICS,A.W.Joshi, 4th Edition, New Age International.
- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Mathematical Physics, H.K. DAAS & DR. RAMA VERMA,2019, S Chand.
- Classical Dynamics: A Modern Perspective, Sudarshan & Mukunda, HINDUSTAN BOOK AGENCY, World Scientific.

Course Outcomes:

The syllabus formulation has been done considering the aspects of both microscopic particle and macroscopic particle. The approach is made parallel for stimulating fields - Gravitational, Magnetic and Electric. Small oscillation and normal modes considering spring model is a simple way to know matter especially solid. Lorentz transformation to knowledge of relativity in tensor will help to better understand the dynamics of particle including two-body decay in an unstable particle.

SEMESTER-VI

DSE T5 – Physics of Earth (6 Credits)

1. The Earth and the Universe

Origin of universe, creation of elements and earth. A Holistic understanding of our dynamic planet through Astronomy, Geology, Meteorology and Oceanography. Introduction to various branches of Earth Sciences.

General characteristics and origin of the Universe. The Milky Way galaxy, solar system, Earth's orbit and spin, the Moon's orbit and spin. The terrestrial and Jovian planets. Meteorites & Asteroids. Earth in the Solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age. Energy and particle fluxes incident on the Earth. The Cosmic Microwave Background.

2. Structure

The Solid Earth: Mass, dimensions, shape and topography, internal structure, magnetic field,

geothermal energy. How do we learn about Earth's interior?

The Hydrosphere: The oceans, their extent, depth, volume, chemical composition. River systems.

The Atmosphere: variation of temperature, density and composition with altitude, clouds.
The Cryosphere: Polar caps and ice sheets. Mountain glaciers.

The Biosphere: Plants and animals. Chemical composition, mass. Marine and land organisms.

3. Dynamical Processes

The Solid Earth: Origin of the magnetic field. Source of geothermal energy. Convection in Earth's core and production of its magnetic field. Mechanical layering of the Earth. Introduction to geophysical methods of earth investigations. Concept of plate tectonics; sea-floor spreading and continental drift. Geodynamic elements of Earth: Mid Oceanic Ridges, trenches, transform faults and island arcs. Origin of oceans, continents, mountains and rift valleys. Earthquake and earthquake belts. Volcanoes: types products and distribution.

The Hydrosphere: Ocean circulations. Oceanic current system and effect of coriolis forces. Concepts of eustasy, tend– air-sea interaction; wave erosion and beach processes. Tides. Tsunamis.

The Atmosphere: Atmospheric circulation. Weather and climatic changes. Earth's heatbudget. Cyclones.

Climate: Earth's temperature and greenhouse effect. Paleoclimate and recent climate changes.

The Indian monsoon system.

Biosphere: Water cycle, Carbon cycle, Nitrogen cycle, Phosphorous cycle. The role of cycles in maintaining a steady state.

4. Evolution

Nature of stratigraphic records, Standard stratigraphic time scale and introduction to the concept of time in geological studies. Introduction to geochronological methods in their application in geological studies. History of development in concepts of uniformitarianism, catastrophism and neptunism. Law of superposition and faunal succession. Introduction to the geology and geomorphology of Indian subcontinent.

Time line of major geological and biological events. Origin of life on Earth.

Role of the biosphere in shaping the environment.

Future of evolution of the Earth and solar system: Death of the Earth.

5. Disturbing the Earth – Contemporary dilemmas

1. Human population growth.

2. Atmosphere: Greenhouse gas emissions, climate change, air pollution.

3. Hydrosphere: Fresh water depletion.

4. Geosphere: Chemical effluents, nuclear waste.

5. Biosphere: Biodiversity loss. Deforestation. Robustness and fragility of ecosystems.

Reference Books

► Planetary Surface Processes, H. Jay Melosh, Cambridge University Press, 2011.

► Consider a Spherical Cow: A course in environmental problem solving, John Harte. University Science Books

► Holme's Principles of Physical Geology. 1992. Chapman & Hall.

► Emiliani, C, 1992. Planet Earth, Cosmology, Geology and the Evolution of Life and

Environment. Cambridge University Press.

Course Outcomes:

Through this course, the students will know about the earth and the universe. They will know about the structure of the earth. The will get familiar with the dynamical processes and the evolution process undergone since the formation of earth. The students will also get the opportunity to study on the contemporary issues that are disturbing the earth.

DSE T6 – Biological Physics (6 Credits)

1. Overview

The boundary, interior and exterior environment of living cells. Processes: exchange of matter and energy with environment, metabolism, maintenance, reproduction, evolution. Self-replication as a distinct property of biological systems. Time scales and spatial scales. Universality of microscopic processes and diversity of macroscopic form. Types of cells. Multicellularity. Allometric scaling laws.

2. Molecules of life

Metabolites, proteins and nucleic acids. Their sizes, types and roles in structures and processes. Transport, energy storage, membrane formation, catalysis, replication, transcription, translation, signaling.

Typical populations of molecules of various types present in cells, their rates of production and turnover. Energy required to make a bacterial cell.

Simplified mathematical models of transcription and translation, small genetic circuits and signaling pathways. Random walks and applications to biology. Mathematical models to be studied analytically and computationally.

3. The complexity of life

At the level of a cell: The numbers of distinct metabolites, genes and proteins in a cell. Complex networks of molecular interactions: metabolic, regulatory and signaling networks. Dynamics of metabolic networks; the stoichiometric matrix. Living systems as complex organizations; systems biology. Models of cellular dynamics. The implausibility of life based on a simplified probability estimate, and the origin of life problem.

At the level of a multicellular organism: Numbers and types of cells in multicellular organisms. Cell types as distinct attractors of a dynamical system. Stem cells and cellular differentiation. Pattern formation and development.

Brain structure: neurons and neural networks. Brain as an information processing system. Associative memory models. Memories as attractors of the neural network dynamics.

At the level of an ecosystem and the biosphere: Foodwebs. Feedback cycles and self- sustaining

ecosystems.

4. Evolution

The mechanism of evolution: variation at the molecular level, selection at the level of the organism. Models of evolution. The concept of genotype-phenotype map. Examples.

Reference Books

► Physics in Molecular Biology; Kim Sneppen& Giovanni Zocchi (CUP 2005)

► Biological Physics: Energy, Information, Life; Philip Nelson (W H Freeman & Co, NY, 2004)

► Physical Biology of the Cell (2nd Edition), Rob Phillips et al (Garland Science, Taylor & Francis Group, London & NY, 2013)

► An Introduction to Systems Biology; Uri Alon (Chapman and Hall/CRC, Special Indian Edition, 2013)

► Evolution; M. Ridley (Blackwell Publishers, 2009, 3rd edition)

Course Outcomes:

While going through this course, the students will learn about the boundary, interior and exterior environment of living cells and the types of cells. They will acquire knowledge about different metabolites. Students will also come to know about the complexity of life and the evolution process.

Skill Enhancement Course

SEMESTER-III

SEC T1 - Computational Physics (2 Credits)

1. Introduction

Importance of computers in Physics, paradigm for solving physics problems for solution. Usage of linux as an Editor. Algorithms and Flowcharts: Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.

2. Scientific Programming

Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems.

3. Control Statements

Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DO- WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems.

4. Programming

1. Exercises on syntax on usage of FORTRAN

2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN.

3. To print out all natural even/ odd numbers between given limits.

4. To find maximum, minimum and range of a given set of numbers.

5. Calculating Euler number using exp(x) series evaluated at x=1

5. Scientific word processing: Introduction to LaTeX

TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. Equation representation: Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors.

6. Visualization

Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot

Hands on exercises

1. To compile a frequency distribution and evaluate mean, standard deviation etc.

2. To evaluate sum of finite series and the area under a curve.

3. To find the product of two matrices

4. To find a set of prime numbers and Fibonacci series.

5. To write program to open a file and generate data for plotting using Gnuplot.

6. Plotting trajectory of a projectile projected horizontally.

7. Plotting trajectory of a projectile projected making an angle with the horizontally.

8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.

9. To find the roots of a quadratic equation.

10. Motion of a projectile using simulation and plot the output for visualization.

11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.

12. Motion of particle in a central force field and plot the output for visualization.

Reference Books

► Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.

► Computer Programming in Fortran 77". V. Rajaraman (Publisher: PHI).

► LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).

► Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)

► Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.

► Computational Physics: An Introduction, R.C. Verma, et al. New Age International Publishers, New Delhi(1999)

► A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning

► Elementary Numerical Analysis, K.E. Atkinson, 3 rdEdn., 2007, Wiley India Edition

5.2 SEC T2 – Renewable Energy and Energy Harvesting (2 Credits)

1. Fossil fuels and Alternate Sources of energy

Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

2. Solar energy

Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

3. Wind Energy harvesting

Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

4. Ocean Energy

Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices.

Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.

5. Geothermal Energy

Geothermal Resources, Geothermal Technologies

6. Hydro Energy

Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

7. Piezoelectric Energy harvesting

Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power

8. Electromagnetic Energy Harvesting

a. Linear generators, physics mathematical models, recent applications

b. Carbon captured technologies, cell, batteries, power consumption

c. Environmental issues and Renewable sources of energy, sustainability.

9. Demonstrations and Experiments

a. Demonstration of Training modules on Solar energy, wind energy, etc.

b. Conversion of vibration to voltage using piezoelectric materials

c. Conversion of thermal energy into voltage using thermoelectric modules.

Reference Books

► Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi

► Solar energy - M P Agarwal - S Chand and Co. Ltd.

► Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.

► Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.

► Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009

► J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).

► http://en.wikipedia.org/wiki/Renewable_energy

Course Outcomes:

1. Able to know about the non-conventional ,conventional energy source
2. Know about the need of renewable energy source.
3. Develop the idea about tidal energy, wind energy, geothermal energy, tidal energy, solar

energy etc.

4. Understand the how can utilize the effect of the piezoelectric effect.
5. Acquire the complete knowledge about the solar pond and its important in cold country.
6. Know the import ants of the energy harvesting.

SEMESTER-IV

5.3 SEC T3 – Radiation Safety (2 Credits)

1. Basics of Atomic and Nuclear Physics

Basic concept of atomic structure; X rays characteristic and production; concept of bremsstrahlung and auger electron, the composition of nucleus and its properties, mass number, isotopes of element, spin, binding energy, stable and unstable isotopes, law of radioactive decay, Mean life and half-life, basic concept of alpha, beta and gamma decay, concept of cross section and kinematics of nuclear reactions, types of nuclear reaction, Fusion, fission.

2. Interaction of Radiation with matter: Types of Radiation

Alpha, Beta, Gamma and Neutron and their sources, sealed and unsealed sources, Interaction of Photons - Photo- electric effect, Compton Scattering, Pair Production, Linear and Mass Attenuation Coefficients, Interaction of Charged Particles: Heavy charged particles - Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling, Channeling and Cherenkov radiation. Beta Particles- Collision and Radiation loss (Bremsstrahlung), Interaction of Neutrons- Collision, slowing down and Moderation.

3. Radiation detection and monitoring devices: Radiation Quantities and Units

Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derived Air Concentration (DAC). Radiation detection: Basic concept and working principle of gas detectors (Ionization Chambers, Proportional Counter, Multi-Wire Proportional Counters (MWPC) and Gieger Muller Counter), Scintillation Detectors (Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors, Thermo luminescent Dosimetry.

4. Biological effects of ionizing radiation

Biological damage under exposure of ionizing radiation, Mechanisms of radiation damage, Determinants of biological effects: rate of absorption, area exposed, variation in species and individual sensitivity, variation in cell sensitivity, Types of radiation damage: stochastic and deterministic effects, Radiation sickness and its phases.

5. Radiation safety management

Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and management of radiation. Nuclear waste and disposal management. Brief idea about Accelerator driven Sub-critical system (ADS) for waste management.

6. Application of nuclear techniques

Application in medical science (e.g., MRI, PET, Projection Imaging Gamma Camera, radiation therapy), Archaeology, Art, Crime detection, Mining and oil. Industrial Uses: Tracing, Gauging, Material Modification, Sterization, Food preservation.

Experiments

1. Study the background radiation levels using Radiation meter

2. Characteristics of Geiger Muller (GM) Counter:

3. Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source).

4. Study of counting statistics using background radiation using GM counter.

5. Study of radiation in various materials (e.g. KSO4 etc.). Investigation of possible radiation in different routine materials by operating GM at operating voltage.

6. Study of absorption of beta particles in Aluminum using GM counter.

7. Detection of α particles using reference source & determining its half-life using spark counter

8. Gamma spectrum of Gas Light mantle (Source of Thorium)

Reference Books

► W.E. Burcham and M. Jobes – Nuclear and Particle Physics – Longman (1995)

► G.F.Knoll, Radiation detection and measurements

► ThermoluninescenseDosimetry, Mcknlay, A.F., Bristol, Adam Hilger (Medical Physics Handbook 5)

► W.J. Meredith and J.B. Massey, “Fundamental Physics of Radiology”. John Wright and Sons, UK, 1989.

► J.R. Greening, “Fundamentals of Radiation Dosimetry”, Medical Physics Hand Book

Series, No.6, Adam Hilger Ltd., Bristol 1981.

► Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowental and P.L. Airey, Cambridge University Press, U.K., 2001

► A. Martin and S.A. Harbisor, An Introduction to Radiation Protection, John Willey & Sons, Inc. New York, 1981.

► NCRP, ICRP, ICRU, IAEA, AERB Publications.

► W.R. Hendee, “Medical Radiation Physics”, Year Book – Medical Publishers Inc. London, 1981

Course Outcomes:

From this course the students will learn about some basic ideas of atomic and nuclear physics. They will develop some ideas about the interaction of radiation with matter and types of radiation. They will get familiar with some radiation detection and monitoring devices and also gather knowledge regarding radiation quantities and units. Students will come to know about the biological effects of ionizing radiation. Students will be introduced to the field of radiation safety management. They will be familiar with the applications of different nuclear techniques.

5.4 SEC T4 – Weather Forecasting (2 Credits)

1. Introduction to atmosphere

Elementary idea of atmosphere: physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; temperature sensors: types; atmospheric pressure: its measurement; cyclones and anticyclones: its characteristics.

2. Measuring the weather

Wind; forces acting to produce wind; wind speed direction: units, its direction; measuring wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws

3. Weather systems

Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes.

4. Climate and Climate Change

Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate

5. Basics of weather forecasting

Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts.

Demonstrations and Experiments

1. Study of synoptic charts & weather reports, working principle of weather station.

2. Processing and analysis of weather data

a. To calculate the sunniest time of the year.

b. To study the variation of rainfall amount and intensity by wind direction.

c. To observe the sunniest/driest day of the week.

d. To examine the maximum and minimum temperature throughout the year.

e. To evaluate the relative humidity of the day.

f. To examine the rainfall amount month wise.

3. Exercises in chart reading: Plotting of constant pressure charts, surfaces charts, upper wind charts and its analysis.

4. Formats and elements in different types of weather forecasts/ warning (both aviation and non-aviation)

Reference Books

► Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books

► The weather Observers Hand book, Stephen Burt, 2012, Cambridge University Press.

► Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.

► Text Book of Agrometeorology, S.R. Ghadekar, 2005, Agromet Publishers, Nagpur.

► Why the weather, Charls Franklin Brooks, 1924, Chpraman& Hall, London.

► Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.

Course Outcomes:

From this course the students will get acquainted with various aspects of atmosphere. They will come to know about the weather systems, climate and climate change. Students will gather knowledge about the basics of weather forecasting when going through this course.

SEMESTER-V

5.5 SEC T5 – Physics Workshop Skill (2 Credits)

1. Introduction

Measuring units: conversion to SI and CGS. Familiarization with meter scale, Vernier calliper, Screw gauge and their utility. Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet, etc. Use of Sextant to measure height of buildings, mountains, etc.

2. Mechanical Skill

Concept of workshop practice. Overview of manufacturing methods: casting, foundry, machining, forming and welding. Types of welding joints and welding defects. Common materials used for manufacturing like steel, copper, iron, metal sheets, composites and alloy, wood. Concept of machine processing, introduction to common machine tools like lathe, shaper, drilling, milling and surface machines. Cutting tools, lubricating oils. Cutting of a metal sheet using blade. Smoothening of cutting edge of sheet using file. Drilling of holes of different diameter in metal sheet and wooden block. Use of bench vice and tools for fitting. Make funnel using metal sheet.

3. Electrical and Electronic Skill

Use of digital Multimeter. Soldering of electrical circuits having discrete components (R, L, C, diode) and ICs on PCB. Operation of oscilloscope. Making regulated power supply with variable output Voltage. Difference from Battery Charger. Making of digital Ammeter and digital Voltmeter. Timer circuit, Electronic switch using transistor and relay. Day Night circuit breaker using LDR. Idea on VARIAC. MEGGER. Green Energy-Solar Panel and Inverter - circuits for domestic application

4. Introduction to prime movers

Mechanism, gear system, wheel, Fixing of gears with motor axel. Lever mechanism, Lifting of heavy weight using lever. Braking systems, pulleys, working principle of power generation systems. Demonstration of pulley experiment. Applications of Chain & Pulley.

Reference Books

► A text book in Electrical Technology - B L Theraja – S. Chand and Company.

► Performance and design of AC machines – M.G. Say, ELBS Edn.

► Mechanical workshop practice, K.C. John, 2010, PHI Learning Pvt. Ltd.

► Workshop Processes, Practices and Materials, Bruce J Black 2005, 3rd Edn., Editor Newnes [ISBN: 0750660732]

► New Engineering Technology, Lawrence Smyth/Liam Hennessy,The Educational Company of Ireland [ISBN: 0861674480]

Course Outcomes:

Starting with measuring instruments like screw guage, Vernier and spherometer one student may become expertise in use of lathe and other common machine tools. A scope to become expertise in H. T. & L.T. electricity is also evident. Consequently, a self dependence option is opened in addition higher study.

5.6 SEC T6 – Electrical Circuits and Network Skills (2 Credits)

1. Basic Electricity Principles

Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with digital multimeter, AC voltmeter and ammeter.

2. Understanding Electrical Circuits

Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three- phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. AC transmission & Watt-less component. Saving energy and money.

3. Electrical Drawing and Symbols

Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop.

4. Generators and Transformers

AC Generator, DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.

5. Electric Motors

Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor.

6. Solid-State Devices & Instruments:

Resistors, inductors and capacitors. Diode rectifiers, PV cell and SCR. Components connected in Series or in shunt. Response of inductors and capacitors with DC or AC sources. AC Meters for H T Line: Megger, Earth Tester, Cross talk Meter and Cable fault locator (time domain reflection).

7. Electrical Protection

Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device)

8. Electrical Wiring- Domestic and outdoor:

Different types of conductors and cables. Basics of wiring-Star and delta connection in both Low tension and High Tension AC transmission. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Armoured and non armoured cable. Cable trays. Conduit: For LT AC transmission. Protection for H.T. AC. Transmission. Ceramic insulators for H.T. AC transmission. Mechanical and Thermal Stress in H T AC transmission line. Splices or joining: wire nuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board. Fault detection in transmission: domestic and Outdoor.

Reference Books

- ► A text book in Electrical Technology - B L Theraja - S Chand & Co.
- ► A text book of Electrical Technology - A K Theraja
- ► Performance and design of AC machines - M G Say ELBS Edn.
- ► H.Cotton, “Advanced Electrical Technology", CBS Publishers, New Delhi,.
- ► Basic Electronics: Principles and Applications, Chinmoy Saha, Arindam Halder, Debarati Ganguly, 2018, Cambridge University Press
- ► Electronics Fundamentals And Applications, P C Chattopadhyay, D. Rakshit, 2020, New Age International Private Limited

Course Outcomes:

The syllabus is itself an independent course for Electricity and Electronics if the 10+2 level relevant parts are gripped earlier. The basis of syllabus is to make a learner with increased knowledge for promoting small industry related exposure or self-earner for livelihood.

SEMESTER-VI

5.7 SEC T7 - Basic Instrumentation Skills (2 Credits)

1. Basic of Measurement

Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.

2. Electronic Voltmeter

Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance.

3. Cathode Ray Oscilloscope

Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance.

Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.

4. Signal Generators and Analysis Instruments

Block diagram, explanation and specifications of low frequency signal generators. Pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.

5. Impedance Bridges & Q-Meters

Block diagram of bridge: working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges.

6. Digital Instruments

Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.

Digital Multimeter

Block diagram and working of a digital multimeter. Working principle of time interval,

frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution.

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.

2. CRO as a versatile measuring device.

3. Circuit tracing of Laboratory electronic equipment,

4. Use of Digital multimeter/VTVM for measuring voltages

5. Circuit tracing of Laboratory electronic equipment,

6. Winding a coil / transformer.

7. Study the layout of receiver circuit.

8. Trouble shooting a circuit

9. Balancing of bridges

Laboratory Exercises

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.

2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.

3. To measure Q of a coil and its dependence on frequency, using a Q- meter.

4. Measurement of voltage, frequency, time period and phase angle using CRO.

5. Measurement of time period, frequency, average period using universal counter/ frequency counter.

6. Measurement of rise, fall and delay times using a CRO.

7. Measurement of distortion of a RF signal generator using distortion factor meter.

8. Measurement of R, L and C using a LCR bridge/ universal

Open Ended Experiments

1. Using a Dual Trace Oscilloscope

2. Converting the range of a given measuring instrument (voltmeter, ammeter)

Course Outcomes:

Through this course, the students will develop the ideas about the basics of measurements. They

learn the uses of various instruments like electronic voltmeter, cathode ray oscilloscope (CRO), Signal Generators and Analysis Instruments, Impedance Bridges & Q-Meters and some digital instruments.

5.8 SEC T8 - Applied Optics (2 Credits)

1. Sources and Detectors

Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients,

Light amplification, Characterization of laser beam, He-Ne laser, Semiconductor lasers.

Experiments on Lasers:

1. Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser.

2. To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser.

3. To find the polarization angle of laser light using polarizer and analyzer

4. Thermal expansion of quartz using laser

Experiments on Semiconductor Sources and Detectors

1. V-I characteristics of LED

2. Study the characteristics of solid state laser

3. Study the characteristics of LDR

4. Photovoltaic Cell

5. Characteristics of IR sensor

2. Fourier Optics

Concept of Spatial frequency filtering, Fourier transforming property of a thin lens

Experiments on Fourier Optics:

1. Fourier optic and image processing

a. Optical image addition/subtraction

b. Optical image differentiation

c. Fourier optical filtering

d. Construction of an optical 4f system

2. Fourier Transform Spectroscopy

Fourier Transform Spectroscopy (FTS) is a powerful method for measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry and forensic science.

Experiment:

1. To study the interference pattern from a Michelson interferometer as a function of mirror separation in the interferometer. The resulting interferogram is the Fourier transform of the power spectrum of the source. Analysis of experimental interferograms allows one to determine the transmission characteristics of several interference filters. Computer simulation can also be done.

3. Holography

Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, interferometry, and character recognition

Experiments on Holography and interferometry

1. Recording and reconstructing holograms

2. Constructing a Michelson interferometer or a Fabry Perot interferometer

3. Measuring the refractive index of air

4. Constructing a Sagnac interferometer

5. Constructing a Mach-Zehnder interferometer

6. White light Hologram

4. Photonics: Fibre Optics

Optical fibres and their properties, Principal of light propagation through a fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating

Experiments on Photonics: Fibre Optics

1. To measure the numerical aperture of an optical fibre

2. To study the variation of the bending loss in a multimode fibre

3. To determine the mode field diameter (MFD) of fundamental mode in a single-mode fibre by measurements of its far field Gaussian pattern

4. To measure the near field intensity profile of a fibre and study its refractive index profile

5. To determine the power loss at a splice between two multimode fibre

Reference Books

► Fundamental of optics, F. A. Jenkins & H. E. White, 1981, Tata McGraw hill.

► LASERS: Fundamentals & applications, K.Thyagrajan&A.K.Ghatak, 2010, Tata McGraw Hill

► Fibre optics through experiments, M.R.Shenoy, S.K.Khijwania, et.al. 2009, Viva Books

► Nonlinear Optics, Robert W. Boyd, (Chapter-I), 2008, Elsevier.

► Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer.

► Optical Systems and Processes, Joseph Shamir, 2009, PHI Learning Pvt. Ltd.

► Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt. Ltd.

► Optical Physics, A.Lipson, S.G.Lipson, H.Lipson, 4th Edn., 1996, Cambridge Univ. Press

Course Outcomes:

Through this course the students will have some ideas about lasers, Fourier transform spectroscopy, holography and fibre optics.
