9. COMPLEMENTARY PHYSICS FOR MATHEMATICS AND STATISTICS

Semester I **2 credits (36 hours)**

PH1CMT01: PROPERTIES OF MATTER & ERROR ANALYSIS

Module I

Elasticity **(13 hours)**

Stress- strain- Hooke's law- Elastic moduli- Poisson's ratio- twisting couple- determination of rigidity modulus- static and dynamic methods- static torsion- torsion pendulum, bending of beams- cantilever, uniform and non-uniform bending, I section girder.

Module II

Surface tension **(3 hours)**

Molecular theory of surface tension - surface energy - excess pressure in a liquid drop, factors affecting surface tension - applications

Hydrodynamics **(7 hours)**

Streamline and turbulent flow - critical velocity - Coefficient of viscosity - Derivation of Poiseuille's equation, Stokes equation-Determination of viscosity by Poiseuille's method - Brownian motion – Viscosity of gases – Bernoulli's theorem.

Module III **(13 hours)**

Error Analysis

Basic ideas – uncertainties of measurement – importance of estimating errors – dominant errors – random errors – systematic errors - rejection of spurious measurements. Estimating and reporting errors – errors with reading scales, errors of digital instruments – number of significant digits –absolute and relative errors – standard deviation. Propagation of errors – sum and differences – products and quotients – multiplying by constants – powers

References:

1. *Elements of properties of matter, D S Mathur*
2. *Advanced course in Practical Physics by D Chattopadhyay*
3. *Properties of Matter- Brijlal and N. Subrahmanyam (S. Chand and Co.)*
4. *Concepts of Modern Physics- A. Beiser (Tata McGraw-Hill, 5th Edn.)*
5. *Modern Physics- G. Aruldas and P. Rajagopal (PHI Pub)*
6. *Physics- Resnick and Halliday*
7. *An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements, John R. Taylor - Univ. Science Books*

Semester II **2 credits (36 hours)**

PH2CMT01: MECHANICS AND ASTROPHYSICS

Module I

Motion under Gravity **(5 hours)**

Velocity- acceleration- force – acceleration due to gravity - compound pendulum (symmetric and asymmetric) radius of gyration – Kater's Pendulum- centripetal acceleration and force - centrifugal force

Rotational Dynamics **(10 hours)**

Angular velocity- angular momentum- torque- conservation of angular momentum- angular acceleration- moment of inertia- parallel and perpendicular axes theorems- moment of inertia of rod, ring, disc, cylinder and sphere- flywheel

Module II

Oscillations **(9 hours)**

Periodic and oscillatory motion- simple harmonic motion- differential equation, expression for displacement, velocity and acceleration- graphical representation- energy of a particle executing simple harmonic motion - damped oscillation- forced oscillation and resonance.

Waves **(4 hours)**

Waves-classifications- progressive wave- energy of progressive wave- superposition of waves-theory of beats- Doppler Effect.

Module III

Astrophysics **(8 hours)**

Temperature and color of a star- elements present in a stellar atmosphere- mass of star- life time of a star- main sequence stars-HR diagram- evolution of stars- white dwarf- supernova explosion- neutron star- black hole- (all topics to be treated qualitatively)

References

1. Elements of properties of matter, D S Mathur Mechanics- H.S.Hans and S.P.Puri. (TMH)
2. Mechanics, D S Mathur
3. Modern Physics- R. Murugeshan, Er. Kirthiga Sivaprasad

4. A text book on oscillations waves and acoustics, M.Ghosh , D Bhattacharya
5. Introduction to Astrophysics-Baidyanath Basu.
6. Mechanics by D.S. Mathur and P.S. Hemne, S. Chand.
7. Waves, Mechanics & Oscillations- S B Puri

Semester III **3 credits (54 hours)**

PH3CMT01: MODERN PHYSICS AND ELECTRONICS

Module I

Modern Physics **(18 hours)**

Basic features of Bohr atom model-formula for energy- vector atom model- various quantum numbers-coupling schemes – LS & JJ-Pauli's exclusion principle- magnetic moments of orbital electrons

Atomic nucleus-classification-basic properties of nucleus-charge, mass, spin, magnetic moment binding energy and packing fraction-nuclear forces-salient features

Radioactivity- properties of alpha, beta and gamma-Soddy Fajan's displacement law, law of radioactive disintegration-decay constant-half life and mean life-radioactive equilibrium - measurement of radioactivity-radio carbon dating

Module II

Quantum Mechanics **(12 hours)**

Inadequacies of classical physics-experimental evidences-evidences for quantum theory-Planck's hypothesis-foundation of quantum mechanics-wave function & probability density- Schrödinger equation-time dependent and time independent particle in a potential box.

Spectroscopy **(6 hours)**

Optical spectra- spectral terms, selection rules, hyperfine structure; molecular spectra-rotational, vibrational and electronic spectra; Raman effect- experimental study, quantum theory; fluorescence and phosphorescence; comparison of Raman, fluorescence and IR spectra; NMR

Module III

Electronics (8 hours)

Current-voltage characteristics of a diode-forward and reverse bias-breakdown mechanism of p-n junction diode-Zener diode and its characteristics-half wave and full wave rectifiers- bridge rectifier-ripple factor, efficiency. Bipolar junction transistor-Construction and operation.

Module IV

Digital Electronics (10 hours)

Different number systems – decimal, binary, octal, hexa decimal number systems-conversion between different number systems- binary mathematics – addition, subtraction (1's compliment and 2's compliment methods) - basic theorems of Boolean algebra- de Morgan's theorems – Simplification of Boolean equations - AND, OR, NOT, NAND, NOR, XOR gates- truth tables- half adder- full adder

References

1. *Modern Physics- R. Murugeshan, Er. Kirthiga Sivaprasad*
2. *Principles of electronics, V K Mehta*
3. *Digital principles and applications- A. P. Malvino and P. Leach*
4. *Concepts of Modern Physics: Arthur Beiser (TMH).*
5. *Basic Electronics , B L Thereja (S. Chand)*

Semester IV 3 credits (54 hours)

PH4CMT01: OPTICS & ELECTRICITY

Module I

Interference, Diffraction and Polarization (22 hours)

Light waves- phase difference and coherence, optical path and phase change, principle of superposition, Analytical treatment of interference-young's double slit experiment, conditions for interference, bandwidth - Interference in thin films-reflected system-colour of thin films-fringes of equal inclination and equal thickness. Newton's rings-reflected system-measurement of wavelength

Fresnel and Fraunhofer diffractions.Fresnel's theory of approximate rectilinear propagation of light-.Fraunhofer diffraction.Theory of Plane transmission grating-determination of wavelength-dispersive power of grating. Prism and grating spectra, resolving power, Rayleigh criterion, resolving power of grating,

Polarization, types of polarization, Brewster's law, dichroism, birefringence – e ray and o-ray, polarizer and analyser, Malu's law, optical activity

Module II

Laser and Fiber Optics **(10 hours)**

Principle of operation of laser-population inversion, metastable states, optical resonator-components of laser- active medium, pump, optical resonant cavity- principal pumping schemes- three level and four level- laser beam characteristics applications of lasers. Light propagation in optical fibers, acceptance angle, numerical aperture-step index fiber - graded index fiber.

Module III

Dielectrics **(10 hours)**

Dielectrics- polar and non-polar dielectrics- polarization- sources of polarization-Gauss's law in dielectrics- permittivity- dielectric displacement vector- dielectric constant-susceptibility- ferro-electricity.

Module IV

Varying Currents **(12 hours)**

Transient currents – Growth and decay of current in an inductive circuit – charging and discharging of a capacitor through a resistance - Peak, mean, rms and effective values of a.c, Ac circuits-AC through RC, LC, LR and LCR series circuits resonance-sharpness of resonance-power factor.

References:

1. *Optics - Brijlal and N. Subrahmanyam, S Chand-2015*
2. *Electricity and Magnetism , D C Tayal*
3. *Electricity and Magnetism- J. H. Fewkes & John Yarwood*
4. *Electricity and Magnetism – R. Murugeshan*

5. *Nuclear physics –Irvin Kaplan*
6. *Lasers – theory & applications- Thyagarajan & Ghatak*
7. *Concepts of Modern Physics- A. Beiser*
8. *Laser Physics and Applications, V K Jain (Narosa Publication)*
9. *Optical Fiber Communications, John M Senior*

10. COMPLEMENTARY PHYSICS FOR CHEMISTRY AND GEOLOGY

Semester 1

PH1CMT02: PROPERTIES OF MATTER AND THERMODYNAMICS

Module I

Elasticity (13 hours)

Stress- strain- Hooke's law- Elastic moduli- Poisson's ratio- twisting couple- determination of rigidity modulus- static and dynamic methods- static torsion- torsion pendulum, bending of beams- cantilever, uniform and non-uniform bending, I section girder.

Module II

Surface tension (3 hours)

Molecular theory of surface tension - surface energy - excess pressure in a liquid drop, factors affecting surface tension - applications

Hydrodynamics (7 hours)

Streamline and turbulent flow - critical velocity - Coefficient of viscosity - Derivation of Poiseuille's equation, Stokes equation-Determination of viscosity by Poiseuille's method - Brownian motion – Viscosity of gases- Bernoulli's theorem.

Text Book: Elements of properties of matter, D S Mathur, Chapter- 14

Module III

Thermodynamics (13 hours)

Thermodynamic systems- thermodynamic equilibrium- thermodynamic processes- isothermal process- adiabatic process- zeroth law of thermodynamics, first law of thermodynamics- heat engine- the Carnot engine- refrigerator, concept of entropy- second law of thermodynamics- third law of thermodynamics- Maxwell's thermodynamic relations

Text Books:

1. Elements of properties of matter, D S Mathur- S Chand
2. Heat and Thermodynamics-Brijlal & Subrahmanyam (S.Chand)

References

1. Mechanics - H.S.Hans and S.P.Puri. (Tata McGraw-Hill)
2. Properties of Matter - Brijlal and N. Subrahmanyam (S. Chand and Co.)
3. Mechanics - J.C. Upadhyaya (Ram Prasad and sons)
4. Heat and Thermodynamics – Mark W Zemanski (Tata McGraw-Hill)

Semester 2

PH2CMT02: MECHANICS AND SUPERCONDUCTIVITY

Module I

Motion under gravity **(5 hours)**

Velocity- acceleration- force – acceleration due to gravity - compound pendulum (symmetric and asymmetric) radius of gyration –centripetal acceleration and force - centrifugal force

Rotational dynamics **(10 hours)**

Angular velocity- angular momentum- torque- conservation of angular momentum- angular acceleration- moment of inertia- parallel and perpendicular axes theorems- moment of inertia of rod, ring, disc, cylinder and sphere- flywheel

Module II

Oscillations **(9 hours)**

Periodic and oscillatory motion- simple harmonic motion- differential equation, expression for displacement, velocity and acceleration- graphical representation- energy of a particle executing simple harmonic motion damped oscillation- forced oscillation and resonance.

Waves **(4 hours)**

Waves-classifications- progressive wave- energy of progressive wave- superposition of waves-theory of beats- Doppler effect.

Module III

Superconductivity (8 hours)

Super conducting phenomenon- Occurrence- BCS theory (qualitative) Meissner Effect- Type I and Type II superconductors- Josephson effects (qualitative) - High temperature superconductors- Applications of Superconductivity

Text Books:

1. *Elements of properties of matter, D S Mathur- S Chand*
2. *Mechanics- D S Mathur- S Chand*
3. *Solid State Physics- P K Palanisamy- Scitech*

References

1. *Properties of Matter- Brijlal and N. Subrahmanyam (S. Chand and Co.)*
2. *A text book on oscillations waves and acoustics, M.Ghosh , D Bhattacharya*
3. *Solid State Physics- R. K. Puri and V.K. Babbar (S. Chand and Co.)*
4. *Elementary Solid State Physics,Ali Omar*
5. *Modern Physics- Murugeshan- S Chand*

Semester III

PH3CMT02: MODERN PHYSICS AND MAGNETISM

Module I

Modern Physics (18 hours)

Basic features of Bohr atom model-formula for energy-vector atom model- various quantum numbers- Coupling schemes-LS and JJ coupling-Pauli's exclusion principle-magnetic moment of orbital electrons,

Atomic nucleus classification-basic properties of nucleus-charge, mass, spin, magnetic moment binding energy and packing fraction-nuclear forces-salient features

Radioactivity- properties of alpha, beta and gamma- Soddy Fajan's displacement law, law of radioactive disintegration -decay constant-half life and mean life-radioactive equilibrium - measurement of radioactivity-.Radio carbon dating

Module II

Quantum Mechanics (12 hours)

Inadequacies of classical physics-experimental evidences-evidences for quantum theory-Planck's hypothesis-foundation of quantum mechanics-wave function & probability density- Schrödinger equation-time dependent and time independent particle in a potential box.

Spectroscopy (6 hours)

Optical spectra- spectral terms, selection rules, hyperfine structure; molecular spectra-rotational, vibrational and electronic spectra; Raman effect- experimental study, quantum theory; fluorescence and phosphorescence; comparison of Raman, fluorescence and IR spectra; NMR

Module III

Electronics (8 hours)

Current-voltage characteristics of a diode-forward and reverse bias-breakdown mechanism of p-n junction diode-Zener diode and its characteristics-half wave and full wave rectifiers- bridge rectifier-ripple factor, efficiency. Construction and operation of a bipolar junction transistor

Module IV

Magnetism (10 hours)

Properties of magnetic materials, Paramagnetism, Diamagnetism, Ferromagnetism, Hysteresis, Ferrites, Magnetostriction, Earth's magnetism-elements of earth's magnetism-dip, declination, horizontal and vertical components-magnetic maps- magnetographs-cause of earth's magnetism

Text Books:

1. *Modern Physics- R. Murugeshan, Er. Kirthiga Sivaprasad . S Chand*
2. *Principles of electronics, V K Mehta, S Chand*
3. *Electricity and magnetism, D C Tayal,*

References

1. *Functional Electronics, Ramanan (Tata McGraw-Hill)*
2. *Electricity and magnetism - Brijlal and N. Subrahmanyam (S. Chand and Co.)*

Semester IV

PH4CMT02: OPTICS AND SOLID STATE PHYSICS

Module I

Interference, Diffraction and Polarization (22 hours)

Light waves- phase difference and coherence, optical path and phase change, principle of superposition, Analytical treatment of interference-- young's double slit experiment, conditions for interference, bandwidth Interference in thin films-reflected system-colour of thin films-fringes of equal inclination and equal thickness. Newton's rings-reflected system-measurement of wavelength

Fresnel and Fraunhofer diffractions.Fresnel's theory of approximate rectilinear propagation of light. Fraunhofer diffraction.Theory of Plane transmission grating-determination of wavelength- dispersive power of grating. Prism and grating spectra, resolving power, Rayleigh criterion, resolving power of grating,

Polarization, types of polarization, Brewster's law, dichroism, birefringence – e ray and o-ray, polarizer and analyzer, Malu's law, optical activity

Module II

Laser and Fiber Optics (10 hours)

Principle of operation of laser-population inversion, metastable states, optical resonator-components of laser- active medium, pump, optical resonant cavity- principal pumping schemes- three level and four level- laser beam characteristics, applications of lasers. Light propagation in optical fibers, acceptance angle, numerical aperture-step index fiber - graded index fiber.

Module III

Dielectrics (10 hours)

Dielectrics- polar and non-polar dielectrics- polarization- sources of polarization-Gauss's law in dielectrics- permittivity- dielectric displacement vector- dielectric constant-susceptibility- ferro-electricity.

Module IV

Crystallography (12 hours)

Crystal structure-crystal lattice and translation vectors-unit cell-types of lattices- Miller indices- lattice directions and planes interplanar spacing-simple crystal structures- sc, fcc, bcc, hcp close packed structures- -sodium chloride structure. X-ray crystallography-diffraction of x-rays-Bragg's law

Text Books:

1. *Optics - Brijlal and N. Subrahmanyam - S Chand-2015*
2. *Electricity and Magnetism , D C Tayal*
3. *Solid State Physics, S O Pillai*

References:

1. *A text book of Applied Physics – A .K Jha*
2. *Electricity and Magnetism – R. Murugeshan (S Chand & Co.)*
3. *Solid state physics, P. K Palanisami*
4. *Lasers – theory & applications- Thyagarajan &Ghatak*

COMPLEMENTARY PHYSICS PRACTICALS

Semester I & II

Complementary Physics Practical 1: PH2CMP01

1. Vernier Calipers -- Volume of cylinder (solid and hollow), sphere and beaker
2. Screw gauge – Radius of wire, volume of sphere and glass piece
3. Beam balance - Mass of a solid (sensibility method)
4. Spectrometer - Refractive Index of material of prism.
5. Diode characteristics- ac and dc resistance
6. Coefficient of viscosity of the liquid – Constant **OR** Variable pressure head method
7. Surface Tension – Capillary rise method
8. Determination of Young's Modulus- Cantilever (Scale and Telescope)
   OR - Uniform bending (Optic lever method)
   OR- Non-uniform bending (Pin and Microscope method)
9. Acceleration due to gravity (g)- Symmetric Compound Pendulum
   OR Kater's pendulum
10. Symmetric Compound Pendulum - Determination of Radius of gyration and moment of inertia
11. Fly wheel – Moment of Inertia
12. Torsion pendulum -Rigidity modulus
13. Determination of moment of inertia of rotationally symmetric body (solid sphere **OR** cylinder **OR** disc) from their period of oscillation on a torsion axle
14. Spring constant - Hooke's law - oscillation
15. Resistivity of the material of the wire- Ohm's law and verification by multimeter
16. Construction of half wave rectifier with and without filter – Ripple factor
17. Laser- Transmission **OR** Reflection Grating- Determination of wavelength
18. Liquid lens - Refractive Index of glass using a liquid of known refractive index
19. Poisson's ratio of rubber
20. Temperature dependence of capacitance- polymer and ceramic capacitors
21. Resistance of a galvanometer and its figure of merit.

Semester III & IV: Complementary Physics Practical 2: PH4CMP02

1. Determination of Young's Modulus- Cantilever (Pin & Microscope)
   OR Uniform bending (pin and microscope)**OR** Non-uniform bending (optic lever)
2. Asymmetric Compound Pendulum- Determination of moment of inertia and Acceleration due to gravity (g)
3. Torsion pendulum (Equal mass method) - Rigidity modulus and Moment of Inertia
4. Spectrometer – Dispersive power of prism
5. Spectrometer – Dispersive power of a Grating
6. Newton's rings -Wave length
7. Characteristics of Zener diode- ac and dc resistance
8. Conversion of Galvanometer into voltmeter
9. Carey Foster's Bridge -Measurement of resistivity
10. Tangent Galvanometer – Ammeter calibration
11. Potentiometer-Calibration of low range ammeter **OR** voltmeter
12. Construction of full wave rectifier (center-tap **OR** bridge) with and without filter – Ripple factor
13. Construction of regulated power supply using Zener diode- line and load regulation
14. Laser diffraction- width of single slit **OR** thickness of wire
15. Refractive index of liquid- Liquid Lens **OR** Spectrometer and Hollow Prism
16. Air wedge-thickness of wire
17. Static Torsion - Rigidity modulus
18. Deflection and Vibration Magnetometer-m & Bh
19. Field along the axis of circular coil- determination of Bh
20. Searle's Vibration Magnetometer - magnetic moment
21. Gates – AND, OR, NOT- verification of truth tables

References

1. *Practical Physics – C L Arora- S Chand*
2. *Properties of Matter -D.S. Mathur*
3. *Optics -Subrahmanyam& Brijlal*
4. *Electricity &Magnetism -Sreevastava*
5. *Electronics Lab Manual (Vol.1) -K. A. Navas*
6. *Laboratory manual for electronic devices and circuits-David A Bell*
7. *Practical Physics- Joseph Ittiavirah, Premnath and Abraham*