

# UNIVERSITY OF KERALA

FOUR

ADVANCED IN

ED

REVISED SYLLABUS

FOR THE DEGREE PROGRAM

PHYSICS

UNDER COORDINATION





## Books for Reference:

1. Heat and Thermodynamics: Zemansky, McGraw-Hill
2. Heat and Thermodynamics: Rose C McCarthy, The Rosen Publishing Group, Inc. NY, 2005
3. Thermodynamics, Kinetic Theory and Statistical Thermodynamics: F. W. Sears and G. L. Salinger, Addison-Wesley Publishing Company, 3<sup>rd</sup> Edn.

## PY 1341 ELECTRODYNAMICS $TC(2) + VT(1)$

(54 Hours-3 Credits).

### Unit 1-Electrostatic Field (10hrs)

Electric field: introduction, Coulomb's law, Electric field, continuous distribution (Revision), Divergence and curl of electrostatic fields; Field lines, flux applications of Gauss's law, Curl of E, Electric potential: Introduction, to potential, Comments on potential, Poisson's and Laplace's equations, potential of a localized charge distribution, Electrostatic boundary, Work and Energy in Electrostatics: The work done to move a charge, the energy of a point charge distribution, The energy of a continuous charge distribution.

### Unit 2-Electrostatic fields in matter (10 hrs)

Polarization: Dielectrics, induced dipoles, Polarization, The field of a polarized object: Bound charges, physical interpretation of bound charges and the field inside a dielectric Electric displacement: Gauss's law in the presence dielectrics, Boundary conditions.

### Unit 3-Magnetostatics (7hrs)

Introduction The Biot- Savart law, Ampere's force law (revision), Magnetic torque, Magnetic flux and Gauss's law for magnetic fields, magnetic vector potential, Magnetic intensity and Ampere's circuital law, magnetic materials.

### Unit 4-Electromagnetic Induction (7hrs)

Electromotive force: Ohm's law Electromagnetic Induction Faraday's law, the induced electric field, Maxwell's equations, Magnetic charge,

### Unit 5-Electromagnetic waves (6hrs)

Waves in one dimension: The wave equation Electromagnetic waves in vacuum: The wave equation for E and B, Monochromatic plane waves, Energy and momentum in electromagnetic waves.

### Unit 6-Transient currents (7hrs)

Growth and decay of current in LR and CR Circuits-Measurement of high resistance by leakage-Charging and discharging of a capacitor through LCR circuit.

### Unit 7-Alternating current (7 hrs)

AC through series LCR (acceptor circuit) and parallel LCR circuit (rejecter circuit)- Q- factor, Power in AC-power factor.



**Books for Study:**

- Electrodynamics: David J Griffith, PHI, 3<sup>rd</sup>Edn.
- Electricity and Magnetism: Murugesan, S.Chand & Co.
- Electricity and Magnetism: K.K.Tiwari, S.Chand & Co.
- Principles of electromagnetics: Matthew N.O. Sadiku and S. V. Kulkarni, Oxford University Press, 6<sup>th</sup>Edn.

**Books for Reference:**

- Electricity and Magnetism: Muneer H. Nayfeh & Norton K. Bressel, John Wiley & Sons
- Electricity and Magnetism: E.M. Purcell, Berkley Physics course, Vol.2, MGH
- Electricity and Magnetism: J.H. Fewkes & John Yarwood, University Tutorial Press
- Classical Electrodynamics: Walter Greiner, Springer International Edn.
- Electromagnetic waves and radiating systems: Jordan & Balmain, PHI
- Electromagnetics: B.B.Laud, Wiley Eastern Ltd., 2<sup>nd</sup>Edn.
- Introduction to electrodynamics: Reitz & Milford Addison Wesley
- Electromagnetic theory fundamentals: Bhag Guru and Huseyin Hiziroglu, Cambridge University Press, 2<sup>nd</sup>Edn.
- Electricity and Magnetism: D.C.Tayal, Himalaya Publishing Co.

**Topic for discussion in Tutorial session/Assignments (sample)**

1. Comment on how electrostatic energy is stored in a field
2. Discuss the electrostatic properties of conductors
3. What is meant by electrostatic shielding? In what way it helps us?
4. Discuss the peculiarities of electric displacement  $D$  and electric field  $E$ . How they are incorporated in Maxwell's Equations
5. Discuss the properties of linear dielectrics. What differentiates a dielectric to be linear or not?
6. Discuss applications of Ampere's circuital law
7. Compare electrostatics and magnetostatics
8. Why magnetic forces cannot do work
9. Discuss about cyclotron motion & cycloid motion
10. Discuss whether there exists any stand-off between ohm's law and Newton's second law
11. A battery has an *emf*. Can this *emf* be a 'force'? How will you interpret electromotive force?
12. Discuss the role of motional *emf* in power generation
13. Discuss the orthogonality of  $E$ ,  $B$  and propagation vector  $k$
14. A wave function can have a sinusoidal representation. Solve the wave equation for this function and discuss the various terms related to a wave such as amplitude, frequency, phase, wave number.
15. Complex representation of wave function has good advantage. Why? Discuss the linearity of wave function. (use complex notation)

16. Discuss AC through LC, LR and CR circuits
17. Show that sharpness of resonance is equal to Q- factor
18. What is a choke coil? Discuss the advantage of using a choke coil instead of a resistor

## PY 1441 CLASSICAL AND RELATIVISTIC MECHANICS

**(54 Hours-3 Credits).**

### Unit 1 - Particle Dynamics (5 hrs)

Mechanics of a particle – equation of motion of a particle – Motion of a charged particle in an electromagnetic field – mechanics of a system of particles.

### Unit 2-Conservation laws (6 hrs)

Linear uniformities of space and conservation of linear momentum – rotational invariance of space; law of conservation of angular momentum – homogeneity of flow of time and conservation of energy.

### Unit 3- Motion in central force field (10 hrs)

Equivalent one body problem – motion in central force field – general features of motion – motion in inverse square law force field – equation of the orbit – Kepler's laws of planetary motion and their deduction.

### Unit 4 - Collisions (6 hrs)

Conservation laws- Conservation of momentum- laboratory and centre of mass systems- kinetic energies in the lab and CM systems-Cross-section of elastic scattering

### Unit 5. Lagrangian Dynamics(9hrs)

Constraints-generalized coordinates- principle of virtual work-D'Alembert's principle, Lagrange's equation from D'Alembert's principle-applications of Lagrange's equation in simple pendulum, Atwood machine and compound pendulum, Comparison of Lagrangian approach with Newtonian approach.

### Unit 6. Hamiltonian Dynamics(5hrs)

Generalized momentum and cyclic coordinates- Hamiltonian function H- conservation of energy Hamilton's equation - examples of Hamiltonian dynamics- one dimensional harmonic oscillator

### Unit 7. Frames of Reference, Galilean transformation and Special theory of relativity(13hrs)

Inertial frames of reference- Galilean transformation- non- inertial frames Origin and significance of special theory of relativity-search for universal frame of reference-Michelson-Morley experiment- postulates of special theory of relativity- consequences-Lorentz transformation equations- kinematical consequences of Lorentz transformations-length contraction-time dilation-twin paradox-transformation of velocity- variation of mass with velocity- mass energy equivalence

### Books for Study:

1. Classical Mechanics: J. C. Upadhyaya, Himalaya Publishing



Mechanics: H.S.Hans and S.P.Puri, Tata-McGraw Hill

Classical Mechanics: G. Aruldhas, PHI Learning Pvt Ltd., 2008

Introduction to classical mechanics: R.G.Thakwale and P.S.Puranik, Tata-McGraw Hill.

Classical Mechanics: Vimal Kumar Jain, Ane Books Pvt. Ltd., 2009

#### Books for Reference:

Classical Mechanics: Goldstein.

Modern Physics: Ronald Gautreau, Schaum's outlines series, 1999

Classical Mechanics-Systems of Particles & Hamiltonian Dynamics: Walter Greiner, Springer, 2<sup>nd</sup> Edn.

Classical Mechanics: N.C Rana and P.S.Joag, TMH Education Pvt. Ltd., 2015

### PY1541- QUANTUM MECHANICS

72 HRS-4 CREDITS)

#### Unit 1 – The Emergence of Quantum Mechanics (18 hrs)

Limitations of classical physics, Black body radiation curve-Optical spectra — photoelectric effect - specific heat of solids -Plank's quantum hypothesis, Einstein's theory of photoelectric effect -Compton effect- Quantum theory of specific heat of solids, -Bohr model- hydrogen atom- Bohr postulates-The correspondence principle.

#### Unit 2-Wave Mechanics (22 hrs)

Wave nature of particles-electron diffraction- standing wave of electron in the orbit uncertainty principle -uncertainty relation among canonically conjugate pairs-application- non-existence of electrons in the nucleus- ground state energy of hydrogen atom- width of spectral lines-Properties of wave function-Conditions for Physical Acceptability of Wave Function, Normalization and orthogonality condition. Superposition Principle- wave packets, relation between - Particle velocity- group velocity and phase velocity- Probability Interpretation of Wave Function -Statistical Interpretation of Wave function -probability current density in one dimension- Expectation value- Time dependent Schrodinger equation, -Time independent Schrodinger equation - stationary states

#### Unit 3-One Dimensional Energy Eigen Value Problems (14hrs)

Free particle Schrodinger equation-square-well potential with infinite walls- Square well potential with finite walls, square potential barrier- The Harmonic oscillator- (Schrodinger method)-

#### Unit 4-General Formalism of Quantum Mechanics (18hrs)

Linear vector space, Linear operator, Eigen values and Eigen functions-, Hermitian operator, Postulates of Quantum Mechanics-Equation of motion-Schrodinger representation- Momentum representation

#### Books for Study:

1. Quantum Mechanics: G. Aruldhas, PHI, 2<sup>nd</sup> Edn., 2002

2. A Text book of Quantum Mechanics: P.M. Mathews & K. Venkatesan- McGraw Hill, 2<sup>nd</sup> Edn., 2002
3. Quantum Mechanics: Robert Eisberg and Robert Resnick, Wiley, 2<sup>nd</sup> Edn. 2002
4. Quantum Mechanics: Leonard I. Schiff, TMH, 3<sup>rd</sup> Edn., 2010
5. Concepts of Modern Physics: Arthur Beiser, TMH, 6<sup>th</sup> Edn.

#### Books for Reference:

1. Quantum Mechanics: Eugen Merzbacher, John Wiley and Sons Inc., 2004
2. Introduction to Quantum Mechanics: David J. Griffith, Pearson Education, 2<sup>nd</sup> Ed. 2005
3. Quantum Mechanics: Walter Greiner, Springer, 4<sup>th</sup> Edn., 2001
4. Quantum Mechanics: Bruce Cameron Reed, Jones and Bartlett, 2008.
5. Quantum Mechanics for Scientists & Engineers: D.A. B. Miller, Cambridge University Press, 2006
6. Shaum's outline series

### PY 1542: STATISTICAL PHYSICS, RESEARCH METHODOLOGY AND DISASTER MANAGEMENT

(72 HRS- 4 CREDITS)

#### Unit 1- Statistical Physics (18 hrs) JV

Statistical probability, Macro and Micro states, Phase space, Statistical ensemble, Postulate of eq probability, Maxwell Boltzmann distribution, Velocity distribution. Indistinguishability of identical particles Bose Einstein and Fermi Dirac distribution function, comparison of three statistics

#### Unit 2 Research Methodology (18 hrs) JV

Research - Objectives and motivation in research – different types of research- research approach Significance of research- Research methods and methodology – Research and scientific method- Various steps in a research process- importance of literature survey- criteria of good research.

Thesis/ Report writing - preliminary section (Title page, declaration of author, certificate of supervisor, table of contents, list of tables and figures, preface acknowledgement), Main Text (abstract, introduction, experimental section, results and discussion), Conclusions, references, scope for future study.

#### • Unit 3 Error Analysis (12 hrs) JV

Significant figures- Basic ideas of error measurement, uncertainties of measurement, importance of estimating errors, dominant errors, random errors, systematic errors, rejection of spurious measurements

Estimating and reporting of errors, errors with reading scales, absolute and relative errors, and standard deviation, Variance in measurements, error bars and graphical representation.

#### • Unit 4 – Disaster Management (24hrs) JV+JJ

Global natural disasters: Natural hazards and natural disasters, Recent major disasters and their relief efforts, Impact of global climate change and major natural disasters, Human adaptability of natural disasters, Fragile natural eco-environment, Disaster reduction activity, achievements, challenges and future developments



earthquake disaster and their effects, Advancement in research of earthquake disaster, earthquake and tsunami warnings, earthquake disaster prevention, earthquake disaster mitigation

Health emergencies and diseases: environmental health and diseases, disasters and emergencies, steps in disaster management, pre-disaster activity, role of water supply, need for protecting large scale water supply schemes, assessment of damaged and available water resources, water quality testing- Personal hygiene, control of communicable diseases and prevention of epidemics, measures for controlling communicable diseases and epidemics.

Radiation emergencies, health consequence of radiation, measures to prevent sudden health emergencies due to radiation

### Books for Study:

- 1 Thermal and Statistical Mechanics: S.K. Roy –New Age International-2001
- 2 Elements of Statistical Mechanics: Kamal Singh and S. P. Singh- S. Chand & Co, 1999
- 3 Thermal Physics, Statistical Physics and Solid State Physics: C. J. Babu, Calicut University Press
- 4 Introduction to Statistical Mechanics: S. K. Sinha, Alpha Science International Ltd. 2005
- 5 Statistical Mechanics: B. K. Agarwal- New Age International 2007
- 6 Research Methodology: C. R. Kothari, New Age International Publishers.
- 7 Natural disaster mitigation – a scientific and practical approach: Science Press, Beijing, 2009
- 8 Environmental health in emergencies and disasters: A practical guide, B. Wisner & J. Adams (Eds.), WHO, Geneva, 2002 ISBN 92-4 154541-0.
- 9 Introduction to Disaster Management: SatishModh, Macmillan, 2010

### Books for Reference:

- 1 Statistical Mechanics: S. Rajagopal
- 2 Introduction to Statistical Physics: Kerson Huang -CRC Press, 2001
- 3 Statistical Mechanics: Norman Davison, Courier Corporation, 2013
- 4 Disaster Management: Harsh K Gupta, Universities Press, 2003

## PY1543-ELECTRONICS

(HOURS - 4 CREDITS)

### Unit 1. Circuit Theory (4 hours)

Kirchhoff's law- Ideal voltage and current sources- Thevenin's and Norton's theorem, Maximum power transfer theorem

### Unit 2. Diode Circuits (14 hours)

Extrinsic semiconductors-n- type and – p-type semiconductors-PN junction-PN junction under forward and reverse biased conditions-r m s value and peak inverse voltage- diode characteristics-ac and dc resistances-



half wave and full wave rectifiers- (average value of current, ripple factor and efficiency)- different types of filters (shunt capacitor, LC and RC)- break down mechanism in diodes- Zener diode- voltage regulator-

### Unit 3. Transistors (16 hours) *TJM*

Theory of BJT operation- CB, CE and CC characteristics-  $\alpha$ ,  $\beta$  and  $\gamma$  - relation between transistor currents- biasing circuits (CE configuration)- stability factors- selection of operating point- ac and dc load lines- Q point- collector feedback; base resistor and potential divider methods- BJT amplifiers- input and output impedances- graphical analysis of CE amplifier (frequency response, band width and gain in dB)- emitter follower.

### Unit 4. Power amplifiers: (5 hours) *TJM*

Amplifier classes and efficiency - class A operation - transformer coupled class A amplifier - class B amplifier - push pull amplifier - basic ideas of class C operation - distortion in amplifiers.

### Unit 5. Feedback & Oscillator circuits (8 hours) *TJM*

Feedback principles - negative feedback - advantages of negative feedback - positive feedback - principle of sinusoidal feedback- oscillation - Barkhausen criterion for oscillations - RC phase shift, Hartley Oscillator, Colpitt's, Oscillator (derivations not required).

### Unit 6. Modulation (5 hours) *TJM*

Fundamentals of modulation - AM, FM - frequency spectrum of AM - power in AM - demodulation of AM signal - frequency spectrum for FM

### Unit 7. Special devices: (8 hours) *TJM*

JFET- Basic construction - Theory of operation - Static characteristics - Drain characteristics- Advantages - MOSFET - Depletion enhancement MOSFET - Construction - Static characteristics. Uni-junction Transistor - Construction- operation.

### Unit 8. Operational amplifiers (IC741) (12 hours) *TJM*

Introduction - Schematic symbol and pin configuration - circuit configuration and block diagram representation - differential amplifier-ideal OP amp. - CMRR - differential mode and common mode - virtual ground principle - parameters of OP amp. - inverting amplifier - non-inverting amplifier - summing - differentiator - integrator amplifiers.

### Books for Study:

1. Basic electronics: Devices, circuits and IT fundamentals: Santiram Kal, PHI, 2009
2. Basic Electronics-Solid State: B. L. Theraja, S. Chand Ltd., 2005
3. Principles of Electronics: V. K. Mehta, S. Chand Ltd., 2005
4. A first course in Electronics: Anwar A. Khan, Kanchan K. Dey, PHI, 2006
5. Communication Electronics: Jose Robin and Ubald Raj, Indira Publications, 2002

### Books for Reference:

1. Electronic Devices and Circuits: Theodore F. Bogart Jr., Universal book stall
2. Electronic devices and Circuit theory: Robert Boylestad & Louis Nashelski, PHI, 5<sup>th</sup> Edn.
3. Electronic fundamentals & applications: John D Ryder, PHI, 4<sup>th</sup> Edn.
4. Electronic Communications: Dennis Roddy, John Coolen, Pearson, 4<sup>th</sup> Edn.

### Topics for assignments/discussion in the tutorial session (sample)

1. Electronic projects using flip flops.
2. Electronic projects using logic gates.
3. Electronic projects using IC 741 OP amp.
4. Electronic projects using timer 555.
5. Electronic projects using IC 311.
6. Constant voltage power supplies.
7. Constant current sources.
8. Oscillators of different frequencies.
9. Low range frequency generators.
10. High range frequency generators.
11. Voltage regulated dc power supplies with variable output.
12. Voltage regulated dual power supplies with variable output.
13. Instrument for the measurement of capacitance.
14. Instrument for the measurement of dielectric constant of a liquid/ solid.
15. Effect of temperature on electronic components.

## PY1544-ATOMIC & MOLECULAR PHYSICS

(HOURS - 4 CREDITS)

### Unit 1- Vector Atom Model (10hrs)

Bohr's theory, correspondence principle Sommerfeld's atom model and explanation of fine structure of H $\alpha$  in Balmer series of hydrogen atom. Limitation of Sommerfeld atom model. Vector atom model - Various quantum numbers associated with vector atom model - L.S and j.j couplings - application of spatial quantization - Pauli's exclusion principle - magnetic dipole moment of electron due to orbital and spin motion - Spin-Orbit coupling.

### Unit 2- Atomic Spectra (14hrs)

Optical spectra - Spectral terms and notations - selection rules - intensity rule and interval rule - fine structure of sodium D lines - hyperfine structure - alkali spectra - Zeeman effect - Larmor's theorem - quantum mechanical explanation of normal Zeeman effect. Anomalous Zeeman effect - Paschen-Back effect - Stark effect.



### Unit 3- X-ray Diffraction (8 hrs)

X-rays- Discovery- properties -scattering -Measurement of X-ray wavelengths by ruled gratings-X-ray Spectra- continuous and characteristics X- ray spectrum-Origin of continuous Spectrum -Origin of characteristic X-rays-X-ray energy level diagram. -Absorption of X-rays-Applications of X-rays

### Unit 4- Molecular spectra (28 hrs)

Electromagnetic spectra-molecular energies-classification of molecules-rotational spectra of diatomic molecules-rotational energy levels-selection rules-rotational spectrum-isotope effect- bond length and atomic mass.

Diatomic vibrational spectra-vibrational energy levels-selection rule-vibrational transitions-Rotation-Vibration transitions-IR spectrometer

Raman scattering- classical description of Raman scattering, quantum theory of Raman scattering-vibrational Raman spectra-diatomic molecules-polyatomic molecules-rotational Raman spectra Raman spectrometer.

Electronic spectra sequences and progressions-Frank-Condon principle-

### Unit 5- Resonance Spectroscopy (12 hrs)

NMR principle-Resonance condition-NMR spectrometer-chemical shift-indirect spin-spinInteraction-applications of NMR spectroscopy-

ESR principle- Resonance condition -ESR spectrometer-hyperfineinteraction -applications of ESR spectroscopy. Mossbauerspectroscopy- principle -isomer shift.

#### Books for Study:

1. Modern Physics: G.Aruldas and P.Rajagopal, PHI, New Delhi, 2005
2. Modern Physics: R.Murugesan, S.Chand & Co., Reprint, 2008
3. Atomic and Nuclear Physics: N.Subramaniam & Brijlal, S.Chand & Co.
4. Atomic Physics: J.B.Rajam, S.Chand & Co.
5. Concepts of Modern Physics: A. Beiser, TMH, New Delhi, 6<sup>th</sup> Edn.

#### Books for Reference:

1. Fundamentals of Molecular Spectroscopy: Banwell, TMH
2. Spectroscopy: Walker & Straw, Chapman & Hill.
3. Molecular Spectroscopy: G.Aruldas, PHI, 2004
4. Atomic and Nuclear Physics: Dr. V.W.Kulkarni-Himalaya Publishing House



**(54 HOURS)**

**Unit I (7 hrs)**

Various forms of energy – renewable and conventional energy systems – comparison – coal, oil, natural gas – availability – applications – merits and demerits.

**Unit 2 (10 hrs)**

Solar energy - Solar radiation measurements, solar energy collector, principle of the conversion of radiation into heat, Solar energy storage, solar heaters, space cooling, solar ponds, solar cookers, distillation, solar furnaces, solar green houses, merits and demerits of solar energy.

**Unit 3 (9 hrs)**

Wind energy: Basic principle of wind energy conversion, basic components of wind energy conversion system (WECS), wind energy collectors, application of wind energy.

**Unit 4 (9 hrs)**

Biomass energy, classification, photosynthesis, biomass conversion process, Gobar gas plants, waste gasification, ethanol from wood, merits and demerits of biomass as energy source.

**Unit 5 (9 hrs)**

Energy from Oceans and Chemical energy resources: Ocean thermal energy Conversion, energy from waves and tides – basic ideas, nature, applications, merits and demerits.

**Unit 6 (10 hrs)**

Patterns of energy consumption in domestic, industrial, transportation and agricultural sectors – energy crisis and possible solutions – energy options for the developing countries – energy storage – primary and secondary cells – fuel cells (basics) – impact due to non-conventional energy sources – global warming.

**Books for Study:**

1. Non – Conventional Energy Resources: G. D. Rai, Khanna Publishers, 2008.
2. Solar energy: G.D. Rai, 5<sup>th</sup> edition, 1995.
3. Solar Energy Fundamentals and application: H.P. Garg and J. Prakash,
4. Tata McGraw - Hill Publishing company Ltd., 1997.

**Books for Reference:**

1. Energy Technology: S. Rao and Dr. B.B. Parulekar, 1997, 2<sup>nd</sup> Edn.
2. Power Plant Technology: A. K. Wahil. 1993.
3. Solar energy: S. P. Sukhatme, Tata McGraw- Hill Publishing company Ltd., 1997.

(72 HOURS - 4 CREDITS)

**Unit 1 Crystal Structure (18 hrs)**

Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Unit Cell. Elements of symmetry - Types of Lattices - two and three dimensional - Miller Indices - Reciprocal Lattice. - Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. X-ray diffraction techniques - Inter atomic forces. Types of bonding

**Unit 2 Conduction in Metals - Free electron model (12 hrs)**

Introduction - conduction electrons - free electron gas - electrical conductivity - electrical resistivity versus temperature - heat capacity of conduction electrons - Fermi surface - electrical conductivity - effects of the Fermi surface - thermal conductivity in metals - Hall effect and magneto resistance - A.C conductivity and optical properties - failure of free electron model. - The Kronig - Penney model - conductors, semiconductors and insulators.

**Unit 3 Band theory (10 hrs)**

Bloch theorem - Kronig Penny model - Band Gaps - Conductors - Semiconductors and insulators - P and N type Semiconductors - Conductivity of Semiconductors - mobility - Hall Effect - Hall coefficient.

**Unit 4 Dielectric Properties of Materials (12 hrs)**

Polarization - Local Electric Field at an Atom - Depolarization Field - Electric Susceptibility - Polarizability - Clausius Mosotti Equation - Classical Theory of Electric Polarizability - Normal and Anomalous Dispersion - Cauchy and Sellmeier relations - Langevin-Debye equation - Complex Dielectric Constant - Optical Phenomena - Application: Plasma Oscillations - Plasma Frequency - Plasmons

**Unit 5 Magnetic Properties of Matter (12 hrs)**

Dia, Para, Ferri and Ferromagnetic Materials. Classical Langevin Theory of Dia and Paramagnetic Domains. Quantum Mechanical Treatment of Para magnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss

**Unit 6 Superconductivity (8 hrs)**

Critical Temperature - Critical magnetic field - Meissner effect - Type I and type II Superconductors - London's Equation and Penetration Depth - Isotope effect - BCS theory - Tunnelling and Josephson effect (Qualitative study)

**Books for Study:**

1. Elements of Solid State Physics: J.P. Srivastava, 2<sup>nd</sup> Ed., 2006, Prentice-Hall of India
2. Elementary Solid State Physics: 1/e M. Ali Omar, Pearson India, 1999
3. Solid State Physics: M.A. Wahab, Narosa Publication, 2011
4. Elements of Solid State Physics: J.P. Srivastava, 2<sup>nd</sup> Edn., Prentice-Hall of India, 2006



### Books for Reference:

1. Introduction to Solid State Physics: Charles Kittel, 8<sup>th</sup> Edn., Wiley India Pvt. Ltd., 2004
2. Introduction to Solids: Leonid V. Azaroff, Tata Mc-Graw Hill, 2004
3. Solid State Physics: Neil W. Ashcroft and N. David Mermin, Cengage Learning, 1976
4. Solid State Physics: Rita John, McGraw Hill, 2014
5. Solid-state Physics: H. Ibach and H Luth, Springer, 2009

## PY 1642 NUCLEAR AND PARTICLE PHYSICS

(72 HOURS - 4 CREDITS)

### Unit 1. General Properties of Nuclei (14 hrs)

Constituents of nucleus and their Intrinsic properties-quantitative facts about size- mass- charge density (matter energy), binding energy- average binding energy and its variation with mass number- main features of binding energy versus mass number curve- nuclear stability- angular momentum- parity- magnetic moments- electric quadrupole moments- Nuclear forces-meson theory.

### Unit 2. Nuclear Models (11 hrs)

Liquid drop model -semi empirical mass formula and significance of various terms, condition of nuclear stability. Shell model-evidence for nuclear shell structure, nuclear magic numbers, basic assumptions of shell model, Collective model.

### Unit 3. Radioactivity: (12 hrs)

Alpha decay-basics of  $\alpha$ -decay processes, theory of  $\alpha$ -emission, Gamow's theory, Geiger Nuttall law.  $\beta$ -decay- energy kinematics for  $\beta$ -decay, positron emission, electron capture, neutrino hypothesis, Gamma decay: Gamma ray emission & kinematics, internal conversion.

### Unit 4. Nuclear Reactions (9 hrs)

Types of Reactions, Conservation Laws, kinematics of reactions, Q-value- reaction rate- reaction cross section- reaction mechanism-Concept of compound nucleus.

### Unit 5. Particle Detectors & Accelerators (6 hrs)

GM counter-scintillation counter- Linear accelerator- Cyclotron- Synchrotron-betatron.

### Unit 6 - Nuclear fission and fusion (12 hrs)

Nuclear fission-energy released in fission-Bohr and Wheeler's theory-chain reaction -multiplication factor-critical size-atom bomb-nuclear reactors-breeder reactors-uses of nuclear reactors. Nuclear fusion-sources of stellar energy-thermonuclear reactions-hydrogen bomb-controlled thermo-nuclear reactions-magnetic bottle-Tokamak- inertial confinement-nuclear power in India.



## Unit 7. Particle physics: (8 hrs) VT

31

Particle interactions- basic features- types of particles and its families- Symmetries and Conservation Laws- baryon number- Lepton number- Isospin- Strangeness and charm- concept of quark model- Cerenkov radiation.

### Books for Study

1. Modern Physics: R. Murugesan, S. Chand & Co., Reprint, 2008
2. Modern Physics: G. Aruldas and P. Rajagopal, PHI, New Delhi, 2005.
3. Nuclear Physics: D. C. Tayal, Himalaya Publishing House, 4<sup>th</sup> Edn.
4. Concepts of Modern Physics: A. Beiser, Tata McGraw-Hill, New Delhi, 6<sup>th</sup> Edn.
5. Atomic and Nuclear Physics: N. Subramaniam and Brijlal, S. Chand & Co.
6. Atomic Physics: J.B. Rajam, S. Chand & Co.
7. Introduction to Elementary Particles: D. Griffith, John Wiley & Sons
8. Nuclear Physics: S.N. Ghoshal, S. Chand & Co.

### Books for Reference:

1. Concepts of nuclear physics: Bernard L. Cohen, Tata McGraw Hill, 1998
2. Nuclear Physics: Kaplan, Narosa publications
3. Introductory nuclear Physics: Kenneth S. Krane, Wiley India Pvt. Ltd., 2008
4. Introduction to the physics of nuclei & particles: R.A. Dunlap, Thomson Asia, 2004
5. Quarks and Leptons: F. Halzen and A.D. Martin, Wiley India, New Delhi
6. Basic ideas and concepts in Nuclear Physics An Introductory Approach: K. Heyde, Institute of Physics Publishing, 2004
7. Radiation detection and measurement: G.F. Knoll, John Wiley & Sons, 2000
9. Theoretical Nuclear Physics: J.M. Blatt & V.F. Weisskopf, Dover Pub. Inc., 1991

## PY 1643- CLASSICAL AND MODERN OPTICS

(72 RS - 4 CREDITS)

### Unit Interference of light (12 hrs) HT

The principle of superposition - coherent sources - Double slit interference (theory of interference fringe and band width) - Interference by division of wave front and amplitude - Fresnel's biprism - interference in thin films - classification of fringes - wedge shaped films - testing of optical flatness - Newton's rings (reflected system) - refractive index of a liquid - Michelson interferometer - determination of wavelength

### Unit Diffraction (14 hrs)

Fresnel diffraction: - Half-period zones - explanation of rectilinear propagation of light - diffraction at a straight edge - zone plate. Fraunhofer diffraction: - Diffraction at a single slit, double slits - plane transmission grating. Rayleigh's criterion for resolution - resolving power of diffraction grating.

**Unit 3. Dispersion (5 hrs)****Unit 4. Polarisation (12 hrs)**

Plane polarized light -polarization by reflection – Brewster's law - pile of plates - Malus law  
Double refraction - Huygens explanation for double refraction in uniaxial crystals - Nicol prism - Nicol  
prism as a polarizer and analyzer – Theory- production and analysis of plane, circularly and elliptically  
polarized light - quarter and half wave plates.

**Unit 4. Laser (14 hrs)**

Basic principle of laser operation Einstein coefficient, light propagation through medium and conditions  
for light amplification population inversion by pumping and cavity threshold condition, line shape function  
optical resonators (qualitative) Q factor various laser systems –Ruby laser - He-NE laser, Dye laser  
semiconductor laser, (working principle only) Application of lasers- characteristics of laser beams -spatial  
coherence - Temporal coherence and spectral energy density Nonlinear optics : Nonlinear Polarization  
second harmonic generation – phase matching

**Unit 5. Fibre Optics (8 hrs)**

Introduction, optical fibre, the numerical aperture, coherent bundle, pulse dispersion in step index  
fibre, graded index fibre, single mode fibre, multimode fibre, Fibre optic sensors (qualitative), fibre optic  
communication (qualitative), Advantages of fibre optic communication system.

**Unit 6. Holography: (7 hrs)**

Principle of holography, recording of holograms, reconstruction of images (Theory not needed)  
application of holography, different types of holograms, transmission and reflection types.

**Books for Study:**

- 1 Text Book of Optics: Subramaniam & Brijlal, .Avadhanulu, 23<sup>rd</sup> edition, 2006
- 2 Optics: Ajoy Ghatak, TMH, 2005
- 3 Optics and spectroscopy: R.Murugesan and K Sivaprasad, S. Chand & Co., 2010
- 4 Lasers Principles, Types and applications: K.R.Nambiar, New Age International Pvt. Ltd. 2006
- 5 Optics: Eugene Hecht, Addison-Wesley 2002

**Books for Reference:**

1. Fundamentals of Optics: Jenkins and White, MCH
2. Modern Classical Optics: Geoffrey Brooker, Oxford University Press, 2003
3. Fundamentals of Optics-Geometrical Physical and Quantum:D. R. Khanna and H. R. Gulati  
Chand, 1984
4. Lasers & Non-Linear Optics: B. B. Laud, New Age International Pvt. Ltd., 2011
5. Electronic Communications: Dennis Roddy & John Coolen, Pearson, 1995

**Topics for assignments/discussion in the tutorial session (sample)**

1. Michelson's interferometer-Standardization of metre.
2. Diffraction at a rectangular aperture and circular aperture



3. Optical activity-Fresnel's theory of optical rotation.
4. Resolving power of prism and telescope
5. Constant deviation spectrometer.
6. Laurent's half shade polarimeter.
7. Laser applications.
8. Study of Fraunhofer lines using spectrometer.
9. Determination of refractive index of liquid by Newton's rings method.
10. Comparison of radii of curvature by Newton's rings method.
- 11.

## PY1644-DIGITAL ELECTRONICS AND COMPUTER SCIENCE

AA/SS

(72HRS-4 CREDITS)

Unit-1(22hrs)

JC

**Number systems** :- Decimal number system-binary number system-conversion of binary number to decimal and decimal number to binary-binary addition and subtraction-2's complement-2's complement-binary subtraction using 2's complement-signed arithmetic operation-conversion of real numbers-conversion of decimal fraction to binary fraction-binary coded decimal-hexadecimal number system-conversion of hexadecimal number to decimal, decimal to hexadecimal, binary to hexadecimal and hexadecimal to binary-real or floating point representation of numbers-ASCII code.

**Boolean algebra and logic gates** :- Logic gates AND, OR, NOT, NAND, NOR And Ex-OR gate-realization of other logic functions using NAND / NOR gates-tri state logic gate-Boolean laws- Demorgan's theorem-Simplification of Boolean equations using Boolean laws. Karnaugh map

**Arithmetic circuits** :- Half adder-full adder-controlled inverter-binary adder- subtractor.

**Sequential circuits** :- Flip-Flop, S-R Flip Flop, J-K Flip-flop, Master slave JK Flip- Flop

Unit2(11hrs)

GIL

**Basics of computers** :- Hardware- input and output units- memory unit-ALU-control unit-basic operational concepts-Software – operating systems

**The memory systems** :- Basic concepts-semiconductor RAM- internal organization memory chips-static memories-asynchronous and synchronous DRAM-structure of large memories- ROM,PROM,EPROM, EEPROM-flash memory-speed size and cost-Basic concepts of cache memory and virtual memories. Secondary storage-magnetic hard disks-optical disks-magnetic tape systems.

Unit-3 Programming in C++ (25 hrs)

**Features of c++** - basic structure of c++ program – library files-header files – preprocessor directives- built-in functions- output using cout- input with cin - constants and variables – data types – declaration of variables – integer variables, character variables, floating point types, type bool - assigning values to variables- manipulators-operators and expressions-arithmetic operators, relational operators, logical operators, short

hand operators-control statements-for loops, while loop, do...while loop- if statement, if.....else, else constructions, switch statement- break, continue, goto statements-user defined functions-function definition, function declaration, function header and body, function call and execution, passing arguments to functions, returning values from functions, overloaded functions, inline functions, default arguments, scope rule, functions- storage classes-Arrays-array elements, array initialization, multidimensional arrays, passing arrays to functions-strings-basics of structures and pointers in c++, classes and objects (introduction only)-basic operations-serial and sequential files, reading and writing -simple examples of c++ programs for solving problems in physics-compilation and execution of data.

#### Unit 4: Introduction to microprocessors (14 hrs)

Microprocessors and microcontrollers (definition only)-intel 8085- 8 bit microprocessor-pin diagram - 8085 instructions - addressing modes(definition only)- interrupts (definition only) -assembly language simple programs- addition, subtraction.

#### Books for study:

1. Fundamentals of Microprocessors and Microcomputers: B. Ram, Dhanpat Rai Publications
2. Digital principles and Applications: Malvino and Leach. TMH, New Delhi, 4<sup>th</sup> Edn.
3. Fundamentals of Computers: V. Rajaram, PHI, New Delhi, 4<sup>th</sup> Edn.
4. A first course in Computers: S. Saxena, Vikas Publishing House Pvt. Ltd.,
5. Programming in C++: D. Ravichandran, Tata Mc Graw Hill, 2011
6. Object oriented programming in C++: Robert L. Fore, Galgotia publications Pvt Ltd., 3<sup>rd</sup> Edn., 2004
7. The C++ programming language: Bjarne Stroustrup, 4<sup>th</sup> Edn. Addison Wesley
8. Object oriented programming with C++: E. Balaguruswami, 5<sup>th</sup> Edn., Tata Mc Graw Hill
9. Programming in C++: M. T. Somasekharan, PHI Pvt. Publishing, 2005
10. Numerical Methods with computer programs in C++: P. Ghosh, PHI Learning Pvt. Ltd.
11. The 8085 microprocessors: K. Udayakumar and B. S. Umasankar, Dorling Kindersley (India) Pvt. Ltd., 2008
12. Microprocessor 8085, 8086: Abhishek Yadav, University Science Press, New Delhi 2008
13. Microprocessor-Architecture, Programming and applications with 8085: R. S. Gaonkar,

#### Books for Reference: -

1. Introduction to digital electronics: NIIT, PHI.
2. A first course in Computers: Sanjay Saxena, Vikas publishing house Pvt. Ltd.

### PRACTICAL

#### PY 1442- Basic Physics Lab 1 (minimum 18 experiments to be done)

1. Fly Wheel - Moment of Inertia X
2. Compound Bar Pendulum - Symmetric ✓
3. Compound Bar Pendulum - Asymmetric X
4. Uniform Bending - Y - Pin and Microscope ✓



5. Uniform bending—Y- optic lever method
6. Non-uniform bending-Y-Optic lever & telescope
7. Rigidity modulus—Static torsion
8. Torsion pendulum I- By Torsional oscillations
9. Torsion pendulum I- By Equal masses
11. Kater's pendulum-Acceleration due to gravity
12. Melde's string—Frequency of fork
13. Phase transition-determination of M.P of wax.
14. Determination of thermal conductivity of rubber
15. Lee's disc-determination of thermal conductivity of a bad conductor
16. Viscosity-Continuous flow method using constant pressure head.
17. Viscosity-Variable pressure head arrangement
18. Surface tension-Capillary rise
19. Sonometer-frequency of A.C
20. Kundt's tube-determination of velocity of sound.
21. Determination of  $m$  and  $Bh$  using deflection and vibration magnetometers.
22. Potentiometer-Resistivity.
23. Comparison of least counts of measuring instruments.
24. Evaluation of errors in simple experiments.

### References

1. Yarwood and Wittle; Experimental Physics for Students, Chapman & Hall Publishers.
2. An advanced course in practical physics, Chathopadhyaya, Rakshit and Saha, New central agency, Kolkata.
3. A text book of practical physics, S. Viswanathan & Co., Chennai.
4. Advanced Practical Physics, B.L. Worsnop and H.T. Flint, Khosla Publishers, Delhi.

### PY1645-Advanced Physics Lab 2 (Minimum 18 experiments to be done)

1. ✓ Spectrometer-A,  $D$  and  $n$  of a solid prism.
2. ✓ Spectrometer—Dispersive power and Cauchy's constants
3. ✓ Spectrometer Grating—Normal incidence-  $N$  & wavelength
4. ✓ Spectrometer- $i$ - $d$  curve
5. ✓ Spectrometer- Hollow prism
6. ✓ Liquid lens-refractive index of liquid and lens
7. Newton's Rings—Reflected system
8. Air wedge-diameter of a wire
9. Potentiometer-Resistivity.
10. Potentiometer-Calibration of ammeter

11. Potentiometer –Reduction factor of T.G
12. Potentiometer –Calibration of low range voltmeter
13. Potentiometer – Calibration of high range voltmeter
14. Thermoemf-measurement of emf using digital multimeter.
15. Carey Foster's bridge-Resistivity
16. Carey Foster's bridge-Temperature coefficient of resistance.
17. Mirror galvanometer-figure of merit.
18. BG- Absolute capacity of a condenser
19. Conversion of galvanometer into ammeter and calibration using digital Multimeter
20. Conversion of galvanometer into voltmeter and calibration using digital Voltmeter.
21. Circular coil-Calibration of ammeter.
22. Study of network theorems-Thevenin's & Norton's theorems and maximum power transfer the
23. Circular coil-Study of earth's magnetic field using compass box.
24. Absolute determination of m and Bh using box type and Searle's type vibration magnetometers.
25. Searle's vibration magnetometer-comparison of magnetic moments.

### References

1. Yarwood and Wittle; Experimental Physics for Students, Chapman & Hall Publishers.
2. An advanced course in practical physics, Chathopadhyaya, Rakshit and Saha, New central age Kolkata.
3. A text book of practical physics, S. Viswanathan & Co., Chennai.
4. Advanced Practical Physics, B.L. Worsnop and H.T. Flint, Khosla Publishers, Delhi.

**PY1646—Advanced Physics Lab 3 (Minimum 18 experiments to be done – 4 from Computer Science)**

### ELECTRONICS

1. PN junction Diode (Ge & Si) characteristics-To draw the characteristic curves of a PN junction diode and to determine its ac and dc forward resistances.
2. Full wave (centre tapped) rectifier-To construct a full wave rectifier using junction diode and to calculate the ripple factor with and without shunt filter (10 readings for  $R_L$  100 to 5000 ).
3. Full wave (centre tapped) rectifier-To construct a full wave rectifier using junction diode and to study the effect of L,C, and LC filters on the ripple factor (for different  $R_L$ ).
4. Bridge rectifier-To construct a bridge rectifier using junction diodes and to calculate the ripple factor with and without shunt filter (10 readings for  $R_L$  100 to 5000 ).
5. Bridge rectifier- Dual power supply-To construct a dual power supply using bridge rectifier and measure the output voltages for different pair of identical load resistors.
6. Zener diode characteristics-To draw the I-V characteristic of a Zener diode and to find the breakdown voltage and the dynamic resistance of the diode.



7. Zener diode as a voltage regulator-To construct a voltage regulator using Zener diode and to study the output voltage variation (i) for different RL and (ii) for different input voltage with same  $R_L$ .
8. Transistor characteristics-CE-To draw the characteristic curves of a transistor in the CE configuration and determine the current gain, input impedance and output impedance.
9. Transistor characteristics-CB-To draw the characteristic curves of a transistor in the CB configuration and determine the current gain, input impedance and output impedance.
10. Single stage CE amplifier-To construct a single stage CE transistor amplifier and study its frequency response.
11. OP amp. IC741- Inverting amplifier-To construct an inverting amplifier using IC741 and determine its voltage gain.
12. OP amp. IC741- Non inverting amplifier To construct a non inverting amplifier using IC741 and determine its voltage gain.
13. OP amp. IC741- Differentiator-To construct an OP amp. Differentiator, determine its voltage gain and study the output response to pulse and square wave.
14. OP amp. IC741- Integrator-To construct an OP amp. Integrator, determine its voltage gain and study the output response to pulse and square wave.
15. Phase shift oscillator-To construct a phase shift oscillator using transistor and measure the frequency of the output waveform.
16. Logic gates- OR and AND-To verify the truth tables of OR and AND gates using diodes.
17. Logic gate- NOT-To verify the truth tables of NOT gate using a transistor.
18. Network theorems (Superposition, Thevenin's & Norton's theorems) To verify the (i) Superposition, (ii) Thevenin's & (iii) Norton's theorems
19. RC-Filter circuits (Low pass) To construct an RC-low pass filter circuit and to find the upper cut off frequency.
20. RC-Filter circuits (High pass)-To construct an RC-high pass filter circuit and to find the lower cut off frequency.

### Computer Science (C++ Programs)

1. Program to find the roots of a quadratic equation (both real and imaginary root)
2. Program to find the dot product and cross product of vectors
3. Program to plot the functions  $\sin x$ ,  $\tan x$  and  $e^x$
4. Program to find the matrix addition, multiplication, trace, transpose and inverse.
5. Program to convert hexadecimal to decimal number, decimal to hexadecimal number, binary to hexadecimal numbers and hexadecimal to binary numbers
6. Program to find the result of binary addition and subtraction.
7. Program to find the moment of inertia of regular bodies about various axes of rotation.
8. Program to find the velocity of a rolling body (without sliding) at any point in an inclined plane

9. Program to study the motion of a spherical body in a viscous fluid
10. Program to study the motion of projectile in central force field
11. Program to study the planetary motion and Kepler's law
12. Monte carlo simulation

### **References:**

1. Basic electronics and linear circuits; N.N. Bhargava, D.C. Kulshreshtha, S.C.Gupta
2. OP- Amps and linear integrated circuits; Ramakant A. Gayakwad
3. Basic electronics; Santiram Kal
4. Basic electronics; B. L. Theraja
5. Principles of electronics; V. K. Mehta
6. A first course in Electronic s; Anwar A. Khan, Kanchan K. Dey

### **PY1661. ELECTIVE COURSES**

**(54 HOURS-2CREDITS) FOR EACH COURSE**



54 HOURS-2CREDITS)

### Unit 1. Universe (12 hrs) [Book3]

Large Scale Structure of the Universe: Astronomy and Cosmology, Our Galaxy, Galaxy types, Radio sources, Quasars, Structures on the largest scale, Coordinates and catalogues of astronomical objects, Expansion of the Universe

### Unit 2. The evolution of Stars (9hrs) [Book4]

Introduction, Classification of Stars: The Harvard classification, Hertzsprung–Russel diagram, Stellar evolution, White dwarfs, Electrons in a white dwarf star, Chandrasekhar limit, Neutron stars, Black holes, Supernova explosion, Photon diffusion time, Gravitational potential energy of a star, Internal temperature of a star, Internal pressure of a star.

### Unit 3. The active Sun (10 hrs) [Book2]

Introduction, Sunspots and Solar storms, Sunspots and Solar activity, Cosmic rays of Solar origin, The Solar wind, Solar corona and the origin of the solar wind, Disturbed Solar wind.

### The earth's Atmosphere (15 hrs) [Book 1]

Introduction, Nomenclature and temperature profile, Temperature distribution in the troposphere, Temperature of stratosphere, temperature of mesosphere and thermosphere, Temperature variability, The pressure profile, Scale height, Density variation. The Ionosphere: Effect on scale height, Ionospheric electric fields, Ionization profile, Layer of charge, Ionospheric hydrogen and Helium.

### Magnetosphere (8 hrs) [Book 2]

Introduction, The magnetic field of Earth, Earth's variable magnetic field, Solar activity and Earth's magnetic weather, solar wind interaction, The Chapman-Ferraro closed magnetosphere, Dungey's open magnetosphere, Structure of the magnetosphere: Magneto tail and Plasma sheet, Plasma sphere, Earth's radiation belts.

### Books for Study

1. Introduction to Space Science – Robert C Hymes (1971), John Wiley & Sons Inc.

2. Earth's Proximal Space- Chanchal Uberoi (2000), Universities Press (India)
3. Introduction to Cosmology- J. V. Narlikar (1993), Cambridge University Press
4. Modern Physics- R. Murugesan, Kiruthika Sivaprasath (2007), S.Chand & Company Ltd.

### **Books for reference**

1. Space Physics and Space Astronomy – Michael D Pappagiannis (1972), Gordon and Breach Science Publishers Ltd.
2. Introductory Course on Space Science and Earth's environment-Degaonkar (Gujarat University, 1972)
3. Introduction to Ionosphere and magnetosphere- Ratcliffe (CUP, 1972).
4. The Physics of Atmospheres-Houghton (Cambridge University Press)
5. Introduction to Ionospheric Physics-Henry Rishbeth & Owen K. Garriot (Academic Press, 1969)
6. Space Science – Louise K. Harra & Keith O. Mason (Imperial College Press, London, 2004)
7. Introduction to Space Physics- Kivelson and Russel
8. Introduction to Astrophysics – Baidyanadh Basu
9. Astrophysics - K. D. Abhayankar (University Press)



## II Complementary Courses

### Semester I (Mathematics Main)

#### PY1131.1 – Mechanics and Properties of matter (36 hours)

##### Unit I (28 hours)

##### Dynamics of rigid bodies (7 hours) $\mu^1$

Theorems of M.I with proof-Calculation of M.I of bodies of regular shapes rectangular lamina, uniform bar of rectangular cross section, annular disc, circular disc, solid sphere-K.E of a rotating body. Determination of M.I of a fly wheel (theory and experiment).

##### Oscillations and waves (13 hours)

Examples of S.H oscillator-compound pendulum-determination of  $g$ -torsion pendulum-oscillations of two particles connected by a spring-vibration state of a diatomic molecule.

Wave motion-general equation of wave motion-plane progressive harmonic wave - energy density of a plane progressive wave -intensity of wave and spherical waves-

##### Mechanics of solids (8 hours) $\mu^1$

Bending of beams-bending moment-cantilever-beam supported at its ends and loaded in the middle-uniform bending-experimental determination of  $Y$  using the above principles with pin and microscope-twisting couple on a cylinder-angle of twist and angle of shear-torsional rigidity, .

##### Unit II (8 hours)

##### Surface Tension (5 hours)

Excess of pressure on a curved surface-force between two plates separated by a thin layer of liquid-experiment with theory to find surface tension and its temperature dependence by Jaeger's method-equilibrium of a liquid drop over solid and liquid surfaces.

##### Viscosity (3 hours) $\mu^1$

Flow of liquid through a capillary tube-derivation of Poiseuille's formula -limitations-Ostwald's viscometer-variation of viscosity with temperature.

##### Books for Study

1. Mechanics: J.C.Upadhyaya, Ram Prasad & Sons
2. Oscillations & Waves: K.RamaReddy, S.Bbadami & V.Balasubramaniam (University Press)

## Semester 2 (Mathematics Main)

## PY1231.1 – Thermal Physics and statistical mechanics (36 hours)

## Unit I – Transmission of Heat (14 hours)

Thermal conductivity and thermometric conductivity-Lee's disc experiment-Weidmann and Franz (statement only)-energy distribution in the spectrum of black body and results-Wien's displacement law-Rayleigh-Jeans law-their failure and Planck's hypothesis-Planck's law-comparison-solar constant-determination-temperature of sun.

## Unit II – Thermodynamics (9 hours).

Isothermal and adiabatic processes-work done-isothermal and adiabatic elasticity Heat engines-Carnot cycle -derivation of efficiency-petrol and diesel engine cycles-efficiency in these two cases-second law thermodynamics-Kelvin and Clausius statements.

## Unit III – Entropy (9 hours)

Concept of entropy-change of entropy in reversible and irreversible cycles-principle of increase of entropy-entropy and disorder-entropy and available energy-T-S diagram for Carnot's cycle-second law in terms of entropy-calculation of entropy when ice is converted into steam.

## Unit 4- Statistical Mechanics(4hours)

Statistical probability-Macro and Microstates- Phase space-statistical ensemble-postulates of equilibrium probability-Maxwell Boltzmann Distribution- velocity distribution.

## Books for Study

1. Heat & Thermodynamics: N.Subramaniam & Brijlal, S.Chand & Co
2. Heat & Thermodynamics: W.Zemansky, McGraw Hill
3. Heat & Thermodynamics: C.L.Arora.

## Semester 3 (Mathematics Main)

## PY1331.1 – Optics, Magnetism and Electricity (54 hours)

## Unit I (34 hours)

## Interference (12 hours)

Analytical treatment of interference-theory of interference fringes and bandwidth.Interference in thin films-reflected system-colour of thin films-fringes of equal inclination and equal thickness -Newton's ring in reflected system-measurement of wavelength and refractive index of liquid.

## Diffraction (14 hours)

Phenomenon of diffraction-classification-Fresnel and Fraunhofer.Fresnel's theory of approximate rectilinear propagation of light-Fresnel diffraction at a straight edge and circular aperture. Fraunhofer diffraction at a single slit, two slits and N slits. Plane transmission grating-determination of wavelength.



### Laser and Fibre Optics (8 hours)

47

Principle of operation of laser-population inversion-optical pumping-ruby laser applications of lasers. Light propagation in optical fibres-step index fibre-graded index fibre-applications.

### Unit II (20 hours)

#### Magnetism (10 hours)

Magnetic properties of matter-definition and relation between magnetic vectors B, H and M. Magnetic susceptibility and permeability. Magnetic properties-diamagnetism-paramagnetism-ferromagnetism-antiferromagnetism. Electron theory of magnetism-explanation of ferromagnetism.

#### Electricity (10 hours)

EMF induced in a coil rotating in a magnetic field-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 and choke coil-transformers.

#### Books for Study

1. A text book of optics – Brijlal & Subramaniam
2. Electricity and Magnetism – R. Murugesan, S. Chand & Co Ltd.
3. A text book of B.Sc subsidiary Physics – P. Vivekanandan.

### Semester 4 (Mathematics Main)

#### PY1431.1 Modern Physics and Electronics (54 hours)

##### Unit 1. Modern Physics (20 hours)

Basic features of Bohr atom model-Bohr's correspondence principle -vector atom model-various quantum numbers-magnetic moment of orbital electrons -electron spin-Spin-Orbit coupling-Pauli's exclusion principle-

Atomic nucleus-basic properties of nucleus-charge, mass, spin, magnetic moment-binding energy and packing fraction-nuclear forces-salient features-radioactivity-radioactive decay-decay laws-decay constant-half life and mean life-radioactive equilibrium-secular and transient equilibrium-measurement of radioactivity.

##### Quantum Mechanics (10 hours)

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

##### Unit 2. (20 hours) Electronics (16 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-transistor configurations-current components-transistor characteristics-DC load line-Q point-AC load line-transistor biasing-need for biasing-bias stabilization-biasing circuits-voltage divider bias. amplifier-basic features of an amplifier-gain, -frequency response and band width

### Digital Electronics (8 hours)

Number systems and codes-decimal numbers-binary arithmetic -1's and 2's complement-decimal to binary conversion-octal numbers-hexadecimal numbers-binary coded decimal-digital codes-logic gates-NOT, OR, AND, NOR and NAND gates. Boolean algebra-Boolean operations -logic expressions-laws of Boolean algebra-DeMorgan's theorem-Boolean expression for gate network-simplification of Boolean expression

### Books for Study:

1. Modern Physics – R.Murugesan, S.Chand & Co. Ltd.
2. Principles of Electronics – V.K.Mehta.

### Semester 1 (Chemistry Main)

#### PY1131.2 – Rotational dynamics and Properties of matter (36 hours)

##### Unit I (28 hours)

##### Dynamics of rigid bodies (7 hours)

Theorems of M.I with proof-Calculation of M.I of bodies of regular shapes-rectangular lamina-uniform bar of rectangular cross section, annular disc, circular disc, solid cylinder, solid sphere-K.E of rotating body-Determination of MI of a flywheel(Theory and Experiment).

##### Oscillations and waves (13 hours)

Examples of S.H oscillator-compound pendulum-determination of g-torsion pendulum-oscillations of two particles connected by a spring-vibration state of a diatomic molecule- Wave motion-general equation of wave motion-plane progressive harmonic wave - energy density of a plane progressive wave -intensity of wave and spherical waves-

##### Mechanics of solids (8 hours)

Bending of beams-bending moment-cantilever-beam supported at its ends-and loaded in the middle-uniform bending-experimental determination of Y using the above principles with pin and microscope-twisting couple on a cylinder-angle of twist and angle of shear-torsional rigidity.

##### Unit II (8 hours)

##### Surface Tension (5 hours)

Excess of pressure on a curved surface-force between two plates separated by a thin layer of liquid-experiment with theory to find surface tension and its temperature dependence by Jaeger's method-equilibrium of a liquid drop over solid and liquid surfaces.

##### Viscosity (3 hours)

Flow of liquid through a capillary tube-derivation of Poiseuille's formula -limitations-Ostwald viscometer-variation of viscosity with temperature.



## References

49

1. Mechanics: J.C. Upadhyaya, Ram Prasad & Sons
2. Oscillations & Waves: K. Rama Reddy, S.B. Badami & V. Balasubramaniam (University Press)

## Semester 2 (Chemistry Main)

### PY1231.2 – Thermal Physics (36 hours)

#### Unit I – Diffusion (4 hours)

Graham's law of diffusion in liquids - Fick's law - analogy between liquid diffusion and heat conduction - methods of estimating concentrations - determination of coefficient of diffusivity.

#### Unit II. Transmission of Heat (14 hours)

Thermal conductivity and thermometric conductivity - Lee's Disc experiment - Weidmann and Franz law (statement only) - Radiation of heat - black body radiation - Kirchhoff's laws of heat radiation - absorptive power - emissive power - Stefan's law (no derivation) - energy distribution in the spectrum of black body and results - Wien's displacement law - Rayleigh-Jeans law - their failure and Planck's hypothesis - Planck's law - comparison - solar constant - temperature of sun.

#### Unit III – Thermodynamics (9 hours)

Isothermal and adiabatic processes - work done - isothermal and adiabatic elasticity. Heat engines - Carnot's cycle - derivation of efficiency - petrol and diesel engine cycles - efficiency in these two cases - second law of thermodynamics - Kelvin and Clausius statements.

#### Unit IV – Entropy (9 hours)

Concept of entropy - change of entropy in reversible and irreversible cycles - principle of increase of entropy - entropy and disorder - entropy and available energy - T-S diagram for Carnot's cycle - second law in terms of entropy - calculation of entropy when ice is converted into steam.

## References

1. The general Properties of matter: F.H. Newman & V.H.L. Searle
2. Heat & Thermodynamics: N. Subramaniam & Brijlal, S. Chand & Co
3. Heat & Thermodynamics: W. Zemansky, McGraw Hill
4. Heat & Thermodynamics: C.L. Arora.

## Semester 3 (Chemistry Main)

### PY1331.2 – Optics, Magnetism and Electricity (54 hours)

#### Unit I (34 hours)

##### Interference (11 hours)

Analytical treatment of interference - theory of interference fringes and 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 and refractive index of a liquid.

**Diffraction (11 hours)**

Phenomenon of diffraction-classification-Fresnel and Fraunhofer. Fresnel's theory of approximate rectilinear propagation of light-Fresnel diffraction at a straight edge. Fraunhofer diffraction at a single slit and N slits. Plane transmission grating-determination of wavelength.

**Polarisation (6 hours)**

Experiments showing the transverse nature of light-plane polarized light-polarization by reflection. Brewster's law-double refraction-Nicol prism-propagation of light in uni-axial crystals-positive and negative crystals-principal refractive indices-half wave plate and quarter wave plate-elliptically and circularly polarized light-optical activity.

**Laser and Fibre Optics (6 hours)**

Principle of operation of laser-population inversion-optical pumping-ruby laser applications of laser. Light propagation in optical fibres-step index fibre-graded index fibre-applications.

**Unit II (20 hours)****Magnetism (10 hours)**

Magnetic properties of matter-definition and relation between magnetic vectors B, H and M. Magnetic susceptibility and permeability. Magnetic properties-diamagnetism-paramagnetism-ferromagnetism-antiferromagnetism. Electron theory of magnetism-explanation of ferromagnetism.

**Electricity (10 hours)**

EMF induced in a coil rotating in a magnetic field-peak, mean, rms and effective values of AC circuits-AC through RC, LC, LR and LCR series circuits-resonance-sharpness of resonance-power factor and choke coil-transformers.

**References**

1. A text book of optics – Brijlal & Subramaniam
2. Electricity and Magnetism – R. Murugesan, S. Chand & Co Ltd.
3. A text book of B.Sc subsidiary Physics – P. Vivekanandan.

**Semester 4 (Chemistry Main)****PY1431.2 – Atomic Physics, Quantum Mechanics and Electronics (54 hours)****Unit I Atomic physics (12 hours)**

Basic features of Bohr atom model-Bohr's correspondence principle -vector atom model-quantum numbers-magnetic moment of orbital electrons -electron spin-Spin-Orbit coupling-Pauli's exclusion principle-periodic table.

**Unit II Superconductivity (8 hours)**

Properties of superconductors-zero electrical resistance- Meissner effect- electrical magnetic Type I and Type II superconductors-isotope effect-high temperature ceramic superconductors-applications of superconductors.



Unit III Quantum mechanics (14 hours) HT

51

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

Unit IV. Spectroscopic Techniques(4hours) HT

EM Spectrum- UV, Visible, IR,, Radio and microwave regions-principle of various spectrometers used in specific regions of EM spectrum-absorption spectroscopy, emission spectroscopy.

Unit V. Electronics (12 hours) Joney

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-transistor configurations-current components-transistor characteristics-DC load line-Q point-AC load line-transistor biasing-need for biasing-bias stabilization-biasing circuits-fixed bias, emitter feed back bias, voltage divider bias (qualitative study only). Transistor amplifier-basic features of an amplifier-gain, input and output resistances-frequency response and band width

Unit V. Digital Electronics(4hours) Joney

Number systems and codes-decimal numbers-binary arithmetic -1's and 2's compliment-decimal to binary conversion-octal numbers-hexadecimal numbers-binary coded decimal-digital codes-logic gates-NOT, OR, AND, NOR and NAND gates..

References

1. Modern Physics – R.Murugesan, S.Chand & Co. Ltd.
2. A text book of B.Sc subsidiary Physics – P.Vivekanandan.
3. Principles of Electronics – V.K.Mehta.

### Books for Study:

1. Modern Physics – R.Murugesan, S.Chand & Co. Ltd.
2. A text book of B.Sc subsidiary Physics – P.Vivekanandan.
3. Principles of Electronics – V.K.Mehta.

## COMPLEMENTARY PRACTICAL (PHYSICS)

(Common for all complementary subjects)

### PY1432-Practical

#### List of Experiments (Minimum 18 experiments to be done)

1. Torsion Pendulum-  $n$  by torsional oscillations
2. Torsion Pendulum-  $n$  and  $I$  using equal masses
3. Fly Wheel
4. Cantilever-  $Y$  by pin and microscope method
5. Uniform bending-  $Y$  by pin and microscope
6. Symmetric bar pendulum -  $g$  and radius of gyration
7. Surface tension- capillary rise method
8. Coefficient of viscosity- capillary flow method
9. Specific heat-method of mixtures applying Barton's correction
10. Lee's disc- Thermal conductivity of cardboard
11. Melde's string- frequency of tuning fork
12. Method of parallax- optical constants of convex lens using
  - i) mirror and mercury
  - ii) mirror and water
13. Method of parallax- refractive index of liquid.
14. Spectrometer-  $A$ ,  $D$  and  $n$
15. Spectrometer- dispersive power of a prism
16. Spectrometer- Grating-normal incidence
17. Deflection and vibration magnetometer-  $M$  and  $B_h$
18. Circular coil- magnetization of a magnet
19. Carey Foster's bridge - Resistivity
20. Potentiometer- Resistivity
21. Potentiometer- Calibration of ammeter
22. Mirror galvanometer- Current and Voltage sensitivity
23. Diode Characteristics (for Ge and Si diodes)
24. Half wave rectifier-Measurement of ripple factor with and without filter capacitor
25. Full wave rectifier- Measurement of ripple factor with and without filter capacitor