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सत्यमेव जयते

# GOVERNMENT OF PUDUCHERRY
## DEPARTMENT OF PHYSICS
## KANCHI MAMUNIVAR CENTRE FOR PG STUDIES
## (AUTONOMOUS)
## COLLEGE WITH POTENTIAL FOR EXCELLENCE
## (REACCREDITED AT B$^{++}$ GRADE BY NAAC )
## (AFFILIATED TO PONDICHERRY UNIVERSITY)
## PUDUCHERRY – 605 008.

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# STRUCTURE OF THE COURSE
# M.Sc. PHYSICS – CHOICE BASED CREDIT SYSTEM (CBCS)
# SCHEME OF EXAMINATION
# SYLLABUS FOR SEMESTER I TO IV
# &
# M. Phil - PHYSICS - SCHEME OF EXAMINATION
# SYLLABUS FOR SEMESTER I & II
## (EFFECTIVE FROM THE ACADEMIC YEAR **2019-2020** AND THEREAFTER)

NOTE : REVISED BY 9$^{th}$ BOS

# STRUCTURE OF THE COURSE
## M.Sc. PHYSICS – CHOICE BASED CREDIT SYSTEM ( CBCS)
## SCHEME OF EXAMINATION
## SEMESTERS - I & II

| SEMESTER | PAPER NUMBERS | COURSE | CODE | TITLE OF THE PAPER | HOURS/ WEEK(30) | CREDITS | TOTAL CREDITS |
|---|---|---|---|---|---|---|---|
| S – I | PAPER-I | Hard Core Course - 1 | PHHT -101 | Classical Mechanics | 4 | 4 | 18 |
| | PAPER-II | Hard Core Course - 2 | PHHT -102 | Mathematical Physics | 4 | 4 | |
| | PAPER-III | Hard Core Course - 3 | PHHT -103 | Electronics and communication | 4 | 3 | |
| | PAPER-IV | Practical - I | PHHP -104 | Practical – I | 8 | 4 | |
| | PAPER-V | Soft Core -I | PHSC -105X (X=A/B/C/D) | From list-I in Annexure-I | 4 | 3 | |
| | | Seminar / Tutorial/ Test | | | 6 | | |
| S -II | PAPER-VI | Hard Core Course - 4 | PHHT- 206 | Quantum Mechanics - I | 4 | 4 | 18 |
| | PAPER-VII | Hard core Course - 5 | PHHT -207 | Statistical Mechanics | 4 | 4 | |
| | PAPER-VIII | Hard core Course - 6 | PHHT- 208 | Condensed Matter Physics | 4 | 3 | |
| | PAPER-IX | Practical - II | PHHP -209 | Practical – II | 8 | 4 | |
| | PAPER-X | Soft Core - II | PHSC -210X (X=A/B/C/D) | From list-II in Annexure-I | 4 | 3 | |
| | | Seminar / Tutorial/ Test | | | 6 | | |

# STRUCTURE OF THE COURSE
## M.Sc. PHYSICS – CHOICE BASED CREDIT SYSTEM(CBCS)
## SCHEME OF EXAMINATION
## SEMESTERS-III&IV

| SEMESTER | PAPER NUMBER | COURSE | CODE | TITLE OF THE PAPER | HOURS /WEEK (30) | CREDITS | TOTAL CREDITS |
|---|---|---|---|---|---|---|---|
| S-III | PAPER-XI | Hard Core Course - 7 | PHHT-311 | Quantum Mechanics - II | 4 | 4 | 20 |
| | PAPER-XII | Hard Core Course - 8 | PHHT-312 | Electrodynamics and Plasma Physics | 4 | 4 | |
| | PAPER-XIII | Hard Core Course - 9 | PHHT-313 | Microprocessor and Microcontroller | 4 | 3 | |
| | PAPER-XIV | Practical - III | PHHP-314 | Practical - III | 8 | 4 | |
| | PAPER-XV | Soft Core -III | PHSC-315X (X=A/B/C/D) | From list-III in Annexure-I | 4 | 3 | |
| | PAPER-XVI | INTERNSHIP PROGRAMME | PHIP-316 | | 4 | 2 | |
| | | Seminar / Tutorial/ Test | | | 2 | | |
| S-IV | PAPER-XVII | Hard Core Course-10 | PHHT -417 | Principles of Spectroscopy | 4 | 4 | 18 |
| | PAPER-XVIII | Hard core Course-11 | PHHT-418 | Nuclear and Particle Physics | 4 | 4 | |
| | PAPER-XIX | Hard core Course-12 | PHHT-419 | Nanoscience | 4 | 3 | |
| | PAPER-XX | Practical - IV | PHHP-420 | Practical –IV | 8 | 4 | |
| | PAPER-XXI | Soft Core-IV | PHSC -421X (X=A/B/C/D) | From list-IV in Annexure-I | 4 | 3 | |
| | | Seminar / Tutorial/ Test | | | 6 | | |

## SEMESTER – I

## PAPER – I: CLASSSICAL MECHANICS ( CODE: PHHT – 101 )

UNIT – I: LAGRANGIAN FORMULATION

Constraints – Classification of constraints - Generalized coordinates – velocity, kinetic energy, momentum and force - Principal of virtual work – derivation. D' Alembert's Principle – Statement and Proof - Lagrange's equations of motion- derivation and application (i) simple pendulum (ii) spherical pendulum - Cyclic coordinates – explanation, Conservation Laws and symmetry properties.

UNIT – II: VARIATIONAL PRINCIPLE AND HAMILTONIAN MECHANICS

Hamiltonian Principle - Deduction of Hamiltonian Principle - Hamiltonian Principle from Lagrange's equation - Hamiltonian's Principle for non – holonomic systems - Hamiltonian's equation of motion – application (i) simple pendulum (ii) spherical pendulum - Hamiltonian's equation from Variational Principle - Integrals of Hamiltonian equations - Canonical Transformations -Poisson Brackets - Poisson Brackets and integrals of motion.

UNIT – III: HAMILTONIAN – JACOBI THEORY

Hamilton – Jacobi equation – derivation - Hamilton's Characteristic Function. Harmonic Oscillator in the Hamilton – Jocobi method. Separation of Variables in the Hamilton – Jocobi method. Action – angle Variables - Harmonic Oscillator in action – angle variables. Kepler problem in action – angle variables.

UNIT – IV: CENTRAL FORCE MOTION AND THEORY OF SMALL OSCILLATION

Centre of mass and frame of reference - Motion in a central force field - Scattering in a central force field. Scattering problem in Laboratory coordinates - Theory of small oscillations. Normal Modes - Two coupled pendulum - Longitudinal vibration of $CO_2$ molecule.

TEXT BOOKS

1.Classical Mechanics :G. AruldhasPrentice – Hall of India Pvt. Ltd.
2.Classical Mechanics :S.N. Biswas Books- Allied Pvt. Ltd.
3.Classical Mechanics :J.C. Upadhyaya- Himalaya Publishing House
4.Classical Mechanics :N.C. Rana and P.S. Joag-Tata McGraw Hill
5.Classical Mechanics :Gupta , Kumar and Sharma- Pragati Prakashan

BOOKS FOR REFERANCE

1.Classical Dynamics : Donald T. Greenwood-Prentice Hall of India Pvt. Ltd.
2.Classical Mechanics : Herbert Goldstein- Narosa Publishing House
3.Classical Mechanics of Particles and Rigid Bodies: Kiran C. Gupta-Wiley Eastern Ltd.
4.Classical Mechanics : R. Douglas Gregory- Cambridge University Press
5.Introduction to Classical Mechanics: David Morin- Cambridge University Press

## SEMESTER – I

## PAPER –II: MATHEMATICAL PHYSICS (CODE: PHHT – 102)

### UNIT – I: VECTOR SPACES AND TENSORS

Groups , fields and vector spaces – definitions - Linear independence and dependence of vectors - Matrix representation of linear operators. Schmidt's orthogonalisation processes - Schwartz inequality. Fundamentals of Tensors – scalars – definitions of the following: Covariant and Contra variant tensors - Symmetric and anti - symmetric tensors. Quotient law and Metric tensor - Conjugate tensor - Associated tensors. Raising and lowering of indices - The Christoffel symbols and their transformation Laws - Covariant derivative of tensors.

### UNIT – II: COMPLEX VARIABLES

Analytic function - Cauchy – Riemann condition for analytic function. Cauchy integral theorem - Cauchy integral formula. Taylor's series and Laurent's Series - Singularities of an analytical function - Residues – Cauchy Residue Theorem - Evaluation of definite integrals.

### UNIT –III: SPECIAL FUNCTIONS AND STURM – LIOUVELLE OPERATORS.

Gamma and beta functions and their relations. Hermit, Legendre, Lagaurre and Bessel equations – series expansions. Rodriguez formula – Generating function – Recurrence relations – orthogonal property. Sturm – Liouville operators – Eigen values and Eigen functions.

### UNIT – IV: FOURIER AND LAPLACE INTEGRAL TRANSFORMS

Fourier transforms – properties of Fourier transform - Fourier transform of a Derivative - Fourier's sine and cosine transforms of a derivative - Finite Fourier Transforms. Laplace transform – properties of Laplace transforms - Laplace transforms of the derivative of a function - Laplace transforms of integral - Inverse Laplace transform – properties of inverse transforms – partial fraction method - Convolution theorem-solving differential equation using inverse Laplace Transform.

### TEXT BOOKS


1.Mathematical Physics: B.D. Gupta – Vikas Pub. House.
2.Vector Analysis Schaum's series : Murray's R. Spiegal – Mc Graw Hill Pvt.Ltd.
3.Fouier – Laplace Schaum's series: Murray's R. Spiegal – Mc Graw Hill Pvt.Ltd.
4.Complex Variable Schaum's series: Murray's R. Spiegal – Mc Graw Hill Pvt.Ltd.
5. Linear Algebra Schaum's Series: Seymour Lipschutz – Mc Graw Hill Pvt. Ltd.
6.Matrices and Tensors: A. W. Joshi - Willy eastern Pvt. Ltd.


### BOOKS FOR REFERENCE


1.Elementray Linear Algebra : Howard Anton – John Wiley & Sons.
2.Advanced Engineering Mathematics : M.D. Greenberg – Prentice Hall International.
3. Special Functions and Complex variables:Shahnaz Bathul – PH of India.
4.Mathematical Methods for Physicists : G. Arfken and H. J. Weber – Harcour –PH of India
5.Mathematical Physics : H.K. Dass and Rama Verma – S.Chand.
6.Mathematical Physics:Sathya Prakash-Pragati Prakashan (New Edition).

SEMESTER – I

PAPER –III: ELECTRONICS AND COMMUNICATION (CODE: PHHT – 103 )

UNIT – I : DIGITAL CIRCUITS

B C D Adder - Decoder and Encoder - Multiplexer and De-multiplexer. State diagram and state equation - Excitation tables - Design of counters using T, D and J K flip flops - Designs of: shift register, Ripple counters and Synchronous Counter.

UNIT – II : OPERATIONAL –AMPLIFIERS ( OP – AMP ) AND APPLICATIONS

Operational amplifiers and its application - differentiator – integrator. Difference amplifier - Astable multi vibrator - Square wave generation. Schmitt trigger circuit – D/A converter-Ladder type – A /D converter-Parallel comparator method – solution of simultaneous equations.

UNIT – III : MICROWAVE COMMUNICATION

Microwave- radio station - Klystron – operating principle - Apple gate diagram - Velocity modulation - Bunching process - Reflex klystron – operating principle- velocity modulation – Types of Travelling wave guide - Amplification process and analysis - circular and rectangular wave guides - Wave modes.

UNIT – IV: SATELLITE COMMUNICATION

Principle – Satellite orbits – synchronous orbit –Satellite communication systems, satellite subsystems – General block diagram of communication satellite – Block diagram of power subsystems – General block diagram of satellite telemetry unit – satellite earth stations – General block diagram of an earth station – Advantages of satellite communication.

TEXT BOOKS

1.Digital Logic and Computer Design: Morris Mano- Prentice Hall of India Pvt, Ltd
2.Digital Principles and Applications: Malvino and Donald Leech- Tata McGraw Hill Ltd
3.Microwave Devices and Circuits: Samuely Liao-Printice Hall of India Pvt. Ltd.
4.Electronic Communication: Rodey and Coohen- Prentice Hall of India Pvt, Ltd
5.Satellite Communication: D.C. Agrawel- Khanna Publications
6. Digital fundamentals - Vijayendiran- SV Publishers

BOOKS FOR REFERENCE

1.Advance Electronics Communication systems: Way Tomasi- Phi Edu
2.Microwave Electronics: K.L. Gupta- Wiley Eastern Ltd
3.Principles of Communication Eng: Umesh Sinha Sathya Prakash – India.
4.Satellite Communication: Timothy , Charles Bostian and Jeremy Allnutt- Wiley India Pvt, Ltd.
5.Telecom Switching Systems and Network:Thiyagarajan & Viswanathan- Prentice Hall of India Pvt, Ltd

SEMESTER – I
PAPER – IV (CODE: PHHP –104 )
PRACTICAL – I: GENERAL EXPERIMENTS
( ANY 10 EXPERIMENTS )

ER 1. Study of elastic constants of glass by Cornu's interference method – elliptical and hyperbolic fringes

KKP 2. Viscosity and Density measurements of liquids and liquid mixtures and their correlation studies – Ostwald's viscometer and RD bottle.

RK 3. Determination of Refractive index of liquids by Abbe's refractometer.

4. Study of Optical bi-refringence using prism and spectrometer.

5. Charge of an electron using spectrometer and prism.

RS 6. Polarizability of liquids – Hallow prism and Spectrometer.

7. Determination of Stephan's constant.

KKP 8. V – I Characteristics of Solar cell.

9. Characteristics of Optical fibres.

10. Study of band gap energy of a thermistor

RS 11. Photo Electric Effect-- Determination of threshold frequencies and Planck's constant.

12. Study of Curie Temperature of magnetic materials.

13. Measurement of resistivity of sheets/ films by two probe method.

RK 14. Study of carrier density, mobility, and Hall coefficient of semiconductor – Hall probe method.

ER 15. MATLAB: a) Matrix operations

b) Digital signal processing

c) Solving Ordinary Differential Equations

Any other Experiment of equal standard.

SEMESTER –I

PAPER –V: ( Soft Core – I :PHSC -105 X; X = A,B,C&D)

| PAPER CODE | TITLE OF THE PAPER |
|---|---|
| PHSC - 105 A | LIQUID CRYSTAL |
| PHSC - 105 B | NONLINEAR DYNAMICS |
| PHSC - 105 C | ENERGY PHYSICS (Other Department Students also) |
| PHSC - 105 D | ASTROPHYSICS |

## SEMESTER – II

### PAPER –VI: QUANTUM MECHANICS – I(CODE :PHHT - 206 )

### UNIT –I : STATIONARY STATE AND EIGEN SPECTRUM

Time independent Schrodinger equation : Square well potential with rigid walls – finite well – Potential barrier – Linear harmonic Oscillator – Schrodinger method – Operator method. Particle moving in a spherically symmetric potential – Hydrogen atom – three dimensional square well potential.

### UNIT –II : MATRIX FORMULATION OF QUANTUM MECHANICS

Quantum state vectors and functions - Hilbert space – Dirac's Bra and Ket Notation - Matrix theory of hormonic oscillator - Schrodinger – Heisenberg and interaction representation - Coordinates and momentum representations. Projection operators - Symmetries and Conservation laws.

### UNIT – III : ANGULAR MOMENTUM

Angular momentum – commutation relation - Eigen value spectrum. Matrix representation of J in the $|\ j\ m >$ basis - Spin angular momentum – spin ½ and spin -1 - total wave function-Addition of angular momenta– Clebsch– Gordan coefficients – spin wave function for a system of two spin -1/2 particles.

### UNIT – IV: APPROXIMATION METHODS FOR TIME INDEPENDENT PROBLEMS

Time independent perturbation theory: Non – degenerate case – first and second order anhormonic oscillator – Variation method – Principle-Upper bound state – ground State of Helium atom-W K B approximation-Principle-Validity of W K B approximation-Solution near the turning point.- Tunneling through a potential barrier.

### TEXT BOOKS


1. Quantum Mechanics: R.K.Srivastava- Printice Hall of India Pvt. Ltd
2. Quantum Mechanics: G. Aruldhas- Printice Hall Of India
3. Quantum Mechanics: Sathya Prakash and C.K.Singh- Kedanath And Ramnath -Meerut
4. Quantum Mechanics: S.L.Gupta,V.Kumar,R.C.Sharma and H.V.Sharma- Jai Nath & Co. India.
5. A Text Book of Quantum Mechanics: P.M. Mathews and K. Venkatesan- Tata Mcgraw Hill.


### BOOKS FOR REFERENCE


1.Quantum Mechanics: L.I. Schiff- Mc Graw –Hill
2.Quantum Mechanics: V.Devanathan- Narosa Publishing House
3.The Principles of Quantum Mechanics: P.A.M.Dirac- Oxford University Press
4.Quantum Mechanics: V.K.Thankappan- Wiley Eastern Ltd
5.Quantum Mechanics: E.Merzbacher- John Wiley
6.Advanced Quantum Mechanics: S.L. Gupta and L.D. Gupta- S.Chand&Co India.

## SEMESTER – II

## PAPER – VII: STATISTICAL MECHANICS (CODE : PHHT -207)

### UNIT – I: FOUNDATIONS OF STATISTICAL MECHANICS

Phase Space – States of a system – Density of states – Liouville's theorem. Statistical equilibrium – relation between statistical and thermo dynamical quantities – Classical ideal gas – entropy of mixing – Gibb's paradox. Ensembles – Micro – canonical – canonical – grand – canonical ensembles – Partition function – relation between partition function and thermo – dynamical quantities.

### UNIT – II: STATISTICS OF SYSTEMS OF INDEPENDENT PARTICLES

Quantum picture – MB, BE and FD statistics – Limit of applicability of the three distribution Laws – Density matrix. MB ideal gas – Maxwell Law of distribution of velocities – Equipartition Law of energy – Classical real gas – Cluster expansion – Virial theorem- equation of state.

### UNIT – III: BOSE – EINSTEIN AND FERMI – DIRAC STATISTICS

Ideal BE gas– Gas degeneracy – BE condensation – $\lambda$ transition in $He^4$ - theory of superfluidity ( London, Tisza and Landau ) – Photon gas – Planck's Law of radiation – Phonon gas – Einstein and Debye's models for specific heat of solids. Ideal FD gas - Gas degeneracy – Electron gas – thermionic emission – Pauli's theory of paramagnetism.

### UNIT – IV: FLUCTUATIONS AND PHASE TRANSITION

Energy and density fluctuation - Correlation of space – time dependent fluctuation – Random walk – Brownian motion – Fluctuation dissipation theorem. Phase transitions and critical phenomena – First order and second order phase transitions – Critical indices Scaling hypothesis – Ising model – mean field theories of Ising model (Exact solutions in one dimension) Landau theory.

### TEXT BOOKS


1.Statistical Mechanics: B.K. Agarwal and Melvin Eisner- New Age International Publishers – New Delhi.
2.Statistical Mechanics SatyaPrakash and J.P. Agrawal- KedarNath Ram Nath& Co – Meerut.
3.Statistical Thermodynamics: M.C. Gupta- New Age International Publishers – New Delhi
4.Statistical Mechanics: S.L. Gupta and V. Kumar- Pragati Prakashan.
5.Staistical Mechanics – Theory and Application – S.K. Sinha - Tata McGraw Hill.


### BOOKS FOR REFERENCES


1.Statistical Mechanics: Kerson Huang- Wiley Eastern Ltd.
2.Fundamentals of statistical Mechanics: B.B.Laud- New Age International Publishers – New Delhi
3.Statistical Physics: J.K. Bhattacharjee- Allied Publishers Ltd.
4.Statistical Mechanics: R.K. Srivastava and J. Ashok- Prentice – Hall of India – Private Ltd. New Delhi.
5.Statistical Mechanics – Donald A. McQuarrie – Viva Books Pvt. Ltd.

## SEMESTER – II

## PAPER – VIII: CONDENSED MATTER PHYSICS (CODE : PHHT-208)

### UNIT –I :LATTICE VIBRATIONS AND THERMAL PROPERTIES

Vibration of monoatomic lattices – Lattices with two atoms per primitive cell – Quantization of lattice vibrations – Phonon momentum – inelastic scattering of neutrons by phonons. Lattice heat capacity – Einstein model – density of mode in one – dimension and three -dimension – Debye model of the lattice heat capacity –Thermal conductivity – Umklapp process.

### UNIT – II:FREE ELECTRON THEORY, ENERGY BANDS AND SEMICONDUCTOR CRYSTALS

Energy levels and density of orbits – Fermi – Dirac distribution – free electron gas in three - dimensions – Heat capacity of electron gas– electrical conductivity and Ohm's law –Wideman- Franz law– Hall effect – thermal conductivity of metals – nearly free electron model – electron in a periodic potential(Kroning-Benny model) – Semiconductors: Band gap – effective mass – intrinsic carrier concentration- law of mass action-$E_F$ variation with temperature.

### UNIT –III:DIAMAGNETISM , PARAMAGNETISM , FERROMAGNETISM AND ANTIFERROMAGNETISM

Classical theory of diamagnetism and paramagnetism–Weiss theory – Quantum theory of paramagnetism–demagnetization of paramagnetic salt – paramagnetic susceptibility of conduction electron – Ferroelectric order – Curie point and the exchange integral – temperature dependence of saturation magnetization – Magnons – thermal excitation of magnons – Ferromagnetic order – Ferromagnetic domains – Origin of domains– Coercive force and hysteresis. Antiferromagnetic order – antiferromagnetic magnons.

### UNIT – IV:DIELECTRICS , FERROELECTRICS AND SUPERCONDUCTIVITY

Macroscopic electric field–Local electrical field at an atom–Dielectric constant and polarizability –Clausisus–Mossotti equation–Ferroelectric crystals–Polarization Catastrophe–Ferroelectric domains. Occurrence of superconductivity - Meissner effect - thermodynamics of superconducting transition- London equation- Coherence length- BCS theory(basic only)- flux quantization- Type-I and Type-II superconductors- Josephson tunneling effect- DC and AC Josephson effect-SQUID- resent development in high temperature superconductivity-application of superconductors.

### TEXT BOKS


1. Solid State Physics: S.O.Pillai- New Age International Publishers-New Delh.
2. Solid state Physics: B.S.Saxsena, R.C.Gupta and P.N. Saxsena- Pragati Pragashan- Meerat.
3. Elements of Solid state Physics: J.P. Srivastava-Prentice Hall of India- Private Ltd.
4. Introduction to Solid State Physics: Arun Kumar-Prentice Hall of India- Private Ltd.
5. Solid State Physics: S.L.Gupta and V. Kumar- K.Nath& Co – Meerut.


### BOOKS FOR REFERENCE


1. Introduction to Solid State Physics: C. Kittel- John Wiley
2. Solid State Physics: N.W.Ashcroft and N. David Mermin- W.B.Saunders company
3. Solid State Physics: A.J. Dekker- Macmillan India Ltd.
4. Elementary Solid State Physics: M. Ali Omar- Addison Wesley Pub Co
5. Condenser Matter Physics : Agrawal and Prakash – Narosa.

SEMESTER – II

PAPER – IX( CODE : PHHP – 209 )

PRACTICAL – II: ELECTRONICS EXPERIMENTS
( ANY 10 EXPERIMENTS )

1. Study of Flip Flops – SR, D and T.
2. Study of Flip flops - JK, Master Slave JK.
3. Mathematical Operation OP-AMP – Adder , Subractor and Multiplier.
4. Mathematical Operation OP-AMP – Differentiator and Integrator , Inverting and Non- Inverting Amplifier.
5. Analog computer design: Solving Simultaneous Equations – Using OP-AMP.
6. Construction of Astable Multivibrator – Using OP-AMP and IC 555.
7. Design of square wave, saw tooth wave and triangular wave generator using IC 741.
8. Schmitt Trigger UsingIC 555 Timer and IC741.
9. Construction of D /A Convertor using R-2R method.
10. Construction of A / D Convertor using comparator and study its performance.
11. Multiplexer and Demultiplexer.
12. Encoder and Decoder.
13. Shift Register using IC7476: serial in – serial out, shift left and shift right.
14. Study of counters: Ripple, MOD3 and MOD5 Counters.
15. Study of synchronous and asynchronous counters.

Any other Experiment of equal Standard.

## SEMESTER – II

### PAPER –X: ( Soft Core – II :PHSC -210 X; X = A,B,C&D)

| | |
|---|---|
| PHSC - 210 A | COMPUTATIONAL PHYSICS |
| PHSC - 210 B | RADIATION PHYSICS |
| PHSC - 210 C | NANO TECHNOLOGY AND ITS APPLICATIONS (Other Department Students also) |
| PHSC - 210 D | LASER AND ITS APPLICATIONS |

SEMESTER – III

## PAPER –XI: QUANTUM MECHANICS – II (CODE : PHHT – 311)

### UNIT – I: APPROXIMATION METHODS FOR TIME DEPENDENT PERTURBATION THEORY

Time- dependent perturbation theory – first order transitions – constant perturbation – transition probability : Fermi Golden Rule – periodic perturbation – harmonic perturbation – adiabatic and sudden approximation. Semi – classical theory of radiation : application of the time dependent perturbation theory to semi – classical theory of radiation –Einsteins coefficients–absorption – induced emission – spontaneous emission – Einsteins transition probabilities– dipole transition – selection rules – forbidden transitions.

### UNIT – II: SCATTERING THEORY

Kinematics of scattering process – wave mechanical picture – Green's functions – Born approximation and its validity – Born series – screened coulomb potential scattering from Born approximation. Partial wave analysis : asymptotic behavior – phase shift – scattering amplitude in terms of phase shifts – differential and total cross sections – optical theorem – low energy scattering – resonant scattering – non – resonant scattering - scattering length and effective range– scattering by square well potential.

### UNIT –III:RELATIVISTIC QUANTUM MECHANICS

Schrodinger relativistic equation – Klein Gordan equation - charge and current densities – interaction with electro magnetic field – Hydrogen like atom – nonrelativistic limit – Dirac relativistic equation – Dirac relativistic Hamiltonian – probability density – Dirac matrices – plane wave solution – eigen spectrum – spin of Dirac particle - significance of negative eigen states – electron in a magnetic field – spin magnetic moment – spin orbit energy.

### UNIT – IV:QUANTISATION OF THE FIELD

Electro magnetic wave as harmonic oscillators – quantisation – classical electromagnetic wave – quantisation of fields oscillators – Photons – number operator – creation and annihilation operators of photons-energy spectrum of wave functions.

### TEXT BOOKS


1. Quantum Mechanics: R.K.Srivastava- Printice Hall of India.
2. Quantum Mechanics: G.Aruldhas- Prentice Hall of India.
3. Quantum Mechanics: Sathya Prakash and C.K. Singh- Kedanath and Ramnath – Meert.
4. Quantum Mechanics: S.L. Gupta ,V. Kumar R.C.Sharma and H.V. Sharma- Jai Nath& Co India.
5. Advanced Quantum mechanics: S.Guptha and L.D. Gupta- S. Chand & Co India.


### BOOKS FOR REFERENCE


1. Quantum Mechanics: V.Devanathan- Narosa Publishing.
2. Quantum Mechanics: V.K. Thankappan- Wiley Eastern.
3. Quantum Mechanics: E. Merzbacher- John Wiley.
4. A Text Book of Quantum Mechanics: P.M. Mathews and K. Venkatesan- Tata Mcg raw Hill.
5. Advanced Quantum mechanics: S.Guptha and L.D. Gupta- S. Chand & Co India.

SEMESTER –III

PAPER – XII: ELECTRODYNAMICS AND PLASMA PHYSICS (CODE: PHHT – 312 )

UNIT – I: THEORY OF ELECTROMAGNETIC WAVES

Wave equation for vector and scalar potential and solution. Retarded potential and Lienard – Wiechart potential , electric and magnetic fields due to uniformly moving charge and an accelerated charge. Linear circular acceleration – angular distribution of power radiated, Bremsstrahlung , Synchrotron radiation and Cerenkov radiation –reaction force of radiation.

UNIT –II:MOTION OF CHARGE UNDER ELECTROMAGNETIC FIELD

Motion of charged particle in electric, magnetic and electromagnetic field. Uniform electric and magnetic fields. Non- uniform fields, diffusion across magnetic field. Time varying electric and magnetic fields, Adiabatic invariants – first, second and third adiabatic invariants.

UNIT –III:PLASMA PRODUCTION AND PROPERTIES

Production of Plasma – Photo – ionization and thermo ionization . Theory of ionization by collision – ionization by shock waves. Plasma production by Laser. Kinetic pressure of partially ionized gas – mean free path diffusion of charged particle. Ampe – polar diffusion in magnetic field – Debye shielding ,optical properties of Plasma - magnetic susceptibility of Plasma.

UNIT – IV:PLASMA DYNAMICS

Motion of charge particles in homogenous magnetic filed , toroidal magnetic field Magnetic mirror confinement. Motion in a crossed R F and magnetic field .Magnetic hydro dynamics, plasma oscillation, plasma parameters, ion oscillation and waves. Oscillation and waves in magnetic field, propagation of electromagnetic waves in plasma containing magnetic field. Magnetosonic waves, application to nuclear fusion, fusion reactor .Magneto generator –principle of hydrodynamics and working-Fusion reactor(TOKAMAK).

TEXT BOOKS

1.Introduction to Electrodynamics: D. J. Griffiths- D. J. Griffiths.
2. Electromagnetic Theory: K.K.Chopra and G.C.Agrawal- Prentice Hall of India.
3. Basic Electromagnetics: Narayana Rao- Prentice Hall of India.
4. Principles of Electrodynamics: B.Chakraborty- Books and Allied.
5. Foundations of Electromagnetic Theory: J.R. Reitz and R.W.Milford- Narosa Puhblication

BOOKS FOR REFERENCES

1.Classical Electrodynamics: J.D. Jackson- Wiley Eastern.
2. Electromagnetics: J.D.Kraus- Mc Graw –Hill.
3. Electromagnetic waves and radiating systems: E.C.Jordan and K.G.Balmin- Prentice Hall Of India.
4. Plasma Physics: F.F.Chen- Mc Graw Hill.
5. Plasma Physics: S.N.Sen- Pragati Prakasham.

SEMESTER – III

PAPER – XIII: MICROPROCESSORS AND MICROCONTROLLERS (CODE: PHHT– 313)

UNIT –I : MICROPROCESSORS 8085

Architecture of 8085: Block diagram- Organization- Registers- Instruction types- Instruction cycles- Interrupts. Instruction set of 8085: Instruction groups with data formats- Addressing modes. Assembly language programming: Simple programmes using arithmetic and logical operations. Applications: Stepper motor control systems – Temperature control system – traffic light control system.

UNIT – II : MICROPROCESSORS 8086

Architecture of 8086 – Memory organization- Register organization – general purpose, index, pointer, segment registers and flags. BUS structure: data BUS, address BUS, effective and physical address and pipe lining. Addressing modes of 8086: register, immediate, direct and indirect addressing.

UNIT – III : MICROCONTROLLERS 8051

Introduction- Comparison between microprocessors and microcontrollers. Architecture of 8051 - Memory organization. Data memory and program memory - Internal RAM and ROM. Addressing modes: immediate, register, direct and indirect. Instruction Set of 8051: MOV, Jump, and Call instruction. Assembly language programming: simple program to illustrate arithmetic and logical operations.

UNIT – IV : INTRODUCTION TO ADVANCED PROCESSORS (BASIC AND GEARAL CONCEPT ONLY)

16-bit (INTEL80186) microprocessors: Introduction-Block diagram. 32–bit (INTEL 80386) microprocessors: Introduction – Block diagram. 64-bit (INTEL80586/Pentium) microprocessor : Introduction–Block diagram of Pentium- Moore's Law. Pentium ® 4 processor (basic idea only: Basics of Pentium® 4 Architecture. Basic idea of PC.

TEXT BOOKS

1. Fundamentals of Microprocessors And Microcomputers:B.Ram-Dhanpat Rai Pub.
2. The 8051 Microcontroller Architecture, Programming andApplications: Kenneth J. Ayala- 3rd Edition Penram International.
3. Microprocessor and Microcontroller: Krishna Kant-Printice Hall of India.
4. Fundamentals of Microprocessor- 8085,8086:V.Vijayendran-SV publication.
5. Microprocessor and Microcontroller :P.S.Manoharan-Charulatha publications.

BOOKS FOR REFERENCES

1. Microprocessors: Gilmore- Tata Mc Graw Hill
2. The 8051 Microcontroller And Embedded Systems: Muhammad Ali Mazidi Janice Gillispie Majidi- Pearson Education.
3.Microcumputer System: The 8086/8088 family-Yu Chang Liu and Glenn A. Gibson- Printice Hall of India.
4.Microcumputer 8086 programming and interfacing: A. Nagoor Kani- RBA publications.
5.. Advanced Microprocessors and Microcontrollers: B.P. Singh Renu Singh- New Age International Publishers.

SEMESTER – III

PAPER – XIV ( CODE : PHHP – 314 )

PRACTICAL – III: MICROPROCESSOR 8085 EXPERIMENTS
( ANY TEN EXPERIMENTS )

1. Addition and Subtraction of 16 bit data without and with carry.
2. Multiplication and Division of 16 bit data without and with carry.
3. Logical operations – AND ,OR& XOR.
4. Code conversion –i) Hexadecimal to Binary, ii)BCD TO Binary, iii) Binary to BCD and ASCII.
5. Arranging data in Ascending and Descending order.
6. Largest and smallest of given data in an array.
7. Block operations – Block Copy & Block Fill
8. Square, Square root and Cube of a given data.
9. Display and moving display.
10. Decimal Counters.
11. Stepper motor interface using 8085.
12. Traffic light control interface using 8085.
13. Switching an array of LED'S using 8051
14. HEX key board interface using 8051.
15. DC motor control interface using 8051.

Any other experiments of equal standards.

## SEMESTER – III

### PAPER – XV ( Soft Core – III :PHSC - 315 X; X = A,B,C&D )

| | |
|---|---|
| PHSC – 315 A | ENVIRONMENTAL PHYSICS |
| PHSC – 315 B | CRYSTAL GROWTH |
| PHSC – 315 C | MEDICAL PHYSICS(Other Department Students also) |
| PHSC – 316 D | PHILOSOPHY OF PHYSICS(Other Department Students also) |

SEMESTER –IV

## PAPER – XVI: PRINCIPLES OF SPECTROSCOPY (CODE : PHHT-417 )

### UNIT – I: INFRARED SPECTROSCOPY

Vibrational study of diatomic molecules – IR rotation – Vibrational spectra of gaseous diatomic molecules – simple gaseous polyatomic molecules – vibrational frequencies and qualitative analysis – Quantitative IR analysis – determination of bond length and moment – determination of interstitial atoms and molecules – IR spectrometer – elementary ideas of FT – IR and spectrometer.

### UNIT – II:RAMAN SPECTROSCOPY

Raman effect – Raman shift – definition – observation of Raman spectra – Raman spectrometer – quantum theory of Raman effect – probability of energy transition in Raman effect – vibrational Raman spectra - structure determination fromRamanand IR spectroscopy – General features of electronic spectra of diatomic molecules – Franck – Condon principles – electronic states – configuration of some typical molecules.

### UNIT – III:NMR SPECTROSCOPY

Basic principles of interaction of spin and applied magnetic field – quantum mechanical description – concepts of NMR spectroscopy – concept of spin – spin and spin – lattice relaxation process – high resolution continuous wave NMR spectrometer – advantage of FT – NMR – Chemical shift – spin – spin coupling between two and more nuclei – simple application to structural determination.

### UNIT – IV:ESR SPECTROSCOPY

Origin of electron spin resonance and resonance condition – quantum mechanical theory of ESR – design of ESR spectrometer – hyperfine structure study – ESR study of anisotropic systems – triplet states study of ESR – application of ESR to solid state physics. (Crystal defects and Biological studies)

### TEXT BOOKS


1.Molecular structure and Spectroscopy G. Aruldhas Prentice Hall of India – Private Ltd.
2.Spectroscopy B.K. Sharma Goel Pub House - Meerut
3.SpectroscopyGurdeep R. Chatwal and Sham K. Anand Himalaya Publishing House
4.Vibrational Spectroscopy D.N. Sathiyanarayana New Age international Publishers New Delhi
5.Elementary Organic Spectroscopy Y.R. Sharma S .Chand


### BOOKS FOR REFERENCE


1.Fundamentals of Molecular Spectroscopy Colin N. Banwell Tata Mcgraw –Hill Pub – New Delhi
2.Organic spectroscopy Jag Mohan Narosa Publishing House
3.Electron Spin Resonance John E. Wertz and James R. Bolton Chapman and Hall - New York
4 .Molecular spectroscopy Jack D. Graybeal McGraw – Hill Book Co.
5.Organic Spectroscopy William Kemp Palgrave New York

## SEMESTER – IV

## PAPER – XVII: NUCLEAR AND PARTICLE PHYSICS (CODE: PHHT - 418)

### UNIT –I: NUCLEAR FORCE

Central force and tensor forces – ground state of deuteron – Magnetic and quadrupole moments – Charge independence and spin dependence of nuclear forces – n-p scattering and p–p scattering at low energies – effective range theory – High energy nucleon – nucleon scattering – exchange forces – Meson theory of nuclear forces.

### UNIT –II:NUCLEAR MODELS

Liquid drop model – Bohr Wheeler theory fission – experimental evidence for shell effects – Shell model – Spin orbit coupling – Magnetic numbers – angular momenta and parities of nuclear ground states –Qualitative discussion and estimates of transition rates – magnetic moments and Schmidt lines – Collective model of Bohr and Mottelson.

### UNIT - III:NUCLEAR DECAY

Beta decay – Fermi theory of beta decay – Shape of the beta spectrum – total decay rate – angular momentum and parity selection rules – Comparative half – lives – allowed and forbidden transitions - Selection rules – Parity violations – Two component theory of neutrino decay – detection and properties of neutrino -gamma decay – Multipole transitions in nuclei – angular momentum and parity - selection rules – internal conversion Nuclear isomerism.

### UNIT – IV: ELEMENTARY PARTICLES

Baryons and Mesons – their properties, decay models – Strong ,weak and electromagnetic interactions – Hadrons and Leptons , Tau – Theta puzzle – Strangeness –Gellman – Nishijima relations - SU(3) classification of Hadrons – Octets and decouplets – elementary ideas of Quarks.

### TEXT BOOKS


1. Nuclear Physics: D.C. Tayal- Himalaya Pub.
2. Nuclear Physics: R.C. Sharma- K. Nath& Co Meerut.
3. Basic Nuclear Physics: B.N. Srivastava- PragatiPrakashan, Meerut.
4. Nuclear Physics: S.N.Ghosal- S.Chand&CopanyLtd.
5. Introduction to elementary particles: D. Griffiths- Wiley International Edition – New York.


### BOOKS FOR REFERENCES


1. Nuclear Physics: R.R. Roy & B.P. Nigam- Wiley Eastern Ltd.
2. Theory of Nuclear Structure: M.K. Pal- Affiliated East -West Press Ltd.
3. The Atomic Nucleus: R.D. Evans- Tata McGraw – Hill Pub.
4. Concepts of Nuclear Physics: Bernard L. Cohen- Tata McGraw – Hill Pub.
5. Nuclear and Particle Physics: W.E. Burcham and M. Jobes- Addison Wesley– Japan.

## SEMESTER – IV

## PAPER – XVIII: NANOSCIENCE (CODE: PHHT - 419)

### UNIT – I:INTRODUCTION AND BASIC PROPERTIES OF NANOPARTICLES

Historical perspectives of Nanomaterials – classification of Nanomaterials, Nanorods – Nanotubes and Nanoparticles – Basic state physics – face centered nano – particles. Metal – nonoclusters – Magic Numbers -Modeling of Nano particles- reactivity magnetic clusters –Bulk - to nanotransition –semiconducting Nanoparticles – Optical properties – Photo fragmentation – rare gas – and Molecular clusters – Inert gas Super fluid and molecular clusters.

### UNIT – II: CARBON NANO STRUCTURES

New carbon structures – small carbon clusters – Structure of $C_{60}$ – Fullerences – other bulky balls – Carbon nanotubes – fabrication Structures – electrical and mechanical properties – application to computers fuel cells chemical sensors – mechanical reinforcement.

### UNIT – III:FERROMAGNETISM AND SPECTROSCOPY OF NANO PARTICLES

Effect of bulk nanostructuring – magnetic properties – dynamics of nanomagnets – nanopore containment – nanocarbon feromagnets – colossal magnetic resistance – Gravitation magnetic resistance – Ferro fluids – spectroscopic study of nanomaterial – qualitative idea of quantum dots.

### UNIT – IV:APPLICATION OF NANO TECHNOLOGY

Biological building blocks – Nucleic acid – Biological nanostructures – Micro electro mechanical system – Nanoelectro mechanical system ( NEMS) – Nanodevices: and machines – molecular – molecular and super molecular structure – nanobiotechnology – DNA chip, DNA array, drug delivery systems.

### TEXT BOOKS


1. Physics of simple metal clusters & microcluster physics: S.Sugano&H.Koizumi- Springer-VerlagHeidalberg(1998)
2. Hand Book of Nanophase Materials: S.N.Khanna- Goldstein Edition, Marcel Decker, Newyork, (1997).
3. Nano Technology in Carbon Materials: R.Saito,G.Dresselhaus & M.S.Dresselhaus- Springer-Verlog(1998).
4. Physicsal Properties of Carbobnano-tubes: R.Saito,G.Dresselhaus & M.S.Dresselhaus- Imperial College Press,London(1999).
5. Hand Book of Nanostructured Materials&Nanotecnology: I.Chang- H.S.Nalwo Edition, Academic Press, Sandiago(2001).

SEMESTER – IV

PAPER – XIX ( CODE : PHHP – 420 )

PRACTICALS – IV: ADVANCED EXPERIMENTS

( ANY TEN EXPERIMENTS )

1. Study of energy gap of semiconductor – Four probe method.
2. Measurement of ultrasonic velocity and Adiabatic compressibility of liquid – Ultrasonic interferometer
3. B-H curve using CRO.
4. Measurement of wavelength and thickness of mica sheet – Michelson Interferometer.
5. Determination of resolution of G. M. Counter.
6. Verification of inverse square law using GM counter
7. Study of end point energy using GM counter
8. Magnetic susceptibility by Quinke's tube.
9. Half shade polarimeter – specific rotation of optically active substances.
10. Study of ESR.
11. Impedance measurements – determination of resistance and reactors
12. Spectral analysis – UV spectra, IR spectra, Raman spectra and NMR spectra.
13. Determination of the impedence of co-axial cable and rectangular wave guide using microwave bench.
14. Determination of dielectric constant of liquids using micro wave bench.
15. Determination of dielectric constant of solids using micro wave bench.

Any other Experiment of equal standard.

SEMESTER –IV

PAPER -XXI: ( Soft Core – IV :PHSC - 421 X; X = A,B,C&D )

| | |
|---|---|
| PHSC- 421 A | CHARACTERIZATION OF MATERIALS<br>(only M.Sc. ) |
| PHSC- 421 B | BIO-ELECTRONICS(only M.Sc. Students other Department also) |
| PHSC - 421 C | PHYSICS IN EVERYDAY LIFE(Other Department Students also) |
| PHSC- 421 D | PROJECT WORK (for Physics Students only) |

# ANNEXURE-I

## LIST OF SOFT CORE PAPERS

| PAPER CODE | TITLE OF THE PAPER | CREDIT |
|---|---|---|
| **LIST- I : SEMESTER-I (PAPER CODE: PHSC-105 X : X = A,B,C&D)** | | |
| PHSC - 105 A | LIQUID CRYSTAL | 3 |
| PHSC - 105 B | NONLINEAR DYNAMICS | 3 |
| PHSC - 105 C | ENERGY PHYSICS (Other Department Students also) | 3 |
| PHSC – 105 D | ASTROPHYSICS | 3 |
| **LIST- II : SEMESTER-II (PAPER CODE: PHSC- 210 X: X = A,B,C&D )** | | |
| PHSC - 210 A | COMPUTATIONAL PHYSICS | 3 |
| PHSC – 210 B | RADIATION PHYSICS | 3 |
| PHSC – 210 C | NANO TECHNOLOGY AND ITS APPLICATIONS (Other Department Students also) | 3 |
| PHSC – 210 D | LASER AND ITS APPLICATIONS | 3 |
| **LIST- III: SEMESTER-III (PAPER CODE: PHSC- 315 X: X = A,B,C&D)** | | |
| PHSC – 315 A | ENVIRONMENTAL PHYSICS | 3 |
| PHSC – 315 B | CRYSTAL GROWTH | 3 |
| PHSC – 315 C | MEDICAL PHYSICS(Other Department Students also) | 3 |
| PHSC – 316 D | PHILOSOPHY OF PHYSICS(Other Department Students also) | 3 |
| **LIST- IV: SEMESTER-IV (PAPER CODE- 421 X ; X = A,B,C&D)** | | |
| PHSC- 421 A | CHARACTERIZATION OF MATERIALS (only M.Sc. ) | 3 |
| PHSC- 421 B | BIO-ELECTRONICS ( all M.Sc. Students ) | 3 |
| PHSC - 421 C | PHYSICS IN EVERYDAY LIFE(Other Department Students also) | 3 |
| PHSC - 421 D | PROJECT WORK (for Physics Students only) | 3 |

ANEXTURE-II

SYLABUS FOR SOFT CORE PAPERS

## PAPER-1: LIQUID CRYSTALS ( PHSC- 105 A )

### UNIT- I: Introduction

States of matter, Liquid crystals, Symmetry, structure and order, Mesogenic molecules, Liquid crystals of achiral and chiral molecules, calamitic, disc shape and polymer liquid crystals.

### UNIT –II: Physical Properties

Order parameters, measurement by magnetic resonance spectroscopy, Optical anisotropy, refractive index, Dielectric anisotropy, dielectric permittivity, Diamagnetic anisotropy, magnetic susceptibility;, Transport properties, Elastic constants, continuum description. Statistical Theories of Nematic Order: Landau-de-Gennes theory, hard particle, Maier saupe- and van der Walls type theories.

### UNIT- III: Types of liquid crystal

Nematic-Smectic A transition- Phenomenological description, McMillan theory, ymorphism in smectic A Phase.

### UNIT- IV: Chiral liquid crystals

Chirality in liquid crystals: chiral nematic phase, optical properties, field induced nematic-cholesteric phase change, distortion of structure by magnetic field; Blue phase. Chiral smectic phases, origin of ferroelectricity: Structure, symmetry and ferroelectric ordering in chiral smectic C phase; Antiferroelectric and ferroelectric chiral smectic C phase.

Reference Books:


1. Liquid Crystals: S. Chandrasekhar.
2. The Physics of Liquid Crystals: P.G. de Gennes and J Prost.
3. Liquid Crystals, Fundamentals: S Singh.

## PAPER -2: NONLINEAR DYNAMICS ( PHSC – 105 B )

UNIT -1: Introduction Oscillator system

Harmonic oscillator, phase space motion in phase space, oscillator as integrable system, pendulum conservation and non-conservation of areas in phase space, damped harmonic oscillators, dissipation, forced oscillator, stability of solutions sensitivity to initial conditions.

UNIT -2: Ordinary differential equation

Linear ODE, S+N decomposition. Linearization of nonlinear equations, stable and unstable manifolds HortmonGrobman theorem, stable manifold theorem. Flows &maps ,Periodic system, Floquet multipliers, Poincore section. Attractors: Types of attractors, strange attractors, stretching and folding, Lorenz and Rossler attractors.

UNIT – 3: Maps

Logistic map, analysis of the logistic map, period doubling, intermittency Feigenbaum universality circle map, standard map, Henonmap.Elements of bifurcation theory, routes to chaos. Characterization of chaotic solutions and attractors, power spectrum, ergo-dicity, invariant measure, Lyapunov exponent, dimensions and their evaluation, K-entropy and symbolic dynamics.

UNIT -4: Hamiltonian systems Introduction

Hamiltonian phase flow and integral invariants, canonical formalism, Hamilton-Jacobi methods, Generating functions, integrable systems, Liouville Arnold integrability Central force problem, Harmonic oscillators, Toda chain, action variables. Perturbation Theory : Adiabatic invariance, Averaging KAM theorem Resonances, variational calculation of Tori, Stochastic motion. Diffusion other area preserving systems: Maps Baker's transformation, Cat map, and Stmbolicsynamics.

Recommended Books:


1. Ordinary Diff. Equations, V. J. Arnold.
2. Differential Equations, Dynamical Systems and an Introduction to Chaos, Hirsch, Smale and Devaney, Academic Press, (Elsevier Imprint), 2004.
3. Int. to applied nonlinear dynamical ststems& Chaos, Wiggins (Springer Verlag).
4. Nonlinear Oscillations, Dynamical Systems and bifurcations of vector fields, Springer Verlag,
5. Guckenheimer and Holmes, (Springer Verlag).
6. Chaotic Evolution and Cambridge, D. Ruelle. (Uni. Press),
7. Nonlinear Ordinary diff. Eq., Jordan & Smith, (Oxford Univ. Press).
8. Nonlinear dynamics & Chaos, Strogatz, (Addison Wesley).
9. Chaos and integrability in Nonlinear Dynamics, An introduction, M. Tabor, (J. Wiley), 1989.
10. Introduction to Dynamics, I. Percival, D. Richards, (Cambridge Univ. Press).
11. Berge Pomeo Vidal, Order within chaos, J.Wiley, 1984.
12. Chaos in Dynamical System, E. Ott, (Cambridge University Press).
13. Chaotic Dynamics, G. L. Baker, J. P. Gollub, (Cambridge University Press).
14. Chaotic Dynamics of Non-linear Systems, S. Neil Rasband, (John Wiley).

## PAPER -3: ENERGY PHYSICS ( PHSC – 105 C )

### UNIT I : Introduction to Energy Sources and solar cells

Energy sources – Types of energy sources – World energy futures- Energy sources and their availability – Prospects of renewable energy sources.Solar Cells: Solar cells for direct conversion of solar energy to electric powers – Solar cell parameter – Solar cell electrical characteristics – Efficiency – Single crystal silicon solar cells – Polycrystalline silicon solar cells – Cadmium sulphide solar cells.

### UNIT II : Applications of Solar Energy

Solar water heating – space heating and space cooling – solar photo voltaics – agricultural and industrial process heat – solar distillation – solar pumping– solar furnace – solar cooking – solar green house.

### UNIT III : Wind Energy

Base principles of wind energy conversion wind data and energy estimation – Base components of wind energy conversion systems (WECS) types of wind machines – Generating systems – scheme for electric generation – generator control – load control – applications of wind energy.

### UNIT IV : Energy from Biomass

Biomass conversion Technologies – wet and Dry process – Photosynthesis-Biogas Generation: Introduction – basic process and energetic – Advantages of anaerobic digestion – factors affecting bio digestion and generation of gas – Classification of Biogas plants: Continuous and batch type – the done and drum types of Bio gas plants – biogas from wastes fuel – properties of biogas – utilization of biogas.

### BOOKS FOR STUDY AND REFERENCE:


1. F. Kreith and J.F. Kreider, Principles of Solar Engineering, Tata McGraw Hill (1978).
2. A.B. Meinel and A.P.Meinel, Applied Solar Energy, Addison Wesley Publishing Co. (1976).
3. M.P.Agarwal, Solar Energy, S. Chand and Co., New Delhi (1983).
4. S.P.Sukhatme, Solar Energy, Tata McGraw Hill (1997).
5. G.D. Rai, Non-conventional Energy sources, Khanna Publications,Delhi (2009).

## PAPER 4 : ASTROPHYSICS ( PHSC – 105 D )

Unit-I: Observational Astronomy

The electromagnetic spectrum; geometrical optics (ray diagrams, focal length, magnification etc); diffraction (resolving power, Airy disc, diffraction limit etc); telescopes (reflecting, refracting, multi-wavelength).

Unit-II: Properties of stars

Brightnesses (luminosities, fluxes and magnitudes); colours (blackbody radiation, the Planck, Stefan-Boltzmann and Wien laws, effective temperature, interstellar reddening); spectral types; spectral lines (Bohr model, Lyman &Balmer series etc, Doppler effect); Hertzprung -Russell diagram; the main sequence (stellar masses, binary systems, Kepler's laws, mass-luminosity relations); distances to stars (parallax, standard candles, P-L relationships, m-s fitting etc); positions of stars (celestial sphere, coordinate systems, proper motions, sidereal and universal time).

Unit-III: The life and death of stars

Quantaization of gravitational field –gravitation-Energy source (nuclear fusion, p-p chain, triple-alpha, CNO cycle, lifetime of the Sun); solar neutrinos; basic stellar structure (hydrostatic equilibrium, equation of state); evolution beyond the main sequence; formation of the heavy elements; supernovae; stellar remnants (white dwarfs, neutron stars, black holes, degeneracy pressure, Swarszchild radius, escape velocities).

Unit-IV: Galaxies

Constituents of galaxies; stellar populations; the interstellar medium; HII regions; 21cm line; spirals and ellipticals; galactic dynamics; galaxy rotation curves and dark matter; active galaxies and quasars.

Recommended texts:


1. Zeilik& Gregory, Introductory Astronomy & Astrophysics,4thed (Saunders College Publishing)
2. Morison, I., Introduction to Astronomy and Cosmology (Wiley)
3. Kutner, M.L., Astronomy: A Physical Perspective (Cambridge University Press)
4. Green, S.F. & Jones, M.H., An Introduction to the Sun and Stars(Cambridge University Press)
5.Jones,M.H.&Lambourne,R.J.A.,AnIntroductionto Galaxies &Cosmology(Cambridge University Press)
6. Carroll, B.W. &Ostlie, D.A., An Introduction to Modern Astrophysics(Pearson)
7. Shu, F.H.,The Physical Universe, An Introduction to Astronomy (University Science Books)
8. Motz, L. &Duveen, A.,The Essentials of Astronomy , (Colombia University Press)

## PAPER-5: COMPUTATIONAL PHYSICS ( PHSC – 210 A )

### Unit -I: Fortran Programming fundamentals

Fortran constants and variables, Type declarations,Arithmetic operators, Hierarchy, Arithmetic expressions, Logical operators and expressions, Arithmetical and assignment statements, Special functions, Input/output statements, Relational operators, Control statements(go to, arithmetic and logical if), Do loop, repeat hile,Dimensioned variables, Formats, Subprograms, Functions and subroutines, Common declaration, File operations (creating, reading, writing, updating and merging of sequential files), Complex Arithmetic, Enough exercises.

### Unit -II: Essentials of Numerical Techniques

Roots of transcendental equations: Bisection,Iteration, Newton- Raphson methods (SS). Linear interpolation: Newton's forward, backward& general formula, Lagrange formula. Least squares curve fitting: (Linear and Nonlinear), Numerical integration: General formula, Simpson's formula's, Gauss quadrature formula, Solution of ordinary differential equations: Runge-Kutta method (first and higher orders), Enough exercises.

### Unit -III: Random numbers, Random walk

Concepts of randomness, Random number generators,Pseudo random numbers, Tests for randomness, Random walk – basic concepts, Brownian motion and diffusion, Enough exercises.

### Unit -IV: Fourier analysis Spectral analysis

Finding root of a polynomial by Newton-Raphson method, Application of Fortran programming to physical problems; Programmes for interpolation and extrapolation, computing eigenvalues and eigen functions of a matrix, Integration and Differentiation, Solution to differential equations, Diffusion and Brownian motion problems(Simple).

Text Books

1. Computer Programming in Fortran 90, V. Rajaraman, PHI
2. Programming with Fortran 77 – Schaum's Outline Series, McGraw Hill
3. Introductory Methods of Numerical Analysis – S. S. Sastry (SS), PHI
4. Numerical Mathematical Analysis – J. B. Scarborough, Oxford & IBH
5. An Introduction to Computational Physics, 2nd ed. – Tao Pang - Cambridge University Press,Cambridge (2006)

References

1. Computational Physics – An Introduction – R.C. Verma, P.K. Ahluwalia and K.C. Sharma, New Age International Publishers, New Delhi (1999)
2. A first Course in Computational Physics – Paul L De Vries, John Wiley & Sons, Inc, New York (1994)
3. Numerical Recipes in Fortran, The art of Scientific Computing, W. H. Press et al Cambridge.
4. Computer Simulation of Liquids, M. P. Allen, D. J. Tyldesley, Clarendon Press, Oxford.

## PAPER-6: RADIATION PHYSICS ( PHSC – 210 B )

### UNIT- 1: Radiation sources

Different types of sources, alpha, beta, gamma, neutron and heavy ion sources, radioactive sources – naturally occurring, production of artificial isotopes, accelerators – cyclotrons, nuclear reactors.

### UNIT – 2: Interaction of radiations with matter

Electrons – classical theory of inelastic collisions with atomic electrons, energy loss per ion pair by primary and secondary ionization, specific energy loss, bremsstrahlung, range energy relation, energy and range straggling Heavy charged particles – stopping power, energy loss, range and range – energy relations, Bragg curve, specific ionization, Gamma rays – Interaction mechanism – Photoelectric absorption, Compton scattering, Pair production,gamma ray attenuation, attenuation coefficients, Elastic and inelasticscattering, Neutrons – General properties, fast neutron interactions, slowing down and moderation .

### UNIT -3: Radiation quantities, Units and Dosimeters

Particle flux and fluence, energy flux andfluence, cross sections, linear and mass absorption coefficients, stopping power, LET,exposure and its measurements, absorbed dose and its relation to exposure,Kerma, Biological effectiveness, Equivalent dose, Effective loss, Dosimeters,Primary and secondary dosimeters, Pocket dosimeter, Films and solid dosimeter (TLD and RPL), Clincal and calorimetric devices.

### UNIT- 4: Radiation transport and shielding

Basic concept, Transport equation, Fick's law and diffusion equation, Boundary conditions, Analytical solution, Slowing down theory,Resonance absorption, Criticality calculations, Fermi age theory, Four factor formula, Shielding factor for radiations, Choice of material, Primary and secondary radiations, Source geometry, Beta shielding, Gamma shielding, neutron shielding, Shielding requirements for medical, industrial and research facilities.

Reference books :

1."Atomic Nucleus" , R.D. Evans
2."Source book on Atomic Energy" – Samuel Glasstone
3."The Physics of Radiology", H.E. Jones and Cunningham, (Charles C Thomas – 1989)
4."Fundamentals of radiology", W.J. Meredith and J.B. Massey (John Right and sons – 1989)
5."Principles of radiation shielding", A.B. Chilton (Prentice Hall of India)

## PAPER- 7: NANOTECHNOLOGY AND ITS APPLICATIONS ( PHSC – 210 C )

### UNIT-I: INTRODUCTION

Introduction to Nano –Technology - Nano particles as building Blocks. Nano – particle - Processing (Mechanical, wet Chemical) Importance of Nano particle – Nano rods – Nano wires.

### UNIT –II: APPLICATION – I (Environment, Energy and Chemistry)

Filtration - Reduction of energy consumption - Increasing the efficiency of energy production - Chemical sensor - Interaction of sensor with its environment. Synthesis of quantum dots - Quantum dots in chemistry - Advantages of inorganic quantum dots over organic Fluoropheres.

### UNIT – III: APPLICATION – II (Information, Communication, and Application to Computers)

Memory Storage - Novel semiconductor devices - Novel optoelectronic devices. Displays - Quantum computers - Nano manipulations - Nano robots - Benefits of Nano computers.

### UNIT – IV: APPLICATION – III (Bio –Medical Application)

Nano electromechanical devices to drug delivery systems-MEMS &NEMS Regulatory dimension - Implantable devices - Photo dynamic therapy in targeted drug administration - Bio sensor types - Bio sensor and marketing of sensor device - Quantum dot technology in cancer treatment - Quantum dots in early diagnosis of cancer.

### TEXT BOOKS

1. Nano Bio Technology SubbiahBalaji Mjppublishers.com
2. Introduction to Nanotechnology Charles P Poole JR and frank J.Owens Wiley International.
3 .Hand Book of Nano technology Akhlesh and Lakhtakia Prentice Hall of India

### BOOKS FOR REFERENCE

1 .Nano scale Materials of Chemistry Kennath J. KlabundeA John Wiley and Sons
2. Nanotechnology Richard Bukker and Earl Boison Wiley Publishing Company
3 Nano bio technologyChristoberM.NiemeyerChadd A. MirkinSchlapbach

## PAPER –8: LASER AND ITS APPLICATIONS ( PHSC – 210 D )

### UNIT – I: LASER FUNDAMENTALS

Unique properties of Laser : coherence , monochromaticity , directionality and Intensity - Absorption , spontaneous emission and stimulated emission. Metastable level - Population inversion - A brief general outline of working of Laser. Light amplification - Threshold Condition - Steady state population inversion - Three level and four level systems.

Laser resonators : Plane mirror and curved mirror cavities- Cavity losses and condition for lasing - Quality factor - Q – Switching and Short laser pulses. Longitudinal laser cavity modes Transverse cavity modes - Mode locking and ultrashort pulses .

### UNIT – II: LASER SYSTEMS

LASER structure - Excitation mechanism - Working with energy level diagram of Low density gain media : Helium – Neon laser , Argon ion laser, Carbon dioxide LASER , Nitrogen LASER and excimer LASERS. High density gain media : Ruby LASER , Nd – YAG and Nd –Glass LASERS , semiconductor LASERS, colour centre LASERS and Dye LASERS.

### UNIT – III: LASER SPECTROSCOPY

Laser Raman Spectroscopy : Hyper Raman effect - stimulated Raman effect -coherent anti – stokes Raman effect , Photo – acoustic Raman scattering. Hormonic generation - Phase matching optical mixing - Photo dependent refractive index - Self focusing. Multiphoton processes : multiquantum photoelectric effect - Theory of two photon processes - Doppler free two photon spectroscopy - Laser fluorescence.

### UNIT-IV: APPLICATIONS OF LASERS

Optical Fibre communication: optical fibres numerical aperture. Pulse dispersion in step index fibers - Modal analysis for a step index fiber. Vector modes optical fibre communications laser ranging. A brief description of LASER applications in industry, medicine, astronomy and biology. Application of LASER in Isotope separation.

### TEXTBOOK

1.Lasers and Non Linear Optics: B.B.Laud- Wiley Eastern Ltd.
2.Laser Theory and Application: A.K.Ghatak and K.Thyagarajan- Macmillan India Ltd.
3.Laser Principles,Types and Application: K.R.Nambiar- New Age International.

### BOOKS FOR REFERENCE

1.Principles of laser: Grazio Svelto- Plemum Press
2.Laser Fundamental: William T. Silfvast- Cambridge University
3.Lasers: Lengyel- Wiley Inter Science

# PAPER –9: ENVIRONMENTAL SCIENCE ( PHSC – 315 A )

## UNIT-I: NATURAL RESOURCES

Renewable and non-renewable resources: Natural resources and associated problems - Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources. Role of an individual in conservation of natural resources, Equitable use of resources for sustainable life styles.

## UNIT-II: ECOSYSTEMS

Concept of an ecosystems – Structure and function of an ecosystem – producers, consumers and decomposers. Energy flow in the ecosystem – Ecological succession – Food chains – Introduction, types, characteristic features, structure and function of the following ecosystem – Forest ecosystem – desert ecosystem – aquatic ecosystem.

## UNIT-III: BIO-DIVERSITY AND ITS CONSERVATION

Introduction – definition: genetic species and ecosystem diversity; Bio - geographical classification of India, value of biodiversity - productive use, social, ethical and option values, Biodiversity at global, national and local levels, India as a mega-diversity nation, Hot – spots of biodiversity, Threats to biodiversity – Habitat loss, poaching of wildlife, man – wildlife conflicts, Conservation of biodiversity – In-situ and ex-situ conservation of biodiversity.

## UNIT-IV: ENVIRONMENTAL POLLUTION

Definition: Cause, effect and control measures of Air pollution, Water pollution, Marine pollution, Thermal pollution, Nuclear hazards, solid waste management – causes effects and control measures of urban and industrial waste – Role of an individual in prevention of pollution, pollution case studies, Disaster management – Floods. Earthquake, cyclone.

## TEXT BOOKS

1.Environmental Science & Engineering: Dr.A. Ravikrishnan- Sri Krishna Hitech Publishing Company Pvt.Ltd.
2. Environmental Science & Engineering: P.Anandan & R. Kumaravelan- Scitech Publications(India) Pvt. Ltd.

## BOOKS FOR REFERENCE

1.Environmental Science and Engineeri: Anubhakaushik and C.P. Kaushik- New Age International Pub
2.Environmental Pollution Control Engineering: C.S.Rao- New Age International Pub.
3.Environmental Chemistry: A.K. De- New Age International Pub.
4.Environmental Studies: Erach Bharucha- University Press.
5.Introduction to Environmental Engineering: P.Anandan & R. Kumaravelan- Prentice-Hall of India.

## PAPER 10: CRYSTAL GROWTH (PHSC – 315 B)

### Unit- 1: NUCLEATION AND KINETICS OF CRYSTAL GROWTH

Theories of nucleation - classical theory of nucleation - heterogeneous nucleation - singular and rough faces - modes on surface roughness - Kossel, Stranski, Volmer (KSV) theory -Burton, Cabrera, Frank (BCF) theory - periodic bond chain theory - Muller-Krumbhaar model.

### Unit -2: CRYSTAL GROWTH FROM THE MELT

Growth from the melt - Bridgeman and related techniques - crystal pulling - convection in melts - simulation of bulk crystal - melt growth of oxide crystals - Czochralski technique -Zone melting technique - Skull melting process - verneuil process - heat exchanger method.

### Unit- 3: SOLUTION GROWTH

Low temperature solution growth - crystal growth system - non-linear phenomena in KDP family crystals - solubility of KDP and ADP - Seed preparation - high temperature solution growth - growth of potassium titanyl phosphate - practical aspects.

### Unit- 4: MODERN CRYSTAL GROWTH TECHNIQUES

Vapour growth (physical and chemical) - Hydrothermal growth - Electro crystallization - Gel growth - Liquid crystals - Technology of Epitaxy - Practical aspects.

### BOOKS FOR STUDY

1. Crystal growth process and methods Dr.P.Santhanaraghavan and Dr.P.Ramasamy: KRU Pub, Kumbakonam, 2000.
2. Physics of crystals, Macmillan S.Bhagavantam and S.Radhakrishna , New Delhi, 1965
3 .Crystal growth processes J.C.Brice , John wiley and sons, New York, 1986

### BOOKS FOR REFERENCE

1. Crystal Growth H.E.Buckley, John wiley and sons, New York, 1986
2The Artand Science of growing crystals J.Gilman:Johnwiley and sons, New York 1965
3. Fundamentals of crystal physics I.Sirotin and P.Shaskolskaya: Mir Publications, New Delhi, 1982.

## PAPER- 11: MEDICAL PHYSICS (PHSC – 315 C )

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### Unit- I: MECHANICS OF HUMAN BODY

Static, dynamic and frictional forces in the body-composition, properties and function of bone-heart-temperature-temperature scales-clinical thermometer- thermography- heat theraphycroyogenics in medicine- heat losses from body-pressure in the body pressure in skull, eye and urinary bladder.

### Unit- II: PHYSICS OF RESPIRATORY AND CARDIOVASCULAR SYSTEM

Body as a machine-airways system-blood & lungs interaction measurements of lung volume-structure and physics of alveoli breathing mechanism- ventilators-types of ventilators- airway resistance- components & functions of cardiovascular systems-work done by heart-components & flow of blood-laminar and turbulent flow-blood pressure-direct and indirect method of measuring- heart sounds.

### Unit- III: ELECTRICITY IN THE BODY

Nervous system & neuron-electrical potentials of nerves electric signals from muscles, eye, heart-block diagram & working to record EMG- normal ECG wave form- electrodes for ECGamplifier and recording device-block diagram and working to record ECG-patient monitoring-pace maker.

### Unit- IV: DIAGNOSTIC X-RAYS AND NUCLEAR MEDICINE

Production and properties of X rays-basic diagnostic X-ray machine - X-ray image - live X-Ray image - X-ray computed tomography-characteristics of radio activity-radio isotopes and radio nuclides - radioactivity sources for nuclear medicine – basic instrumentation and clinical applications-priniciples of radiation therapy - nuclear medicine imaging devices-radiation sources – Basic principles of photodynamic therapy.

Books for study

1. Study Material prepared by the Department
2. Hand of biomedical instrumentation (section 33.3 & 33.4)
3. R.S.Khandhur, 2010, Tata McGraw Hill education privatelimited.

## PAPER – 12: PHILOSOPHY OF PHYSICS (PHSC -315 D)

Unit-I: Basics tools of logic

Propositions, Observations, concept, theory, Meaning of knowledge and process of knowledge generation, Inductive and detective logic, evolution of symbolic logic. Truth and proofs. Otology and epistemology in knowledge.

Unit-II: Space time and motion

Definition of time, prediction, and simultaneity. Equation of motion and realism. Generalized formulations and reality. Principle of correspondence. Absolute and Relative space time. Newton's Determinism.

Unit-III: Philosophy in quantum mechanics

Measurement, identity, observer observable paradox, Non Locality, space time Quantum mechanics and entanglement, correlation. Vector space and reality. Concept of free will. Probability, sets and Godales theorem.

Unit-IV: Contemporary issues in physics and philosophy

Relation of statistics and mechanics. Duality and questions in non-deterministic approach of reality. Bohr, Bohm, Einstein logic in physics. Inclusiveness in metaphysics.

Textbooks

1. J. T. Cushing (1998) Philosophical Concepts in Physics (Cambridge: Cambridge University Press)

## PAPER-13 : CHARACTERIZATION OF MATERIALS ( PHSC – 421A )

UNIT – I: Structural characterizations

Construction, Principle and working of XRD, SEM, TEM, AFM, XPS, TGA-DTA characterization techniques- Data analysis using above characterization techniques.

UNIT – II: Compositional Analysis

Atomic Absorption Spectrometry: EDAX, Augurelectron spectroscopy- Working, actual determination, limitations, procedure, and experimental analysis.

UNIT – III: Optical Properties

UV–Vis, IR, 2D-NMR and Raman spectroscopy and photoluminescence: principle and working, reflection, absorption, transmission analysis, band gap determination, Identification of molecular groups for radicals in solids, zero phonon mode of vibration, electron-phonon and phonon-phonon interactions and scattering geometry in Raman spectroscopy.

UNIT - IV: Thermal characterization

Theories of TGA,DTA,DSC-Experimental procedure- Data analysis.

Reference books


1. Elements of X- ray diffraction By B. D. Cullity, (1956), Addison-Wesley Publishing company Inc., USA
2. X ray theory and experiments by Compton and Alison
3. Instrumental methods of analysis (Vthedition) by Willard, Merritt, DeanSettle
4. Photoelectrochemical solar cells by Suresh Chandra
5. Solar cells by Martin a Green
6. Thin film preparation by Joy George
7. Characterization techniques by ChatwalAnand
8. Modern Raman Spectroscopy: Practical Approach by Deon and Smith
9. Microscopy of materials - D.K. Bowen & C.R. Hall (the MacMillan press Ltd. (London) 1975
10. Characterization of Materials, John B. Wachtman&Zwi. H. Kalman, Pub. Butterworth-Heinemann (1992)

## PAPER-14 : BIO-ELECTRONICS ( PHSC – 421 B )

UNIT - 1 Signals & classification

Biosignals& origin, volume conduction, Time & frequency domain, characteristics of biosignals such as ECG, EEG, EP, EMG, MEG Signal acquisition & processing basics.

UNIT - 2 Electrode + electrode interface

Polarization, Electrode behavior & circuit model, Electrode skin interface, Body surface electrodes, internal electrodes, Microelectrodes, electrode arrays, Displacements, resistive, capacitive, piezoelectric sensors, temperature measurement, fiber-optic sensors, radiation sensors for biomedical uses

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UNIT - 3 Bioelectric amplifiers

Basic requirements, Differential amplifier, Instrumentation amplifier, Integrators, differentiators, active filters, ECG amplifier, right leg driven system, EEG multichannel amplifiers &filters, noise filtering & transient protection, Amplifiers for use with glass electrodes & intracellular electrodes.

UNIT - 4 Stimulators, Recording

Constant current & constant voltage stimulator, internal external stimulators Pacemaker types & circuits, Photo-stimulator for vision, Acoustic stimulators for hearing, Wave shaping circuits &waveform generator, Complete recording system for ECG, EMG, EEG, EP & specifications, Cardiac monitors, defibrillator, ventilator systems, hemodiatctar system, micro shock, macro shock hazards, Basic approach for shock protection.

Text Books:

1. Principles of Neural Science – Kandel & Schwartz (Elsevier, North Holland), 1981.
2. Op-Amps & linear Integrated Circuits - Gaikwad, (EEE Prentice Hall).
3. Biomedical Instrumentation, (EEE Prentice Hall).
4. Introduction to Biomedical Equipment Technology-Carr& Brown (John Wiley)
5. Design of Microcomputer based medical Inst, Webster & Tompkins
6. Encyclopedia of Biomed, Inst. Ed. Webster
7. Digital Electronics, Malvino& Leach

## PAPER-15: PHYSICS IN EVERYDAY LIFE (PHSC– 421 C )

( For other Department also)

Unit – 1:Physics and Life

Physics in Earth's Atmosphere: Sun, Earth's atmosphere as an ideal gas; Pressure, temperature and density, Pascal's Law and Archimedes' Principle, Coriolis acceleration and weather systems, Rayleigh scattering, Red sunset, Reflection, refraction and dispersion of light, Total internal reflection, Rainbow.

Unit – 2:Physics in Human Body:

The eyes as an optical instrument, Vision defects, Rayleigh criterion and resolving power, Sound waves and hearing, Sound intensity, Decibel scale, and temperature control.

Unit – 3:Physics in Sports:

The sweet spot, Dynamics of rotating objects, Running, Jumping and pole vaulting, Motion of a spinning ball, Continuity and Bernoulli equations, Banana shot: Magnus force, Turbulence and drag.

Unit – 4:Physics in Technology:

Microwave ovens, Lorentz force, Global Positioning System, CCDs, Lasers, Displays, Optical recording, CD, DVD Player, Tape records, Electric motors, Hybrid car, Telescope, Microscope, Projector etc.

Text Book


1. University Physics by F. W. Sears, M. Zemansky, R. A. Freedman, and H. D. Young, Pearson Education
2. Fundamentals of Physics by D. Halliday, R. Resnick, J. Walker, John Wiley & Sons