# PERIYAR UNIVERSITY
# PERIYAR PALKALAI NAGAR
# SALEM – 636 011

**DEGREE OF MASTER OF SCIENCE**

**CHOICE BASED CREDIT SYSTEM**

**SYLLABUS FOR M.SC. PHYSICS**

**FOR THE STUDENTS ADMITTED FROM THE**

**ACADEMIC YEAR 2012 – 2013 ONWARDS**

## 01. OBJECTIVES OF THE COURSE

The recent developments in Physical sciences, had been included in the enriched M.Sc.,(Physics) Syllabus to meet out the present day needs of Academic and Research Institutions and Industries.

## 02. DURATION OF THE PROGRAMME

The two – year post – graduate programme in M.Sc., Physics consists of four semesters.

## 03. ELIGIBILITY

A candidate who has passed the B.Sc., Degree Examination in Branch III Physics Main or B.Sc., in Applied Physics or B.Sc., Physics – (Vocational) of this University or an examination of some other universities accepted by the Syndicate as equivalent thereto shall be permitted to appear and qualify for the M.Sc., Physics (CBCS) Degree Examination of this University after a course of two academic years.

## 04. COURSE OF STUDY

The course of study for the degree shall be BRANCH III (B) – Physics (Choice Based Credit System) under semester system with internal assessment according to the syllabus prescribed from time to time.

Total marks - 2000

For each paper - 100 Marks (Int.25+ Ext.75)

Project - 200 Marks

## 05. DISTRIBUTION OF CREDIT POINTS

The minimum credit requirement for a two – year Master's Programme shall be 90 Credits. The break – up of credits for the programme is as follow:

Core Courses : Minimum 74 credits

Elective Courses : Minimum 16 credits

## 06. STRUCTURE OF THE COURSE

| Semester | Code | Course Title | Hours per Week | Credit | Exam. Hrs | Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Int. | Ext. | Total |
| I | PPHC 01 | Classical and Statistical Mechanics | 4 | 4 | 3 | 25 | 75 | 100 |
| | PPHC 02 | Mathematical Physics | 4 | 4 | 3 | 25 | 75 | 100 |
| | PPHC 03 | Quantum Mechanics I | 4 | 4 | 3 | 25 | 75 | 100 |
| | PPHC 04 | Practical – I<br>General Physics Experiments | 6 | 6 | 4 | 25 | 75 | 100 |
| | PPHEC 01 | Elective – I | 4 | 4 | 3 | 25 | 75 | 100 |
| II | PPHC 05 | Electronics | 4 | 4 | 3 | 25 | 75 | 100 |
| | PPHC 06 | Electromagnetic Theory | 4 | 4 | 3 | 25 | 75 | 100 |
| | PPHC 07 | Condensed Matter Physics | 4 | 4 | 3 | 25 | 75 | 100 |
| | PPHC 08 | Practical –II<br>Electronics Experiments | 6 | 6 | 4 | 25 | 75 | 100 |
| | PPHEC 02 | Elective - II | 4 | 4 | 3 | 25 | 75 | 100 |
| III | PPHC 09 | Computational Methods<br>and Programming | 4 | 4 | 3 | 25 | 75 | 100 |
| | PPHC 10 | Microprocessor and Microcontroller | 4 | 4 | 3 | 25 | 75 | 100 |
| | PPHC 11 | Nuclear and Particle Physics | 4 | 4 | 3 | 25 | 75 | 100 |
| | PPHC 12 | Practical -III<br>Microprocessor, Microcontroller & Computer programming | 6 | 6 | 4 | 25 | 75 | 100 |
| | PPHEC 03 | Elective - III | 4 | 4 | 3 | 25 | 75 | 100 |
| IV | PPHC 13 | Molecular Spectroscopy | 4 | 4 | 3 | 25 | 75 | 100 |
| | PPHC 14 | Quantum Mechanics - II | 4 | 4 | 3 | 25 | 75 | 100 |
| | PPHC 15 | Communication Electronics | 4 | 4 | 3 | 25 | 75 | 100 |
| | PPHEC 04 | Elective - IV | 4 | 4 | 3 | 25 | 75 | 100 |
| | PPHO 16 | Project with viva voce | 8 | 8 | - | - | - | 200 |
| | | Total | 90 | 90 | | | | 2000 |

## 07. EXAMINATION

For the purpose of uniformity, particularly for interdepartmental transfer of credits, there will be a uniform procedure of examinations to be adopted by all teachers offering courses. There will be three tests and seminars and one end semester examinations during each semester. The practical examinations for P.G course should be conducted at the end of even semester.

The distribution of marks between sessional evaluation and end semester will be 25% and 75% respectively. The sessional evaluation is distributed to tests, seminars and attendance as 15% & 5% and 5% respectively.

## 08. QUESTION PAPER PATTERN

Question paper pattern for University Examinations

| | | |
|---|---|---|
| Time | : | 3 Hours |
| Maximum | : | 75 Marks |
| Passing Minimum | : | 38 Marks |

Part – A (5×5 = 25 Marks)

Answer all questions

(Either or Type)

Part – B (5×10 =50 Marks)

Answer all questions

(Either or Type)

## 09. PASSING MINIMUM

In order to pass a paper 50% Minimum is compulsory both in the internal and external.

A candidate who has secured a minimum 50 marks ( internal – 12 and external – 38) in all the courses prescribed in the programme and earned a minimum of 90 credits will be considered to have passed the Master's Programme.

## 10. COMMENCEMENTS OF THIS REGULATION

These regulation and syllabus shall take effect from the academic year 2012 – 2013, that is, for students who are admitted to the first year of the course during the academic year 2012 – 2013 and thereafter.

**List of Elective Courses:**

1. PPHECO1 - Bio – electronics and Bio Sensors
2. PPHECO2 - Opto electronic devices
3. PPHECO3 - Nano Science and Technology
4. PPHECO4 - Energy Physics
5. PPHECO5 - Non Linear Dynamics
6. PPHECO6 - Materials Synthesis and Characterization
7. PPHECO7 - X –ray Crystallography and Bio-Physics
8. PPHECO8 - Ultrasonics and its applications

**List of Supportive Courses:**

1 Electronic Appliances

2. Medical Physics

3. Geo Physics

4. Lasers and Applications

# PPHC01 : CLASSICAL AND STATISTICAL MECHANICS

**UNIT - I : Lagrangian Formulation and Hamilton Principle**

Mechanics of a system of particles: constraints of motion, generalized coordinates,D'Alembert's principle and Lagrange's velocity—dependent forces and the dissipation function, Applications of Lagrangian formulation.

Calculus of variations- Hamilton's principle, Lagrange's equation from Hamilton's principle, Legendre transformation and Hamilton's canonical equations, Canonical equations from a variational principle, Principle of least action.

**UNIT - II : Canonical Transformation and Hamilton-Jacobi Theory**

Canonical transformation and its examples, Poisson's brackets, Equations of motion, Angular momentum, Poisson's Bracket relations, infinitesimal canonical transformation, Conservation theorems. Hamilton-Jacobi equations for principal and characteristic functions, the harmonic oscillator problem- Action-angle variables for systems with one-degree of freedom. The Kepler problem in action angle variables.

**UNIT – III : Action angle , variable adiabatic invariance of action angle variable and relativity**

Theory of small oscillations in Lagrangian formulation, normal coordinates - Vibrations of a tri- atomic molecule.

Independent co-ordinates of rigid body, Ortho normal transformations, Eulerian angles, Eulerian theorem, Coriolis force, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of a symmetrical top.

Special theory of relativity- Lorentz transformations - Relativistic kinematics and mass–energy equivalence.

**UNIT – IV :**

Phase space, Liouville's Theorem, micro- and macro states, microcanonical, canonical and grand-canonical ensembles, comparison of various ensembles. Free Energy and connection with thermodynamic quantities - Entropy of an ideal gas: Sackur-Tetrode equation, entropy of mixing and Gibbs' paradox. Ideal gas in canonical and grand canonical ensembles.

**UNIT –V :**

Brief outline of classical and quantum statistics, ideal Fermi and Bose gases, principle of detailed balance, Blackbody radiation and Planck's distribution law. Equation of state, Bose condensation, Equation of state of ideal Fermi gas, Fermi gas at finite T.

Cluster expansion for a classical gas, virial equation of state, Van der Waals gas, Phase transition of second kind. Ising Model in one and two dimensions, fluctuations in ensembles, Energy fluctuation in quantum statistics, Concentration fluctuation in quantum statistics, One dimensional random walk, Brownian motion-Longevin theory.

**BOOKS FOR STUDY AND REFERENCE :**


1. Classical Mechanics: H. Goldstein, C.Poole and J.Safko (Pearson Education Asia, New Delhi, 2002).
2. Classical Mechanics of Particles and Rigid Bodies: K.C. Gupta (New Age International Publishers, 1997)
   New Delhi).
3. Classical Mechanics: S.N. Biswas (Books and Allied Ltd, Kolkata, 1998 )
4. Statistical Mechanics : K Huang ( John Wiley and Sons , New Delhi, 1975))
5. Statistical Mechanics : B.K. Aggarwal and M.Eisner ( New Age International, New Delhi, 1998)
6. Elementary Statistical Mechanics : Gupta and Kumar ( Pragati Prakashan, Meerut, 2005)
7. Statistical Mechanics : R.K. Patharia and Paul D Beale ( Elsevier Publishers, 1996)

# PPHC02 : MATHEMATICAL PHYSICS

**UNIT – I : Vector Analysis**

The scalar and vector fields- Gradient, Divergence, curl and Laplacian – Orthogonal and curvilinear co-ordinates – Rectangular, cylindrical and spherical co-ordinates. Vector integration – Line integrals, surface integrals and volume integrals – Gauss Divergence theorem – Stokes theorem and Green's theorem.

**UNIT – II : Fourier's and Laplace's integral transforms**

Fourier transform- properties of transform-Fourier transform of a derivative- Fourier's sine and cosine transform of a derivative- Finite Fourier transforms-Simple application of Fourier transforms of integral – Inverse Laplace transform-Properties of inverse Laplace transforms- Properties of inverse Laplace transform –convolution theorem-Applications of Laplace Transform.

**UNIT – III : Complex variable**

Function of complex variables-limit-continuity -Differentiability- Analytic Function – Cauchy-Rieman condition –Differential equation -Cauchy Integral theorem-Cauchy Integral formula—Moreva's theorem –Liouville's theorem-Taylor's series-Laurent's series-singularities of an analytical fuction-Residues-Cauchy Residue theorem-Evaluation of definite integrals-contour integration.

**UNIT – IV : Special Functions**

Legendre, Bessel, Hermite and Laguerre differential equations- power series solutions-Generating functions- Recursion relations- Rodrigue's formula – Orthogonality relations.

**UNIT - V : Beta, Gamma, Delta Functions**

Definition of gamma function - Fundamental property of gamma function and values of gamma function – Definition of beta function – Different forms of beta function – Relationship between beta and gamma functions – Reduction of different integrals to gamma function – Dirac delta function – Derivatives of delta function.

**BOOKS FOR STUDY AND REFERENCE**


1. M. R. Spiegel, Vector Analysis, Schaum'a outline series, McGraw Hill, New York, 1974.
2. L. A. Pipes and L.R. Harvill, Applied Mathematics for Engineers and Physicists, McGraw Hill, London, 1970.
3. P. K. Chattopadhyay, Mathematical Physics, Wiley Eastern, New Delhi, 1992.
4. B. D. Gupta, Mathematical Physics, Vikas Publishing House Pvt. Ltd, New Delhi, 2004.
5. D. G. Zill and M. R. Cullen, Advanced Engineering Mathematics, 3rd Ed. Narosa, New Delhi, 2006.
6. E. Kveyszig, Advanced Engineering Mathematics, Wiley Eastern, New Delhi, 1983.
7. H. K. Dass, Mathematical Physics, S. Chand & Co, New Delhi, 2003.
8. S. S. Rajput, Mathematical Physicsc, Pragati Pragasan, Meerut, 11$^{th}$ Edition, 1996.

# PPHC03 : QUANTUM MECHANICS-I

**UNIT – I : Foundations of wave mechanics**

Equation of motion of matter waves- Schroedinger equation for the free particle – Physical interpretation of wave function-normalized and orthogonal wave functions-expansion theorem-admissibility conditions - solution of Schroedinger wave equation - stationary state solutions operator associated with different observables - expectation values - probability current density- Ehrenferts theorem.

Postulates of wave mechanics-representation of states-dynamical variables-commutation relations-expectation values-linear operators adjoint and self-adjoint operators-degeneracy-eigen value, eigen functions-observables: completeness and normalization of eigen functions-Physical interpretation of eigen values and eigen functions and expansion coefficients- momentum eigen functions-Uncertainty principle-states with minimum value-commuting observables: removal of

degeneracy-evolution of system with time: constant of motion. Interacting and Non-interacting systems- System of identical Particles: symmetric and antisymmetric wave functions - Exclusion principle.

**UNIT - II : Stationary state and eigen spectrum**

Stationary states: time independent Schrodinger equation - Particle in a square well potential – Bound states –eigen values, eigen functions - nonlocalized states –potential barrier – quantum mechanical tunneling – reflection at barriers and wells-multiple potential well – Splitting energy levels-energy bands-Kronig - Penny model.

**Exactly soluble Eigenvalue Problems**

The simple harmonic oscillator: Energy Eigenvalues and energy eigen functions – properties of stationary states- abstract operator- eigen value spectrum-eigen functions- Angular momentum: operators- Separation of variables-eigen values and eigen functions- spherical harmonics – physical interpretation –Angular momentum in stationary states of systems with spherical symmetry: rigid rotator – diatomic particles- energy level spacing – particle in a potential – radial wave function – Hydrogen atom: solution of the radial equation – stationary state wave functions – bound states.

**UNIT – III : Approximation methods for Time - independent Problems**

Perturbation theory for discrete levels: Equations in various orders of perturbation theory – Non-degenerate case-first and second orderanharmonic oscillator-Degenerate case- removal of degeneracy – Effect of electric field (stark effect) on ground state of Hydrogen atom - two electron atom.

Variation method: Variation Principle - for excited states- ground state of Helium atom – hydrogen atom ion - WKB approximation – one dimensional Schrodinger equation-Asymptotic solution-validity of WKB approximation-solution near a turning point – connection formula for penetration barrier – Bohr-Sommer field quantization condition- tunneling through a potential barrier.

**UNIT – IV : Matrix formulation of quantum theory and equation of motion**

Quantum state vectors and functions- Hilbert space-Dirac ᾽ s –Bra-Ket notation-basis in Hilbert space – dynamical variables and linear operators – abstract operators – self adjoint – eigen value, eigen vectors – unitrary operators – representations of state vector-dynamical variables as matrixoperators – commutation relation – diagonalization Harmonic oscillator – Schrodinger, Heisenberg and Interaction representation – coordinates and momentum representations – symmetries and conservation laws

**UNIT –V : Angular momentum**

Angular momentum operators-commutation rules-eigen value spectrum matrix representation of J in the |jm> basis – spin angular momentum – spin 1/2 , spin-1, total wave function- addition of angular momenta- Clebsch-Gordan coefficients-spin wave functions for a system of two spin-1/2

particles.

**Identical Particles and spin**

Identical Particles – symmetry and Antisymmetric wave function – exchange degeneracy – Spin and statistics: Pauli's exclusion Principle- Slater determinant- collision of identical particles-spin and Pauli's matrices- density operator and density matrix.

**BOOKS FOR STUDY AND REFERENCE**

1. A Text book of Quantum Mechanics – P. M. Mathews and K.Venkatesan; Tata McGraw –Hill Publications

2. Quantum Mechanics – Satya Prakash; Kedar Nath Ram Nath and Co. Publications

3. Quantum Mechanics (5th Edition) – Theory and Applications by A.K.Ghatak and Lokanathan ; Macmillan India Ltd Publication.

4. Principle of Quantum Mechanics (2nd Edition) - R.Shankar; PlenumUS Publication.

5. Quantum Mechanics – Leonard I. Schiff ; McGraw-Hill International Publication.

6. Quantum Mechanics (2nd Edition )– V. K. Thankappan, New Age International (P) Ltd. Publication.

7. Quantum Mechanics (3nd Edition )- E. Merzbacher; John Wiley Interscience Publications.

8. Quantum Mechanics –Vol.I – Claude Cohen-Tannoudji, Bernard Diu, Franck Laloe – John Wiley Interscience Publications.

9. Quantum Mechanics – Pauling & Wilson

# PPHC04: GENERAL PHYSICS EXPERIMENTS

**ANY FIFTEEN EXPERIMENTS**

1. Measurement of Hall Coefficient of given semiconductor: identification of type of semiconductor and estimation of charge carrier concentration
2. Young's modulus – Elliptical fringe method
3. Young's modulus – Hyperbolic fringe method
4. B.H. loop using Anchor ring
5. Four Probe Method – Determination of resistivity of semiconductor at different temperatures
6. Determination of Ultrasonic velocity in given liquid for a fixed frequency
7. Determination of optical absorption coefficient and determination of refractive index of the liquids using He-Ne / Laser
8. Measurement of laser parameters using He – Ne laser / diode laser
9. Refractive index of liquids / Using – He-Ne laser / Diode laser
10. Determination of wavelength of a laser by Michelson Interferometer method
11. Determination of semiconductor band gap
12. Displacement measurements using LVDT
13. Thermistor – Determination of energy gap
14. Determination of numerical aperture of an optical fiber
15. Determination of wavelength of a laser source using diffraction grating.
16. Determination of operating voltage of a GM tube and determine the linear absorption coefficient and verify inverse square lane.
17. Determination of operating voltage of a GM tube and verify inverse – square law
18. Direct reading of Zeeman effect (e/m of an electron) with a laser source
19. Compact microwave training system Experiment
20. Stefan's constant.
21. Susceptibility – Guoy and Quincke's methods.

22. Hydrogen spectrum and solar spectrum – Rydberg's constant.
23. Are Spectra Fe.Hg (or) Cu-Hg (or) Brass – Hg
24. Molecular spectra ALO band (or) CN band
25. Solar constant

# PPHC05 : ELECTRONICS

## UNIT – I : SEMI CONDUCTOR DIODES

The continuity equation – Application of the continuity equation for an abrupt PN junction under forward and reverse bias – Einstein equation – Varactor diode – Schottky diode – Tunnel Diode – Gunn diode – Optoelectronic diodes – LASER diode, LED and photo diode.

## UNIT – II : SPECIAL SEMICONDUCTOR DEVICES

JFET- Structure and working - I -V Characteristics under different conditions - biasing circuits - CS amplifier design – ac analysis - MOSFET: Depletion and Enhancement type MOSFFT – UJT characteristics - relaxation oscillator - SCR characteristics - application in power control DIAC,TRIAC.

## UNIT – III : OPERATIONAL AMPLIFIER

Operational amplifier characteristics - inverting and non-inverting amplifier – instrumentation amplifier - voltage follower – Integrating and differential circuits – log & antilog amplifiers – op amp as comparator - Voltage to current and current to voltage conversions – active filters : low pass, .high pass, band pass & band rejection filters – Solving simultaneous and differential equations.

## UNIT - IV : OP-AMP APPLICATIONS (OSCILLATORS AND CONVERTORS)

Wien bridge, phase shift oscillators – triangular, saw-tooth and square wave generators – Schmitt's trigger – sample and hold circuits – Voltage control oscillator – phase locked loops. Basic D to A conversion: weighted resister DAC – Binary R-2R ladder DAC – Basic A to D conversion: counter type ADC – successive approximation converter – dual slope ADC.

## UNIT – V : IC FABRICATION AND IC TIMER

Basic monolithic Ics - epitaxial growth - masking - etching impurity diffusion – fabricating monolithic resistors, diodes, transistors, inductors and capacitors - circuit layout - contacts andinter connections - charge coupled device - applications of CCDs.555 timer - description of the functional diagram - mono stable operation - applications of mono shots – as table operation pulse generation.

**BOOKS FOR STUDY AND REFERENCE**


1. T.F.Schubert and E.M.Kim, "Active and Nonlinear Electronics", John Wiley Sons, New York (1996).
2. L.Floyd, Electronic Devices, "Pearson Education" New York (2004)
3. Dennis Le Crissitte, Transitors, Prentice Hall India Pvt. Ltd (1963)
4. J.Milman and C.C. Halkias, Integrated Electronics, McGraw Hill (1972)
5. A. Mottershed, Semiconductor Devices and Applications, New Age Int Pub
6. M. Goodge, Semiconductor Device Technology Mc Millan (1983)
7. S.M.Sze, Physices of Semiconductor Devices , Wiley-Eastern Ltd.,
8. Milman and Taub, Pulse, digital and switching Waveforms, McGrew Hiil (1965)
9. Ben.G.Streetman, Solid state electronic devices, Printice Hall, Englewood cliffs, NJ (1999)
10. R.A.Gayakwad, Op-Amps & Linear integrated circuits, Printice Hall India Pvt. Ltd.(1999)

# PPHC06 : ELECTROMAGNETIC THEORY

## UNIT – I : Electrostatics

Coulomb's Law – Electric field intensity – Field due to point and continuous charges - Gauss' Law and its applications- Gauss's law and application – Electric potential – Electric field and equipotential plots. Electric field in free space, conductors, dielectric -Dielectric polarization - Dielectric strength - Electric field in multiple dielectrics- Molecular polarisability and electric susceptibility-Electrostatic energy in dielectric medium- Clausius- Mossotti equation Laplace and Poisson equations, boundary value problems.

## UNIT – II : Magnetostatics

Lorentz Law of force, magnetic field intensity – Biot–savart Law - Ampere's Law – Magnetic field due to straight conductors, circular loop, infinite sheet of current – Magnetic flux density (B) – B in free space, conductor, magnetic materials – Magnetization – Magnetic field in multiple media – Boundary conditions – Scalar and vector potential – Magnetic force – Torque – Inductance – Energy density – Magnetic circuits.

## UNIT – III : Electrodynamic fields

Faraday's laws, induced emf – Transformer and motional EMF – Forces and Energy in quasi-stationary Electromagnetic Fields - Maxwell's equations (differential and integral forms) – Displacement current – Relation between field theory and circuit theory. Vector and scalar potential- Gauge transformation- Lorentz gauge- Coulomb gauge- Conservation laws for a system of changes- Poynting theorem.

**UNIT – IV : Electromagnetic waves**

Generation – Electro Magnetic Wave equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Electromagnetic waves in free space, dielectrics, and conductors; Reflection and refraction, polarization, Fresnel's Law, interference, coherence, and diffraction; Dispersion relations in plasma skin depth, Poynting vector Wave guides-Propagation of waves in a rectangular wave guide-inhomogeneous wave equation and retarded potentials-field and radiation due to an oscillating electric dipole.

**UNIT – V : Plasma physics:**

Defnition of plasma; Its occurrence in nature; Dilute and dense plasma; Uniform but time-dependent magnetic field: Magnetic pumping; Static non-uniform magnetic field: Magnetic bottle and loss cone; MHD equations, Magnetic Reynold's number; Pinched plasma; Bennett's relation; Qualitative discussion on sausage and kink instability.

**BOOKS FOR STUDY AND REFERENCE:**


1. Mathew N. O. Sadiku, 'Elements of Electromagnetics ( Oxford University press Inc. First India edition, 2007)
2. Ashutosh Pramanik, Electromagnetism – Theory and Applications (Prentice-Hall of India Private Limited, New Delhi, 2006)
3. J.A. Bittencourt, Fundamentals of Plasma Physics, Third edition, (Springer Publication, 2004)
4. David J Griffiths -Introduction to Electromagnetics- III Edition – (Prantice Hall of India Pvt.Ltd.- New Delhi, 2000)
5. T.V.S Arun Murthy, Electromagnetic fields, ( S. Chand, New Delhi,2008)
6. Joseph. A.Edminister, Theory and Problems of Electromagnetics, Second edition, Schaum Series (Tata McGraw Hill, 1993)
7. William .H.Hayt, 'Engineering Electromagnetics', (Tata McGraw Hill edition, 2001)
8. John R.Reitz-Foundations of Electromagnetic Theory-VI Edition ( Narosa Publishing House, New Delhi, 2000)
9. K.L. Goswami, Introduction to Plasma Physics ( Central Book House, Calcutta)

# PPHC07 : CONDENSED MATTER PHYSICS

**UNIT - I : Crystallography and Bonding**

Reciprocal lattices – Vector development of reciprocal lattice – Properties of the reciprocal lattice – Reciprocal lattice to bcc lattice and fcc lattice – Bragg's condition in terms of reciprocal lattice – Crystal diffraction – Neutron and electron diffraction – Brillouin zones.
Binding energy of ionic crystals – Madelung constant – Cohesive energy – Compressibility and bulk modulus – Born Haber cycle.Crystals of inert gases – Vanderwaal's interaction – London interaction – Cohesive energy.

**UNIT - II : 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 – III : Free Electron theory, Energy Bands and Semiconductor Crystals**

Energy levels and density of orbitals – Fermi-Dirac distribution – Free electron gas in three dimensions – Heat capacity of the electron gas –Electrical conductivity and Ohm's law – Motion in magnetic fields – Hall effect – Thermal conductivity of metals – Nearly free electron model –Electron in a periodic potential – Semiconductors – Band gap – Effective mass – Intrinsic carrier concentration.

**UNIT - IV : Diamagnetism, Paramagnetism, Ferromagnetism and Antiferromagnetism**

Langevin classical theory of Diamagnetism and Paramagnetism – Weiss theory – Quantum theory of Paramagnetism – Demagnetization of a paramagnetic salt – Paramagnetic susceptibility of conduction electrons – Hund's rules- Kondo effect. Ferroelectric order – Curie point and the exchange integral – Temperature dependence of saturation magnetization – Magnons – Thermal excitation – Ferromagnetic order – Antiferromagnetic order – Antiferromagnetic Magnons – Ferromagnetic domains – Origin of domains – Coercive force and hysteresis.

**UNIT - V : Dielectrics, Ferroelectrics and Superconductivity**

Macroscopic electric field – Local electrical field at an atom – Dielectric constant and Polarizability – Clausius-Mossotti equation – Ferroelectric crystals – Polarization Catastrophe – Ferroelectric domains.Occurrence of Superconductivity – Meissner effect – Thermodynamics of Superconducting transition – London equation – Coherence length – BCS theory – Flux Quantization – Type-I and Type-II Superconductors –Josephson tunneling effect- DC and AC Josephson effect – SQUID – Recent developments in high Temperature Superconductivity – Application of superconductors.

**BOOKS FOR STUDY AND REFERENCE**


1. Solid State Physics – S.L.Gupta & Dr.V.Kumar.

2. Fundamentals of Solid State Physics – Saxena Gupta and Saxena.

3.C. Kittel, Introduction to Solid State Physics, 5th Edition Wiley Eastern, New Delhi (1977)

4. N. W. Asherof and N. D. Mermin, Solid State Physics, Holt, Rinehart and Winston, International Edition, Philadelphia.

5. J. S. Blakemore, Solid State Physics, Second edition Cambridge University press, Cambridge, London (1974)

6. A. J. Dekker, Solid State Physics, Mac Millen, Madras (1971)

7. M. M. Woolfson, An Introduction to X-ray Crystallography, Vikas publishing Ltd. (1978)

8. Thomas P. Sheahen, Introduction to High-Temperature Superconductors, Plenum Press, New York (1994)

9. S. O. Pillai, Solid State Physics, New Age International (p) Ltd, New Delhi (1995).

# PPHC08: ELECTRONICS EXPERIMENTS

## ANY TWENTY EXPERIMENTS:

1. Study of Transistor Bias Stability
2. Construction a single stage RC coupled amplifier using transistor and study its frequency response.
3. Construction of a two stage RC coupled amplifier using transistor and study its frequency response.
4. Study of Silicon Controlled Rectifier
5. Study the characteristics of UJT
6. Experiment on FET and MOSFET characterization and application as an amplifier
7. Construction of an Astable multivibrator circuit using OP AMP & 555 IC's
8. Characteristics of Tunnel diode and Gunn diode
9. Construction of a bistable multivibrator circuit using IC555 and study its performance.
10. Construction of adder, subtracter, differentiator and integrator circuits using the given OP – Amp
11. Construction of an A/D converter circuit and study its performance
12. Construction of an D/A converter circuit and study its performance
13. Construction of half – adder and full – adder circuit using NAND gates and study their performance.
14. Construction of half – subtracter and full – subtracter circuit using NAND gates.
15. Design of sehimitt's Trigger using ICs 741 and 555 timer – study of frequency divides.
16. Flip flops – RS, JK and D flip flops
17. Shift register and Photo diode characteristics
18. Study of counters: Ripple, Mode 3, Mod 5 counters
19. Photo – diode characteristics
20. Photo – transistor characteristics
21. Analog computer circuit design – solving the simultaneous equations.
22. Multiplexer and Demultiplexer
23. Decoders and Encoders

24. Design of second order Butter worth active filter circuits low pass, High pass and multiple feed basic band pass filters
25. Determination of color Television and digital recoding

# PPHC09 : COMPUTATIONAL METHODS AND PROGRAMMING

**UNIT – I : C++ programming**

Constants, variables and their declarations – Input, output and comparison operators-if, if. else, switch, while, do-while, for, break statements- main, void, exit, swap functions- Arrays-passing by value and passing by reference.

**UNIT – II : Curve fitting and interpolation**

Curve fitting: Method of least squares- Normal equations- Straight line fit- Exponential and power-law fits.

Newton interpolation polynomial: Linear Interpolation- Higher-older polynomials-First-order divided differences-Gregory-Newton interpolation polynomials-Lagrange interpolation – Truncation error.

**UNIT – III : Solutions of Linear and Nonlinear Equations**

Simultaneous linear equations: Gauss elimination method – Jordan's modification-Inverse of a matrix by Gauss- Jordon Method – Roots of nonlinear equations: Newton-Raphson method – Iterative rule – Termination criteria – Pitfalls - Order of convergence

**UNIT - IV : Numerical integration and Differentiation**

Newton-Cotes quadrate formula – Trapezoidal, Simpson's 1/3 and 3/8 rules – Errors in the formulas.

Differentiation: First –order derivative:-Two and four-point formulas second –order derivative: Three and five-point formulas.

**UNIT – V : Numerical solution to ordinary Differential Equations**

First-order equations: Euler and improved Euler methods-Formulas-Local and global truncation errors-Fourth-order Runge-Kutta method-Geometric description of the formula-Errors versus step size –Second order equation- Euler methods and Fourth order Runge-Kutta method.

**BOOKS FOR STUDY AND REFERENCE**


1. J. R. Hubbard, Programming with C++, McGraw-hill, New Delhi, 2006.
2. J. H. Mathews, Numerical Methods for Mathematics, Science and Engineering, Prentice-Hall of India, New Delhi, 1998.
3. M. K. Jain S.R.K Iyengar and R.K.Jain, Numerical Methods for Scientific and Engineering Computation, New Age International, New Delhi, 1993.
4. S. D. Conte and C.Boor, Elementary Numerical Analysis, 3rd Ed, McGraw Hill, Singapore, 1981.

# PPHC10 : MICROPROCTSSORS AND MICROCONTROLLERS

**UNIT - I Architecture and Programming of 8085**

Architecture of 8085 – Organization of 8085: Control, data and address buses – registers in 8085 – Addressing modes of 8085 – Instruction sets of 8085: Instruction types (based on number of bytes, based on operation), data transfer, arithmetic, logical, branching, stack and I/O instructions. Timing and sequencing : Instruction cycle, machine cycle, halt state, walt state - Timing diagram for opcode fetch, memory read and write cycles. Assembly language programming, Simple programs using arithmetic and logical operations – Interrupts: Maskable and non-maskable, hardware and multilevel interrupts.

**UNIT - II Architecture of 8O86**

Memory organization, Register organization: General purpose, index, pointer, segment registers and flags - Bus structure: data bus, address bus, effective & physical address and pipeling. Addressing modes of 8086: Register, immediate, direct and indirect addressing.

**UNIT - III Applications of Microprocessors**

Microprocessor based process control - closed loop control - open 1oop control. Example for closed loop control – crystal growth control. Microprocessor based temperature monitoring systems - limit setting - operator panel - block diagram. Analog to digital conversion using ADC 0809 interfacing through PPI 8255 - Block diagram.

**UNIT - IV Architecture of Microcontroller 8051**

Introduction - comparison between microcontroller and microprocessors - Architecture of 8051 - Key features of 8051 - memory organization – Data memory and prograrn memory - internal RAM organization – Special function registers - control registers – I/O ports - counters and timers - interrupt structure.

**UNIT - V Programming the Microcontroller 8051**

Instruction set of 8051 - Arithmetic, Logical, Data move jump and call instructions, Addressing modes – Immediate, register, direct and indirect addressing modes - Assembly language programming - simple programs to illustrate arithmetic and logical operations (Sum of numbers, biggest and smallest in an array) – software time delay.

**BOOKS FOR STUDY AND REFERENCE**


1. Aditya P.Mathur, Introduction to Microprocessors, Tata McGraw Hill Company, II edition.
2. Ramesh S.Gaonkar, Microprocessor Architecture, Programming and Application with 8085,Wi1ey Eastern.
3. Douglas V.Hall, Microprocessors and Interfaces, Tata McGraw Hill Company.
4. Aditya P.Mathur, Introduction to Microprocessors, Tata McGraw Hill Company, III edition.
5. Kenneta J.Ayala, The 8051 Microcontroller, Penram International – India.
6. Lance A.Leventhal, Introduction to Microprocessors software, hardware, Programming, Prentice Hall of India.
7. Kenneth L. Short, Microprocessor and Programmed Logic, Prentice Hall of India.
8. Gilmore, Microprocessors, TMH Edition.

## PPHC11 : NUCLEAR AND PARTICLE PHYSICS

### Unit – I : Nuclear Structure

Distribution of nuclear charge – spin and magnetic moment – determination of nuclear mass – Binding Energy – Nuclear stability – Mass parabolas – Nuclear Shell model – Liquid drop model – Optical Model – Collective Model.

### Unit – II : Nuclear Interactions

Exchange forces – Yukawa's meson theory – Yukawa potential – Ground state of deuteron – Low energy n-p scattering – effective range – spin dependence and charge independence of nuclear forces.

### Unit – III : Nuclear Reactions

Types of reactions and Energetics of nuclear reactions – conservation laws – Q Value – Scattering and reaction cross sections – Compound nucleus – Reciprocity theorem – Breit and Wigner Dispersion formula – stripping and pickup reactions.

### Unit – IV : Radioactive Decays

Alpha decay – Geiger - Nuttal law - Gamow's Theory – Neutrino hypothesis – Fermi theory of beta decay – Selection rules – Gamma decay – Selection rules – Internal conversion

### Unit – V : Elementary Particles

Types of interactions between elementary particles – Leptons – Hadrons – Mesons – Hyperons – Pions – Gell – Mann Okubo mass formula for octet and decaplet – SU(2) – SU(3) Multiplet – Quark model – Color and flavor – weak and strong interactions.

**BOOKS FOR STUDY AND REFERENCE**


1. R.P. Roy and B.P. Nigam, Nuclear Physics, Age International Ltd, New Delhi, 2005.
2. B.L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill, New Delhi, 1983.
3. H.Semat, Introduction to Atomic and Nuclear Physics, Chapman and Hall, New Delhi, 1983.
4. W.S.C Williams, Nuclear and particle Physics Claredon Press, London, 1981.
5. K.S. Krane, Introductory Nuclear Physics, John – wiley, New york, 1987.
6. S.B. Patel, Nuclear Physics: An introduction, Wiley – Eastern, New Delhi, 1991.
7. D.C. Tayal, Nuclear Physics, Himalaya Publishing house, New Delhi, 2004.

## PPHC12: MICROPROCESSOR, MICROCONTROLLER AND COMPUTER PROGRAMMING EXPERMENTS

**ANY FIFTEEN EXPERIMENTS**

**MICROPROCESSOR BASED EXPERIMENTS – I**

1. 16 – bit Addition, Subtraction, Multiplication and Division using 8085
2. (i) BCD to Binary (ii) Binary to BCD (iii) ASCII to HEX (iv) HEX to ASCII
3. Ascending and descending order of numbers and characters
4. Determination of n factorial and biggest and smallest of n
5. Temperature conversion
6. Stepper Motor Interface
7. Traffic Control
8. Wavefrom Generator
9. Digital Clock
10. D/A Converter, A/D Converter – Interfacing

**MICROCONTROLLER BASED EXPERIMENTS – II**

11. Code conversion using 8051 Microcontroller
12. Microcontroller array operations

**COMPUTER PROGRAMMING - III**

13. Matrix addition, subtraction and multiplication
14. To write a program to compute the Eigen values of a given matrix
15. Transpose of a matrix
16. Evaluating a root of non – linear equation by Newton – Raphson method using external function

17. Program for straight line fit using the method of least squares for a table of data points

18. To integrate a given function by Simpson rule and Trapesoidal rule

19. Solution of Differential equation by Runga Kutte Method

20. To write a program to compute the complex roots of a given polynomial of $N^{th}$ degree by Graffe's Method.

## PPHC13 : MOLECULAR SPECTROSCOPY

### UNIT – I : IR – Spectroscopy

Principle and theory of Infrared spectroscopy – Far and Near IR absorption spectroscopy – Mid and Near IR reflectance spectroscopy- Photo acoustic IR spectroscopy – Dispersive IR spectrometer – IR Imaging – FT – IR spectroscopy – Vibrational frequencies and qualities analysis – sampling methods – Instrumentation- Applications.

### UNIT – II : Raman Spectroscopy

FT Raman spectroscopy – degree of depolarization – structure determination using IR and Raman spectroscopy – Resonance Raman spectroscopy – Coherent anti – Stokes Raman spectroscopy – Inverse Raman and surface Enhanced Raman spectroscopy – principles, techniques and applications – non – linear Raman spectroscopy.

### UNIT – III : Electronic Spectra : Florescence & Phosphorescence Spectroscopy

Electronic Excitation of Diatomic Species – Vibrational Analysis of Band Systems of Diatomic Molecules – Deslandre's Table – Intensity Distribution – Franck Condon Principle – Rotational Structure of Electronic Bands – Resonance and Normal Fluorescence – Intensities of Transitions – phosphorescence Population of Triplet State and Intensity – Experimental Methods – Applications of Florescence and Phosphorescence.

### UNIT – IV : NMR & NQR Spectroscopy

**NMR Spectroscopy :** Quantum Mechanical and Classical Description – Bloch Equation – Relaxation Process – Experimental Technique – Principle and Working of High Resolution NMR Spectrometer – Chemical Shift

**NQR Spectroscopy :** Fundamental Requirements – General Principle – Experimental Detection of NQR Frequencies – Interpretation and Chemical Explanation of NQR Spectroscopy

**UNIT – V : ESR & Mossabauer Spectroscopy**

**ESR Spectroscopy :** Basic Principles – Experiments – ESR Spectrometer – Reflection Cavity and Microwave Bridge – ESR Spectrum – Hyperfine Structure

**Mossabauer Spectroscopy :** Mossabauer Effect – Recoilless Emission and Absorption – Mossabauer Spectrum – Experimental Methods – Hyperfine Interaction – Chemical Isomer Shift – Magnetic Hyperfine and electric Quadrupole Interaction

**BOOKS FOR STUDY AND REFERENCE:**


1. C.N. Banwell, Fundamentals of Molecular Spectroscopy. Tata MCGraw Hill (1972)
2. B.P. Straughan and Walkar, Spectroscopy Vol. 1, Chapman and Hall (1976)
3. B.P. Straughan and Walkar, Spectroscopy Vol. 2, Chapman and Hall (1976)
4. D.N. Sathyanarayana – Vibrational Spectroscopy and Application – New Age International Publications (2004)
5. G. Aruldas – Molecular Structure and Spectroscopy (2001) – Prentice Hall of India Pvt. Ltd. – New Delhi
6. Raymond Chang, Basic Principles of Spectroscopy, McGraw Hill Koyakusha Ltd., (1980)
7. D.A. Long, Raman Spectroscopy, Mc Graw Hill, International Book Company.

# PPHC14 : QUANTUM MECHANICS – II

**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 – Einstein's coefficients – absorption - induced emission-spontaneous emission –Einstein's 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 – screend coulombic 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 – nonresonant scattering-scattering length and effective range– Ramsauer-Townsend effect – 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.

Quantisation of the field Electro magnetic wave as harmonic oscillators –quantisation: classical E.M.wave –quantisation of fields oscillators- Photons- number operator – creation and annihilation operators of photons.

**UNIT – IV : Quantum theory of Atomic and Molecular structure**

Central field approximation: residual electrostatic interaction-spin-orbit interaction-Determination of central field: Thomas Fermi statistical method-Hartree and Hartree-Fock approximations (self consistent fields) –Atomic structure and Hund ' s rule – effect of magnetic field in Hydrogen atom- weak and strong field-quadratic Zeeman effect.

Molecules: Born –Oppenheimer approximation – An application : the hydrogen molecule Ion (H2+) – Molicular orbital theory: LCAO- Hydrogen molecule – Heitler- London method - energy level of the two atoms molecule- Van der waals force.

**UNIT - V : Methods of electronic structure calculation**

Hartree-Fock SCF method –formulation-Hartree-Fock approach- restricted and unrestricted HF calculations – Roothaans equations – selection of basis sets – electron correlation – Moller – Plesset many body perturbation theory – DFT - Semi-emphirical methods.

**BOOKS FOR STUDY AND REFERENCE**


1. A Text book of Quantum Mechanics – P. M. Mathews and K.Venkatesan; Tata McGraw –Hill Publications
2. Quantum Mechanics (2nd Edition )– V. K. Thankappan; New Age International (P) Ltd. Publication
3. Quantum mechanics – Franz Schwabl; Narosa Publications.
4. Molecular Quantum mechanics (3rd Edition) – P.W.Atkins and R.S.Friedman;Oxford University Press publication.
5. Quantum Mechanics – Satya Prakash; Kedar Nath Ram Nath and Co. Publications.
6. Quantum Mechanics (5th Edition) – Theory and Applications by A.K. Ghatak and Lokanathan ; Macmillan India Ltd Publication
7. Quantum Mechanics – Leonard I. Schiff ; McGraw-Hill International Publication.
8. Quantum Mechanics (3nd Edition )- E. Merzbacher; John Wiley Interscience Publications.
9. Quantum Mechanics –Vol.II – Claude Cohen-Tannoudji, Bernard Diu, Franck Laloe – John wiley Publications.

## PPHC15 : COMMUNICATION ELECTRONICS

### UNIT - I : Antennas & Wave Propagation

Radiation field and Radiation resistance of a short dipole antenna -Grounded $\lambda/4$ Antenna-Ungrounded $\lambda/2$ Antenna- Antenna Arrays-Broadside and End Side Arrays-Antenna Gain-Directional High Frequency Antennas- Sky Wave Propagation-Ionosphere-Ecles & Larmor Theory-Magneto Ionic Theory-Ground Wave Propagation.

### UNIT - II : Pulse Code and Digital Modulation Techniques

Sampling theorem – Low – Pass and Band – Pass signals, PAM, Channel BW for a PAM signal. Natural sampling. Flat–top sampling, Signal recovery through Holding, Quantization of signals, PCM transmission, quantization of noise, differential PCM Delta Modulation, Adaptive Delta modulation, CVSD. Signal to noise ratio in PCM and Delta Modulations – ASK, FSK, BPSK, DPSK, QPSK, QASK, MSK and QAM.

### UNIT – III : Microwaves(Operation only)

Microwave Generation-Multicavity Klystron-Reflex Klystron-Magnetron-Travelling WaveTubes (TWT) and other Microwave Tubes-MASER-Gunn Diode.

### Broad Band Communication Systems

Multiplexing – Frequency division – Time division. Short and medium Haul systems: Coaxial cables – fibre optic link – Microwave link – Tropospheric Scatter links. Long Haul system: Submarine cables.

### UNIT - IV : Radar and Television

Elements of a Radar System-Radar Equation-Radar Performance Factors-Radar Transmitting Systems- Radar Antennas-Duplexers-Radar Receivers and Indicators-Pulsed Systems-Other Radar Systems. Colour TV Transmission and Reception – Colour mixing principle – Colour Picture Tubes –Delta Gun picture tube – PIL colour picture tube – Cable TV, CCTV and Theatre TV.

### UNIT - V: Optical Fibres

Propagation of Light in an Optical Fibre-Acceptance Angle-Numerical Aperture-Step and Graded Index Fibres-Optical Fibre as a Cylindrical Wave Guide-Wave Guide Equations-Wave Equations in Step Index Fibres-Fibre Losses and Dispersion-Applications.

### Satellite communication

Orbital Satellites, Geostationary Satellites, Orbital Patterns, satellite system link models, satellite system parameters, satellite system link equation, Link budget. INSAT communications satellites.

**BOOKS FOR STUDY & REFERENCE:**


1.Handbook of Electronics by Gupta & Kumar – 2008 Edition

2.Electronic Communication System-George Kennedy & Davis -Tata McGraw Hill 4th

edition 19889

3. Taub and schilling, ‘‘Principles of Communication Systems’’,Second edition, Tata McGraw Hill (1991)

4. Electronic Communications – Dennis Roddy & Coolen , Prentice Hall of India, IV Edition, 1995

5. Wayne Tomasi, ‘‘Advanced electronics communication Systems’’,fourth Edition, Prentice Hall, Inc., (1998)

6. M. Kulakarni, ‘‘Microwave and Radar Engineering’’, Umesh Publications, 1998.

7. Monochrome and Colour TV – R.R.Gulati.

## LIST OF ELECTIVE COURSES

# PPHEC01 : BIOELECTRONICS AND BIOSENSORS

**UNIT -I : Introduction**

Nature of Biomedical signals; Bio Electronic potentials; Necessity of Bio Electronics; Components; Scope and Application; Basics of cell biology; Structure of the cell, the nervous system and the neuron; function of enzymes; nucleus and role of DNA and RNA, adhesion of cell to surfaces.

**UNIT - II : Bio electronic device production**

Elements in contact with the surface of a biomaterial: blood composition, plasma proteins, cells, tissues - Phenomena at the biointerfaces. Molecular and cellular processes with living environment, blood-materials interaction, short and long term reactions to the body - Testing of biomaterials: in vitro, in vivo preclinical and in vivo clinical tests - Technologies of biomaterials processing, as implants and medical devices; improvement of materials biocompatibility by plasma processing.

**UNIT - III : Materials in clinical devices**

Metals: Sulzer recall of prosthetic hip implant - Composition of stainless steel and Fe/Co/Ti alloys; Mechanical - properties - Hard Materials: Bioceramics and Bioglasses, Carbons - Polymers as Biomaterials - Biodegradable Polymers - Composites. Biological reactions to implants - Natural Biomaterials - Collagen - Potential advantages & Developments towards a biomolecular computer, development of molecular arrays as memory stores - molecular wires and switches; mechanisms of unit assembly.

**UNIT – IV : Biosensors**

Introduction to Biosensors – Types of sensors - target analytes – various recognition – signals and device types – basic design consideration – calibration – dynamic range – signal to noise – sensitivity – selectivity – interference – immobilization – adsorption – encapsulation– covalent attachment – device integration: micro scale and nano scale – Bio MEMS – nano wires – Quantum dots – magnetic beads, PEBBLE sensors.

**UNIT - V : Electrical signal transduction:**

Seismic (mass) and thermal sensors: Electromechanical resonance - electrochemical forces - Henry's and ideal gas laws - Surface acoustic wave (SAW) devices - atomic force microscopy - manometric sensors - thermometric detection - Electrochemical sensors: Redox potentials, membrane potential, Gauss's Law, basic electrochemistry; conductimetric sensors; potentiometric sensors (ISE's and ISFETs); amperometric sensors; Charge sensing with FET - Optical sensors: fundamentals of optics- sources (LED's, lasers, lamps), detectors (photodiodes, photomultiplier tubes, charge coupled devices), and optical circuits (filters, gratings, fiber optics); detection of absorbance, reflectance, and fluorescence - Surface plasmon resonance (SPR) based devices.

**BOOKS FOR STUDY AND REFERENCE**


1. H.Boenig, Fundamentals of Plasma Chemistry and Tehnology, Technomic Publishing Co.Inc. Lancaster Basel, 1990.

2. Itamar Willner and Eugenii Katz, Bioelectronics: From Theory to Applications, WILEY, 2005.

3. S. Bone and B. zebba, Bioelectronics, Wiely

4. J. Koryta Ions, Wiely

5. B. D. Ratner and A. S. Hoffman, Biomaterials Science, An Introduction to Materials in medicine, Eds. Academic Press, New York, 1996.

6. Eggins, B. R., John, Chemical Sensors and Biosensors, Wiley & Sons, 2002.

7. Biosensors – E.A. Hells Wiley

8. J. B. Park and J. D. Bronzion, Biomaterials: Principles and applications, CRC Press, 2003.

9. J. W. Gardner., V.K. Varadan., O. O. Awadelkarim., Micro Sensors, MEMS and Smart Devices, Wiley, 2001.

10. Sujatha V. Bhat, Biomaterials, Narosa Publishing House, New Delhi, 2002.

# PPHEC02 : OPTO ELECTRONICS

## UNIT – I : INTRODUCTION

Propagation of electromagnetic waves in dielectric wave guides – fibers – boundary conditions – phase velocity and group velocity – Dispassion – cut off frequencies - EM field in core and cladding – single mode and multimode fibres.

## UNIT – II : ACTIVE DEVICES

LED's lasers – Laser principles – spontaneous and stimulated emission – coherence – gain equation – three level, four level lasers- examples of lasers (He-Ne) Ruby, diode – homojunctioin and heterojunction diode lasers.

## UNIT – III : FIBRE OPTICS COMMUNICATION

LED and lasers source – Transmitter modulator – acousto – optic, electro optic modulator – AM, FM, DCM modulation – detection and demodulation radiation detection – PIN, APD and PM tube.

## UNIT – IV : OPTICAL FIBER SENSORS

General features, types of OFS, intrinsic and extrinsic sensors, intensity sensors, shuttes based multimode OFS, simple fibre based sensors for displacement, temperature and pressure measurements – reflective OFS and applications, Fibre Bragg grating based sensors.

## UNIT – V : INTERFEROMETRIC FOS

Basic principles, interferometric configurations, Mach – Zendes. Michelson and Fabri – Perot configurations – components and construction of interferometric Fos, applications of interferometric FOS, Sagnac interferometer, fibers gyro, OTDR and applications.

**BOOKS FOR STUDY AND REFERENCE**


1. H.G. Unges, planas optical guides and fibres – clenedon press, oxford 1977.
2. A. Yariv, Principles of optical Electronics, John wiely, New York, 1984.
3. H.A. Hauz, waves and field in opto electronics, prentice hall, New Jeeey, 1984.
4. Optics – Ajoy Ghatak
5. Fundamentals of Fibes optics in telecommunications and sensor systems systems – B.P.pal
6. Optical Measurement Techniques and Applications – P K Rastogi

# PPHEC03 : NANO SCIENCE AND TECHNOLOGY

**UNIT – I : Basics of Nanotechnology**

Background to Nanotechnology – scientific revolutions – types of nanotechnology and nano machines – atomic structure molecules & phases – molecular and atomic size – surfaces and dimensional space – top down and bottom Nanoscale formation

**UNIT – II : Nanocrystals**

Synthesis of metal Nan particles and structures – Background on quantum semiconductors – Background on reverse Miceller Solution – Synthesis of semiconductors – Cadmium telluroid nano crystals – Cadmium sulfide nano crystals – Silver sulfide nano crystals – Nano manipulator – Nano tweezes – Nanodots.

**UNIT – III : Nano Tubes**

Types of nanotubes – formation of nanotubes – methods and reactants – arcing in the presence of cobalt – laser methods – ball milling – chemical vapour deposition methods – properties of nano tubes – plasma arcing – electro deposition – pyrolytic synthesis – Zeolites and templated powders layered silicates.

**UNIT – IV : Characterization of Nanomaterials**

Scanning Electron Microscope : Theory – Instrumental setup and its application – Low KV SEM and its application – Low temperature SEM and its application – working of electron probe micro analysis and its application in elemental analysis – EDX spectra Important material systems – optical process in semiconductors – optical process in quantum wells – semi conducting optoelectronic devices – organic optoelectronic devices (qualitative).

**Unit – V : Applications of Nanotechnology**

Structural and Mechanical materials – Nan electronics – opto electronic devices – LED – Applications – Colorants and Pigments – Nano – Lithography – Nanobiotechnology – DNA – Chips, DNA array devices, drug delivery systems.

**BOOKS FOR STUDY AND REFERENCE:**


1. Nanotechnology: Basic science and emerging technologies – Mick Wilson, Kamali Kannagara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press ( 2005).
2. Amorphous and Nanocrystalline Materials: Preparation, Properties, and Applications, A.Inoue, K.Hashimoto(Eds.,) (2000).
3. Introduction to Nanotechnology, Charles P. Poole, Frank J. Owens, Wiley – Interscience (2003).
4. Fundamentals of Surface and Thin Film Analysis, Leonard C.Feldman and James W.Mayer.
5. Nanocomposite science and technology, Pulickel M. Ajayan, Linda S. Schadler, Paul V. Braun, Wiley – VCH Verag, Weiheim (2003).
6. Quantum Heterostructures : Microelectronics and Optoelectronics, Vladimir Mitin
7. Smart Electronic Materials (Fundamentals and applications), Jasprit Singh
8. Nanostructures and Nanomaterials (Synthesis, Properties and Applications), Guozhong Cao.
9. Nanoelectronics and Information technology Edited by Rainer Weser.

# PPHEC04 : ENERGY PHYSICS

**UNIT – I :**

Introduction to energy sources: Energy sources and their availability – prospects of renewable energy sources.

**UNIT - II :**

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 – III :**

**Applications of solar energy:** Solar water heating – space heating and space cooling – solar photo valtaics – agricultural and industrial process heat – solar distillation – solar pumping – solar furnace – solar cooking – solar green house.

**UNIT - IV :**

**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 - V :**

**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. Kreith and Kreider, Principles of Solar Engineering, McGrew Hill Pub.,
2. A.B.Meinel and A.P.Meinal, Applied Solar Energy.,
3. M.P.Agarwal, Solar Energy, S.Chand & Co.,
4. S.P.Sukhatme, Solar Energy, TMH.,
5. G.D.Rai, Non-conventional Energy sources, Khauna Publications, Delhi.

# PPHEC05 : NONLINEAR DYNAMICS

**UNIT – I : Introduction to Nonlinear Dynamical Systems**

The notion of nonlinearity – superposition principle and its validity – linear and nonlinear oscillators – autonomous and non autonomous systems – equilibrium points – phase space classification of equilibrium points.

**UNIT – II : Chaos**

Simple bifurcations – the logistic map – period doubling phenomenon – onset of chaos – bifurcation scenario in Duffing oscillator – chaos in conservative systems – Poincare surface of section – Henon – Heiles systems – Lyapunov exponents.

**UNIT – III : Solitons**

Nonlinear dispersive system – cnoidal solitary waves – the scott Russles Phenomenon and K – dV equation – Fermi – Pasta – Ulam Numerical experiment – Numerical experiment of Zabusky and kruskal – birth of soliton.

**UNIT – IV : Tools to solve Non – linear Equations**

Integrability and methods to solve equations the notion of Integrability – Painleve analysis – Lax pair – Inverse Scatting Transform method – Bilinearization procedure – examples – Koteweg – de – Vires – Nonlinear Schordinger equations.

**UNIT – V : Application of Non – Linear Dynamics**

Applications – Chaos and secure communications – soliton in condensed matter system – Non linear optics and biological systems.

**BOOKS FOR STUDY AND REFERENCES**


1. M. Lakshmanan and S. Rajasekar, Nonlinear dynamics Integrability Chaos and Patterns, Springer – Verlag, Berlin (2003).
2. P.G. Drazin, Nonlinear systems, Cambridge University Press, Cambridge (1992).
3. P.G.Drazin and R.S.Johnson, Solitons, An introductions, Cambridge University Press, Cambridge (1989).
4. M.J. Ablowitz and P.A Clarkson, solutions, Nonlinear Evolution Equations and Inverse Scattering, Cambridge University Press, Cambridge(1991).

## PPHEC06 : MATERIALS SYNTHESIS AND CHARACTERIZATION

### UNIT – I : Nucleation and Growth

The crystalline state - concept of crystal growth – historical review – Importance of crystal growth – crystal growth theory : classical theory – Gibbs – Thomson equation- kinetic theory of nucleation – Energy of formation of a nucleus – kinetics of thin film formation – Film growth – five stages – Ncleation theories – In corporation of defects and impurities in films – Deposition parameters and grain size – structure oof thin films.

### UNIT – II : Growth Techniques

**Solution growth technique :** low temperature solution growth : solution –Solubility – constant temperature bath an crystallizer – seed preparation and mounting – slow cooling and solvent evaporation methods.

**Gel growth technique :** Principle – various types – structure of gel – Importance of gel – Experimental procedure – Advantage of gel method.

**Melt technique :** Bridgman technique – czochralski technique – Experimental arrangement – Growth process.

**Vapous technique :** physical vapour deposition – chemical vapour deposition (CVD) – chemical vapour transport.

### Unit – III: Thin Film Deposition Techniques

Thin films – Introduction to vaccum technology –deposition techniques – physical methods – resistive heating , electron beam cun and laser gun evaporation – sputtering : Reactive sputtering , radio frequency sputtering – chemical methods – spray pyrolsis – preparation of transport conducting oxides.

**Unit – IV : Characterization Technique**

X-ray Diffraction (XRD) – power and single crystal – fourier transform infrared analysis – FT –Raman analysis – Elemential dispersive x-ray analysis (EDAX) – scanning electron microscopy (SEM) – UV –VIS Spectrometer Vickers micro hardness – Auger emission spectroscopy. Photolumine scene (PL) – UV –Vis –IR spectrometer- AFM- Hall effect – SIMS – X-ray – photoemission spectroscopy (XPS) – dynamic light scattering – ellipsmety method.

**Unit – V : Applicaions**

Micro electrochemical systems (MEMS) – optoelectronic devices : LED , LASER and solar cell – polymer films – Fabrication and characterization of thin film transistor, capacitor , resistor , inductor and FET – Sensor – quanum dot – Applications of ferromagnetic and super conducting films : Data storage , Giant magneto resistance (GMR).

**BOOKS FOR STUDY AND REFERENCE**

1.K.Sangawal , Elementary crystal growth – shan publisher , UK ,1994.

2.P.Santhana Ragavan , P.Ramasamy ,Crystal Growth and processes. KRU publications. Kumbakonam(2000).

3.J.C.Brice , Crystal Growth Process , John wiley publications , NewYork (1996).

4.L I Maissel and R clang , Hand book of thin films Technology , Mc Graw – Hill (1970).

5.J.L. Vossen and W.kern ,Thin films process , Academic press ,1978.

6.M.Ohring , The materials science of Thin Films, Academic press , 1992.

7.M.William and D.Steve , Instrumental Methods of analysis (CBS publishers ) Newdelhi. (1986).

8.H.H. Williard , L.L. Merritt.Methods, J.Dean, and F.A. Settle , Instrumental methods of analysis – Sixth Edition. Cbs Publishers & distributors, Delhi (1986).

9.R.W.Berry , P.M.Hall and M.T.Harris, Thin Film Technology , Vn Nosrand (1968).

10.A.Goswami , Thin film Fundamentals , New Age International (P) Ltd. Publishers, New Delhi(1996).

## PPHEC07 : X-RAY CRYSTALLOGRAPHY & BIOPHYSICS

### UNIT –I : X-ray and crystals

Origin of X-rays – conventional generators-construction and geometry sealed tube-rotating anode generator-choice of radiation-Synchrotron radiation - Lattice planes-Miller indices - X-ray diffraction - Crystal systems and symmetry – unit cell – space lattices- non primitive lattices – point groups–space groups – analysis of space group symbols - Crystallization – growing crystals – choosing a crystals – crystal mounting- alignment – measurement of crystal properties.

### Data collection techniques for single crystals

Laue method- single crystal diffraction cameras: rotation and Oscillation method – Ewald construction . Single crystal diffractometers: Instrument geometry-crystal in a diffracting position – Data collection strategy: determination of unit cell –orientation matrix - Intensity Data collection - Unique data –equivalent reflections –selection of data.

### UNIT-II : Data Reduction

Integration of intensity - Lorenz and Polarization corrections – absorption – deterioration or radiation damage-scaling – Interpretation of Intensity.

### Structure factors and Fourier syntheses

Structure factor – Friedel's Law – exponential and vector form – generalized structure factor – Fourier synthesis –Fast Fourier transform – Anomalous scattering and its effects. Calculation of structure factors and Fourier syntheses.

**UNIT-III**

**Phase Problem**

Methods of solving Phase Problem: Direct methods – Patterson methods –Heavy atom methods.

**Refinement of crystal structures**

Weighting – Refinement by Fourier syntheses – Locating Hydrogen atoms identification of atom types – least squares – goodness –of-fit –least square and matrices-correlation coefficients-Relationship between Fourier and Least squares – Practical consideration in least squares methods - Random and systematic errors - Molecular geometry - absolute configuration – thermal motion.

**UNIT-IV : Cell: Its organelles and molecules**

Basic structure of prokaryotic and eukaryotic cells–mitochondiria and the generation of ATP– Chemical composition of living systems – molecular components of cell – chemical structure of carbohydrate–Lipids-proteins– Nucleic acids–hetro macro molecules.

Molecular interactions: Molecular forces–forces hold macro molecules together–intermolecular weak forces-van der waals-inductive force-dispersion force-Lenard-Jones potential-hydrogen bond – hydrophobic forces-acid, bases and pH, pK, pl and buffering.

**UNIT-V : Macromolecular Structure**

Nucleic acid structure–conformation of monomers and polymers–double helical structure of DNA–polymorphism of DNA–DNA super coiling – structure of transfer RNA. Protein structure–amino acids–primary structure–peptide bond–secondary structure – α-helix and β-sheet-tertiary and quaternary structure – Virus structure.

**BOOKS FOR STUDY AND REFERENCE**


1. X-ray Structure Determination (2nd Edition) - Stout and Jensen – John Wiley Publications.

2. Fundamentals of Crystallography –(2nd Edition)- C. Giacovazzo- Oxford Press.

3. Structure Determination by X-ray Crystallography (2nd Edition) - Ladd and Palmer.

4. Molecular Biophysics –Structure in motion- M. Duane; Oxford University Press.

5. Introduction to Molecular Biophysics – J. A. Tuszynski and M.Kurzynski; CRC Press Publications.

6. Principles of Physical Biochemistry- K.E. Van Holde, N.C. John and P.S. Ho Prentice Hall Publications.

7. Biophysics – M. V. Volkenshtein ; Mir Publications , Moscow.

8. Practical Protein Crystallography- Duncan E. McRee- Academic Press Publications.

9. Elements of X-ray crystallography – Leonid V.Azaroff- McGraw-Hill Publications.

10.Biophysics An Introduction – Rodney M. J. Cotterill; John Wiley Publication.

11. Biophysics – Vasantha Pattabhi and N.Gautham; Narosa Publishing House.

12. Biophysics – Roland Glacer; Pringer Publications.

13. Elementary Biophysics An Introduction – P. K. Srivastava ; Narosa Publishing House.

## PPHEC08: ULTRASONICS AND ITS APPLICATIONS

**UNIT - I :Source of Ultrasonic waves:**

Piezo electric - magnetostrictive transducers, electromechanical coupling factors and transducer efficiency - Transducers and band width characteristics - Equivalent electrical circuit of piezoelectric vibrators.

Detection of ultrasonic waves: - Mechanical, thermal, electrical and optical methods.

**UNIT - II : Techniques used in ultrasonic investigations:**

Interferometer, Optical, pulse, sing-around, radiation pressure and streaming methods - Measurement of propagation constants in different media - Relative merits of the techniques - Diffraction effects of sound velocity and absorption measurements - Hypersonic velocity and absorption measurements.

**UNIT - III**

**Propagation of ultrasonic waves in liquids:** mixtures. Excess compressibility and the relation to excess volume – Excess intermolecular free length – relative association. Sound velocity and compressibility of electrolytic solutions - Dispersion of sound in liquids - Different mechanisms of the absorption of sound -Relaxation phenomenon.

**UNIT - IV : Dielectric measurements**

Continuous wave and pulse techniques for measuring elastic constants of solids - Determination of elastic constants of cubic crystals – Dielectric behavior of materials – Dipole moment of polar and non – polar molecules – dielectric relaxation time – permittivity of solutions – breakdown – Strength of Glasses – Dielectric properties of liquid mixtures at different temperatures – Dielectric absorption.

**UNIT – V : Applications**

Acoustical grating – sonar – depth of sea – measurement of velocity of blood flow and movement of heart – Ultrasonic imaging – High resolution images – Non destructive testing – Principle – Methods – Liquid penetrant method - - Ultrasonic flaw detector – X – ray Radiography and Fluoroscopy – Thermography - Applications of ultrasonics in NDT.

**BOOKS FOR STUDY AND REFERENCE**


1. Fundamentals of Ultrasonics by J.Blitz, 2nd Edition, Plenum Press, New York, 1967.
2. Physical Acoustics by W.P.Mason, 1959.
3. Sonics by P.P.Hueter and R,H. Bolt, Wiley, New York, 1955.
4. Molecular Acoustics by J.matheson, Wiley, New York, 1971.
5. Ultrasonics : Fundamental Technologies, Leonard Bond Dale Ensminger, CRC press.

## LIST OF SUPPORTIVE COURSES

## ELECTRONIC APPLIANCES

### UNIT – I : ELECTRONIC COMPONENTS

Components – Resistors – Condensers – resistance Value – Capacitor Value – Diodes – transistors – IC's.

### UNIT – II : ELECTRICAL APPLIANCES

Basic of UPS – Stabilizers – Voltage regulators – Iron Box – Heaters – Electrical Over – Refrigerators – Air Conditioners – Freezers – Washing Machines.

### UNIT – III : ELECTRONIC APPLIANCES

Basics of Radio – TV – CD Players – LCD Projectors – Digital Camera – Scanners – Video Conferencing.

### UNIT – IV : COMPUTERS

Block diagram of a Computer – Input Device – Memory Device – Control Unit – Arithmetic logic unit – Output device – Microprocessor – RAM – ROM.

### UNIT – V : COMMUNICATION ELECTRONICS

Basics of Telephones – Mobile Phones – Wireless Phones – Antenna – Internet – Satelites.

### BOOKS FOR STUDY AND REFERENCE


1. S. S. Kamble, Electronics & Mathematical Data Book, Allied Publishers Ltd., (1997).
2. William David Cooper, Electronic Instrumentation and Measurement Technique ($2^{nd}$ Edition).

## MEDICAL PHYSICS

**Unit – I**

Bioelectric Signals – Electrodes – Surface, Needle and Micro Electrodes – Biosensors – Pulse Sensors.

**Unit – II**

Transducers: Thermistors : Photo electric type – transducer – photo voltaic cells – Photo emissive cells – Diode – Detectors – Optical fibers.

**Unit – III**

Blood Pressure measurements: Sphygmomanometer Measurement of heart rate – Basic Principles of EGC – Basic Principles of Electroneurography (ENG) – basic Principles of MRI.

**Unit – IV**

Basic of X-ray – Production of X-ray – X-ray Image – Applications of X-ray Examinations – Basic Principles of X-ray Tomography.

**Unit – V**

Endoscopes – Thermography – Liquid Crystal thermography – Microwave thermography – Basic Principles of ultrasonography – Laser – Uses of Lasers in Medicine.

**KS FOR STUDY AND REFERENCE**


1. Biomedical Instrumentation – Dr. M. Arumugam, Anuratha Agencies Publishers (2002).
2. Handbook of Biomedical Instrumentations, TMG, New Delhi (2005) – R.S.Khandpur.
3. Bio-Medical Electronics & Instrumentation – Prof. S.K.Venkata Ram – Galgotia Publications Pvt. Ltd.

# GEOPHYSICS

## UNIT – I : ORIGIN OF EARTH:

Petrology – Evolution and composition of earth – Major subdivisions of earth's Sphere – Atmosphere – Hydrosphere – Lithosphere – Interior of earth – Composition of earth crust - Relative abundance of earth's crust.

## UNIT – II: GEOMAGNETISM

Origin of earth's magnetism – elements of earth's magnetic field – inclination, declanation and dip- earth's magnetic field – Diurnal, annual and secular variations – magnetosphere.

## UNIT – III : SEISMOLOGY

Basic principles of elasticity and wave motion – primary wave (P-waves) and elasticity wave ( S-wave ) – density within the earth – pressure distribution – variation of 'g' and elastic constants - earth quakes – Elementary ideas about Ritter's scale.

## UNIT – IV: GEO – THERMAL EFFECT

Fundamental concept of Thermal conductivity – heat flow measurement on ground level and ocean – heat flow gravity variation – temperature of the primitive earth – inner core – melting point – adiabatic temperature gradient.

## UNIT – V : GRAVIMETRY

Fundamental concepts of gravitational field – gravitational anomalies – use of gravitational anomalies in geophysical prospecting – petroleum and mineral survey – factors affecting gravitational field due to magnetic storms and cosmic ray showers - Hammond and Faller method of absolute gravity measurement – principle and working.

## BOOKS FOR STUDY AND REFERENCE

1. Pedology – Concept and applications – J.SEHGAL Kalyani publishers, 4863/2B, Bharat Ram Rode , 24, Daryaganj, New Delhi – 110 002
2. Introduction to, geophysics (mantle, core and crust)- George G. Garland, W.B.Saunder's company – Philadelphia – London and Toranto.
3. Physics and Geology – Jacobbs ,Russel and Wilson – International Students Edition, Tata McGraw Hill , New Delhi
4. Rock Magnetism – Nagata – McGraw Hill Publications, New Delhi
5. Geology – Debrin – McGraw Hill Publications , New Delhi.
6. Physics and Geology n- A.J.Aitken – tata McGraw Hill – Publications, New Delhi.
7. Bio – graphy of the earth (Its past , present and future) – George Gamove - Macmillon company Ltd , Canada

# LASERS AND APPLICATIONS

## Unit –I : Introduction

Review of elementary quantum physics, Schrodinger equation, Properties of Laser Beams-monochromativity, temporal and spatial coherence , Directionality, Brightness, Radiation Trapping Superradiance, Superfluorescence, Amplified Spontaneous Emission, Non-radiative delay.

Absorption, spontaneous emission and stimulated emission processes, relation between Einstein's A and B coefficients, population inversion, pumping, gain, optical cavities.

## Unit-II : Pumping process:

Optical pumping and pumping efficiency - Electrical pumping and pumping efficiency. Passive Optical Resonators, Rate Equations, Three -level Laser, Four-level Laser, Methods of Q-switching: Electro optical shutter, mechanical shutter, Acousto - optic Q-switches, Mode locking.

## Unit-III : Main components of Laser

Main components of Laser, principle of Laser action, introduction to general lasers and their types. Three and four level Lasers, CW and Pulsed Lasers, atomic, ionic, molecular, excimer, liquid and solid state Lasers and systems, short pulse generation and measurement. Spatial Frequency Filtering – Holography – Applications of holography – HNDT (Holographic Non-Destructive Testing) holographic storage – optical disk storage – Laser speckle and speckle meteorology – SNDT (Speckle Non-Destructive Testing).

## Unit - IV : Lasers in Science

Saturation spectroscopy – excited state spectroscopy – nonlinear spectroscopy – time domain and its applications – stimulated Raman Emission – Laser fusion – Isotope separation – Medical applications, photo-chemical applications. Multiphoton photo-electric effects, Two-photon, Three-photon and Multiphoton Processes Raman Scattering, Stimulated Raman Effect.

## Unit-V: Lasers in industry

Materials processing – drilling, cutting, welding – alloying – glazing – oblation – laser chemical vapour deposition (LCVD) – laser thermal deposition – hardening, annealing – Laser Tracking – Lidar.

**BOOK FOR STUDY AND REFERENCE**


1. K.R. Nambiar, “Laser Principles, Types and Application” New Age International.
2. S. A. Ahmad, “Laser concepts and Applications” New Age International.
3. B.B. Laud , Lasers and Non-linear Optics ( New Age International, New Delhi,2007)
4. K. Thyagarajan and A.K. Ghatak, Lasers Theory and Applications, Mcmillan (1981).
5. K. Koebner (ed.), Industrial Applications of Lasers, Wiley (1984).
6. J.T. Cuxon and D.E. Parker, Industrial Lasers and their Applications, Prentice Hall (1985).
7. B. Culshaw, Optical Fiber Sensing and Signal Processing, Peter Peregrinus Ltd. (1984).
8. F.C. Appard, Fiber Optics Handbook, McGraw-Hill (1989).