PERIYAR UNIVERSITY

PERIYAR PALKALAI NAGAR

SALEM-636 011

M.Sc. DEGREE

Branch-III (B)-PHYSICS

(Choice Based Credit System (CBCS)

REGULATIONS AND SYLLABUS

(Effective from the academic year 2015-2016 and thereafter)

M.Sc. BRANCH III (B) - PHYSICS -CHOICE BASED CREDIT SYSTEM

REGULATIONS AND SYLLABUS

(For the candidates admitted from 2015-2016 onwards)

1. DURATION OF THE PROGRAMME

The two-year postgraduate program in M.Sc. Physics consists of four semesters under Choice Based Credit System.

2. CONDITION FOR ADMISSION

A candidate who has passed B.Sc. Degree Examinations in Branch III- Physics of this University or examinations of some other university accepted by the syndicate as equivalent there to shall be permitted to appear and qualify for the M.Sc Physics (CBCS) Degree Examinations of this university after a course of two academic year in the Department of Physics of Periyar University.

3. 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 8 credits
- Supportive Courses : Minimum 8 credits

4. COURSE OF STUDY

The course of study for the degree shall be in Branch III (B)-Physics (Choice Based Credit System) with internal assessment according to the syllabus prescribed from time to time.

Total	: 2200 Marks
For Each Paper	: 100 Marks (Int.25+Ext.75)
Project	: 200 Marks

5. STRUCTURE OF THE COURSE

M.Sc. Branch III (B) Physics -Choice Based Credit System (CBCS)

Subject Code	Title of the Course	Credits L T P C	Internal Assessment Marks	End Semester Exam Marks	Total Marks 100
CORE COURSES					
15PGPHY C01	Mathematical Physics	4 0 0 4	25	75	100
15PGPHY C02	Classical Mechanics	4 0 0 4	25	75	100
15PGPHY C03	Electromagnetic Theory	4 0 0 4	25	75	100
15PGPHY C04	Advanced Practical –I	0 0 4 4	25	75	100
15PGPHY C05	Quantum Mechanics-I	4 0 0 4	25	75	100
15PGPHY C06	Semiconductor Electronics	4 0 0 4	25	75	100
15PGPHY C07	Statistical Mechanics	4 0 0 4	25	75	100
15PGPHY C08	Advanced Practical –II	0 0 4 4	25	75	100
15PGPHY C09	Quantum Mechanics-II	4 0 0 4	25	75	100
15PGPHY C10	Spectroscopy	4 0 0 4	25	75	100
15PGPHY C11	Microprocessors and Microcontroller	4 0 0 4	25	75	100
15PGPHY C12	Advanced Practical –III	0 0 4 4	25	75	100
15PGPHY C13	Condensed Matter Physics	4 0 0 4	25	75	100
15PGPHY C14	Nuclear and Particle Physics	4 0 0 4	25	75	100
15PGPHY C15	Numerical Methods and Programming	4 0 0 4	25	75	100
15PGPHY C16	Advanced Practical –IV	0 0 4 4	25	75	100
15PGPHY C17	Project Work	0 0 10 10	-	-	200

ELECTIVE COURSES					
15PGPHY E01	X-ray Crystallography	4 0 0 4	25	75	100
15PGPHY E02	Energy Physics				
15PGPHY E03	Nonlinear Dynamics-I	4 0 0 4	25	75	100
15PGPHY E04	Crystal Growth and Characterization	4 0 0 4	25	75	100
15PGPHY E05	Thin Film Growth and Technology	4 0 0 4	25	75	100
15PGPHY E06	Nanoscience	4 0 0 4	25	75	100
15PGPHY E07	Biomedical Instrumentation	4 0 0 4	25	75	100
15PGPHY E08	Molecular Biophysics	4 0 0 4	25	75	100
15PGPHY E09	Photovoltaic Science	4 0 0 4	25	75	100
15PGPHY E10	Nonlinear Dynamics-II	4 0 0 4	25	75	100
15PGPHY E11	Instrumental Methods of Analysis	4 0 0 4	25	75	100
SUPPORTIVE COURSES					
15PGPHY S01	Laser physics and its Applications	4 0 0 4	25	75	100
15PGPHY S02	Geo Physics	4 0 0 4	25	75	100
15PGPHY S03	Electronics in Daily Life	4 0 0 4	25	75	100

Note: C- Core Course; E- Elective Course: S-Supportive Course

One elective in semester II and III have to be chosen from among the list of electives.

Two supportive courses have to be chosen from among the four supportive courses, by the other Departments.

6. EXAMINATIONS

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 test and seminars and one end semester examinations during each semester.

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

a. Sessional Test I will be held during seventh week for the syllabi covered till then.

b. Sessional Test II will be held during eleventh week for the syllabi covered between eighth and eleventh week.

c. Sessional Test III will be held during 16th week for the syllabi covered between 12th Week and 16th Week. The highest two marks scored of the three sessional Tests will be taken for sessional assessment.

7. QUESTION PAPER PATTERN

Question paper pattern for University Examinations

Time: 3 hours Maximum: 75 Marks

Passing minimum: 38 Marks

Part-A (10 x 2 =20)

Answer all questions (No Choice)

Part-B (5 x 5 = 25 Marks)

Answer all questions (Either or Type)

Part-C (3 x 10 = 30)

Any three from five questions

Note:

- At least two questions must be problem in Part-A and one question must be a problem in Part-B in the core and elective Courses/ Papers
- Part-A : Two questions from each Unit
- Part-B : One question from each Unit
- Part-C : One question from each Unit

8. 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 of 50 marks 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.

9. COMMENCEMENT OF THIS REGULATION

These regulation and syllabus shall take effect from the academic year 2015-2016, that is, for students who are admitted to the first year of the course during the academic year 2015-2016 and thereafter.

15PGPHY C01 MATHEMATICAL PHYSICS

UNIT – I Vectors Space and Tensors

Vector Space – Definitions - Linear independence of vector – Bilinear and quadratic forms – change of basis - Schmidt's orthogonalisation processes - Schwartz inequality – Application of vector to hydrodynamics the equation of flow in solids.Tensors – N-dimensional space – superscripts – subscripts – coordinate transformations Kronecker delta symbol - properties of kronecker. Generalized kronecker delta Tensors of higher Ranks- Algebric operations of Tensors- symmetric and asymmetric Tensors – Applications of Tensors– Dynamics of a particle – Elasticity – Rigid bodies.

UNIT- II Complex Variables

Functions of complex variables- limit – continuity- Differentiability- Analytic function – Cauchy – Riemann condition – differential equation – Cauchy Integral theorem- Cauchy integral formula-Taylors Series-Laurent's series- singularities of an analytical function- Residues-Cauchy Residue theorem- Evaluation of definite integrals- contour integration.

UNIT- III Fourier's and Laplace's Integral Transforms

Fourier transform - Properties of Fourier's transform – Fourier transform of a derivative – Fourier's sine and cosine transforms of a derivative – Finite Fourier transforms – simple Applications of Fourier transforms – Laplace transforms - Properties of Laplace transforms – Laplace transforms of the derivative of a function – Laplace transforms of integral – Inverse Laplace transform – Properties of inverse Laplace transform – convolution theorem- Application of Laplace transform.

UNIT- IV Special Functions

Gamma and Beta functions - Louville problem- solutions for Bessel- Legendre –Lagure and Hermite differential equation – properties-Generating functions- Rodrigue's formula- orthogonal properties-recurrence relations. Dirac -Delta function - Three dimensional delta function – Green's function- for one Dimensional case – symmetry properties of green function –Green's function for poison equation – Quantum mechanical scattering problem.

UNIT- V Group Theory

Definition of Group - Subgroup, invariant group, abelian group, orthogonal and unitary groups - Homomorphism, isomorphism - Reducible and irreducible representations – Orthogonality theorem- Applications of Group theory.

Books for Study and References:

1. L.A. Pipes and Henvil, Applied Mathematical for Engineers and Physics, International Students Edition, Mc Graw Hill Ltd.
2. Erwin Kreyszig, Advanced Engineers Mathematics, 10th Edition, Wiley.
3. P.K Chattopadhyay Mathematical Physics, Wiley Eastern Ltd.
4. B.D.Gupta, Mathematical Physics, Vikar Publishing House Pvt. Ltd.
5. Satyaprakash, Mathematical Physics, Sultan Chand & Sons.

6. A.K.Ghatak, I.G.Goyal and A.J.Chua, Mathematical Physics, Mc-Millan.
7. M.D.Greenbey, Advanced Engineering Mathematics, 2nd Edition, Printice-Hall.
8. Charlie Harper, Introduction to Mathematical Physics, Prince-Hall, India Pvt. Ltd.
9. S.S.Rajput, Mathematical Physics, Pragati Pragasam, Meerut, 11th Edition.
10. Murray R.Spiegel, Theory and Problems of Laplace Transforms –Schaum's outline series, McGraw-Hill International Edition.
11. Charlie Harper, Introduction to Mathematical Physics, California State University, Hayward.
12. George Arfken and Hans Weber, Mathematical Methods for Physicists-A Comprehensive Guide (7th edition), Academic Press.

15PGPHY C02 **CLASSICAL MECHANICS**

UNIT-I **Lagrangian Formulation**

System of particles- constraints and degrees of freedom- generalized coordinates- conservation laws- conservations of linear and angular momenta- D'Alemberts principle of virtual work- Lagrange's equation of motion- applications of Lagrange equations of motion: single particle in space- Atwood's machine- bead sliding in rotating wire.

Unit -II **Hamilton Principle**

Calculus of variation- Hamilton's principle- derivation of Lagrange's equation from Hamilton's principle- Hamilton's principle for nonholonomic system- variational principle- Legendre transformation and Hamilton's equation of motion- Cyclic coordinates and conservation theorem- Hamilton's equations from variational principle- principle of least action- Canonical transformations- Generating functions- Examples- Poisson brackets and its properties.

UNIT-III **Central Force Problem**

Reduction to the equivalent one body problem- Centre of mass- Equation of motion and first integral- Equivalent one dimensional problem and classification of orbits- Kepler problem: Inverse-Square law of force- Scattering in a central force field- transformation of scattering to laboratory coordinates.

UNIT-IV **Kinematics of Rigid Body**

Independent coordinates of rigid body- orthogonal transformation- properties of transformation matrix- Euler angle and Euler's theorem- infinitesimal rotation- rate of change of vector- Coriolis force- angular momentum and kinetic energy of motion about a point- moment of inertia tensor- Euler's equations of motion- torque free motion of a rigid body- heavy symmetrical top.

UNIT-IV **Hamilton – Jacobi Theory and Relativity**

Hamilton-Jacobi equation for Hamilton's principle function- Example: Harmonic oscillator problem- Hamilton's characteristic function- Action-angle variable in systems of one degree of freedom- application to Kepler problem- Formulation of the problem- Eigen value equation- frequencies of free vibrations- Normal coordinates- vibrations of linear triatomic molecule- Special theory of relativity- Lorentz transformations- relativistic kinematics and mass- energy equivalence.

Books for Study and References:

1. H. Goldstein, Classical Mechanics, Narosa Publishing House.
2. S.L. Gupta, V. Kumar and H.V. Sharma, Classical Mechanics, Pragati Prakashan.
3. Donald T. Greenwood, Classical Mechanics, Prentice-Hall of India Private Ltd.
4. K.C. Gupta, Classical Mechanics of Particles and Rigid Bodies, Wiley Eastern.
5. N.C. Rana and P.J. Joag, Classical Mechanics, Tata McGraw Hill.
6. J. Michael Finn, Classical Mechanics, Infinity Science Press LLC.
7. J.C. Upadhaya, Classical Mechanics, Himalaya Publishing House Pvt. Ltd.
8. G. Aruldhas, Classical Mechanics, Eastern Economy Edition.
9. Satyendra Nath Maitti, Debi Prasad Raychaudhuri, Classical Mechanics and general properties of Matter New Age international publishers.
10. Alexe Deriglazov, Classical Mechanics Hamiltonian and Lagrangian formalism, Kindle Edition

15PGPHY C03 **ELECTROMAGNETIC THEORY**

UNIT- I **Electrostatics**

Coulomb's law- Electric field-Gauss' law- Differential form of Gauss' law- surface distributions of charges and dipoles- Poisson and Laplace equations- Green's theorem- Solution of boundary value problem with green's function- Electrostatic potential energy and capacitance.

UNIT- II **Boundary Value Problems in Electrostatics**

Method of Images- point charge in the presence of a – grounded conducting sphere-charged, insulated, conducting sphere- point charge near a conducting sphere at fixed potential-conducting sphere in a uniform electric field by method of Images- Laplace equations in spherical co-ordinates- multipole expansion- boundary value problems with dielectrics-molecular polarizability and electric susceptibility- electrostatic energy in dielectric media.

UNIT- III **Magnetostatics**

Biot and Savart law- Differential equations of magneto statics and Ampere's law- vector potential- magnetic fields of localized current distribution and magnetic moment- force, torque and energy of a localized current distribution- macroscopic equations and boundary conditions of B and H- methods of solving boundary value problems in magneto statics- uniformly magnetized sphere.

UNIT- IV **Electromagnetics**

Faraday's law of induction-Maxwell's equations- vector and scalar potentials- gauge transformation- Lorentz gauge- Coulomb gauge- Poynting's theorem and conservation of energy and momentum- electromagnetic waves- plane electromagnetic waves in a non-conducting medium- linear and circular polarization- reflection and refraction of EM waves- plane interface between dielectrics- cylindrical cavities and wave guides

UNIT-V **Applications of E.M. waves in Plasma**

Introduction to plasma-Plasma behavior in magnetic field-Plasma as a conducting field-Pinch effect- Instabilities in Plasma-hydromagnetic waves-Alfen waves.

Books for Study and References:

1. J.D. Jackson, Classical Electrodynamics, Third Edition, John Wiley.
2. David J. Griffiths, Introduction to Electrodynamics, Prentice-Hall of India.
3. E.C. Jordan and K.G. Balmin, Electromagnetic waves and radiating system, Second edition, Prentice Hall of India.
4. John R. Reits, Fredrick, J. Milford and Robert W. Christy, Foundation of Electromagnetic Theory.

15PGPHY C04 **ADVANCED PRACTICAL –I**

(Practical at the end of I Semester)
General Experiments
(Any twenty Experiments)

1. Young's Modulus by Elliptical fringes method.
2. Young's Modulus by Hyperbolic fringes.
3. Determination of compressibility of the given liquid by ultrasonic interferometer.
4. Determination of ultrasonic velocity of sound in the given liquid using Aqua grating.
5. Hall effect by four probe method.
6. Determination of Dielectric constant of a Solid.
7. Zeeman effect
8. Michelson's interferometer- Determination of wavelength of the given source of thickness.
9. GM Counter- Verification of inverse square law magnetic susceptibility measurement using Guoy's/ Quincke's method.
10. Stefan's Constant
11. Determination of Specific Charge by Thomson's method.
12. B.H. Curve- Energy lose of the magnetic material.
13. Solar Cell I-V Characteristics and efficiency
14. LVDT Characteristics curve and displacement measurement.
15. Determination of Self Inductance of ac coil by Anderson's method
16. Determination of band gap by Thermisters
17. Redburg's constant using constant deviation Spectrometer
18. Determination of refractive index by using hollow prism
19. Determination of Planck's Constant by photo electric method.
20. Laser experiments-Diffraction& Interference experiments
21. Measurement of He Ne Laser Wavelength using meter scale
22. Study of Fraunhofer diffraction through circular apertures
23. Measurement of numerical aperture of an optical fiber
24. Demonstration of FT-IR spectrometer and powder X-ray diffraction patterns
25. Study of magneto optic –Faraday Effect
26. Study of Kerr-effect experiment
27. Study of linear electro optic effects –Pockel-effect

15PGPHY C05 QUANTUM MECHANICS-I

UNIT-I Foundations of Wave Mechanics

Matter waves- Equation of motion- Schrodinger equation for the free particle – physical interpretation of wave function-normalised and orthogonal wave functions-expansion theorem-admissibility conditions- stationary state solution of Schrodinger wave equation - expectation values-probability current density- Ehrenferts theorem.

Postulates of wave mechanics -adjoint and self-adjoint operators-degeneracy-eigen value, eigen functions-observables - Physical interpretation-expansion coefficients-momentum eigen functions-Uncertainty principle-states with minimum value-commuting observables - constant of motion-Interacting and Non-interacting systems.

UNIT -II Stationary State and Eigen Spectrum

Time independent Schrodinger equation - Particle in a square well potential – Bound states – eigen values, eigen functions –Potential barrier – quantum mechanical tunnelling-infinite potential-finite potential – multiple potential well – alpha emission.

UNIT-III Exactly Soluble Eigenvalue Problems

One dimensional linear harmonic oscillator – properties of stationary states- abstract operator method - Angular momentum operators- commutation relation-Parity- spherical symmetry systems -Particle in a central potential – radial wave function – Hydrogen atom: solution of the radial equation – stationary state wave functions – bound states-the rigid rotator: with free axis-in a fixed plane-3-Dimentional harmonic oscillator.

UNIT -IV Matrix Formulation of Quantum Theory and Equation of Motion

Quantum state vectors and functions- Hilbert space-Dirac's Bra-Ket notation-matrix theory of Harmonic oscillator – Schrodinger, Heisenberg and Interaction representation – coordinates and momentum representations – Projection operator

Identical Particles and Spin

Identical Particles – symmetry and antisymmetric wave functions – 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.

UNIT –V Angular Momentum

Angular momentum -commutation rules - eigen value spectrum - matrix representation of J in the |jm> basis – spin angular momentum – spin ½ , spin-1- addition of angular momenta-Clebsch-Gordan coefficients-spin wave functions for a system of two spin- ½ particles.

Books for Study and References:

1. P. M. Mathews and K. Venkatesan , A Text book of Quantum Mechanics, Tata McGraw –Hill Publications
2. Satya Prakash, Quantum Mechanics, Kedar Nath Ram Nath and Co. Publications
3. A. K. Ghatak and Lokanathan, Quantum Mechanics (5th Edition) – Theory and Applications, Macmillan India Ltd Publication.
4. Leonard I. Schiff, Quantum Mechanics, McGraw-Hill International Publication.

5. V. K. Thankappan, Quantum Mechanics (2nd Edition), New Age International (P) Ltd. Publication.
6. E. Merzbacher, Quantum Mechanics (3nd Edition), John Wiley Interscience Publications.
7. Claude Cohen-Tannoudji, Bernard Diu, Franck Laloë , Quantum Mechanics (Vol .I), John Wiley Interscience Publications
8. Pauling & Wilson, Quantum Mechanics, Dover Publications
9. R. Shankar, Principle of Quantum Mechanics (2nd Edition), Plenum US Publication.

15PGPHY C06 **SEMICONDUCTOR ELECTRONICS**

UNIT -I

Junction- Diode characteristics-The open – circuited P-N junction- The P-N junction as rectifier- The current components in a P-N diode – The Volt – Ampere characteristic- The temperature dependence of the V/I characteristic - Diode resistance - Space – charge or transition, capacitance C_r. Diode circuits- The diode as a circuit element – The load- line concept- The Piecewise linear diode model- Clipping (limiting) circuits- Clipping at two independent levels- Comparators- Sampling gates – Rectifiers.

UNIT- II

Transistor characteristics- The junction transistor- Transistor current components- The transistor as an amplifier- Transistor construction- The Common- Base configuration – The Common – Emitter configuration – The CE cutoff region – The CE saturation region – Typical transistor – Junction voltage values – CE current gain – Common Collector configuration – Expressions for characteristics – Maximum voltage – Phototransistor.

UNIT –III

The transistor at low frequencies – Graphical analysis of CE configuration – Two port devices – Hybrid model – h parameters – conversion – Amplifier circuit using h parameters – Thevenin's and Norton's Theorems – The Emitter follower – Comparisons of configurations – Linear analysis – Miller and its Dual theorems – Cascading Amplifiers. Transistor Biasing – The operating point – Bias stability – Self bias or Emitter bias.

UNIT- IV

Multistage amplifier - Classification – distortions – Frequency response – Bode plots step response – Band Pass – RC coupled – Effect of an Emitter By pass capacitor on low frequency response. Feedback amplifiers – Classification - feedback concept – Transfer gain with feedback – Negative feedback – Characteristics of Amplifier – Method of analysis – Voltage series.

UNIT –V

Linear Analog Systems: Basic Operational Amplifier applications – Differential DC amplifier – Stable AC amplifier – Analog Integration and Differentiation. Nonlinear Analog Systems- Comparators – Sample and hold circuits – AD/DA converters – Logarithmic amplifier – Wave form generators – Schmitt Trigger, Digital circuits – Binary operation – The OR, AND, NOT gates – Transistor switching times – INHIBIT operation- X-OR – De Morgan's Laws. Sequential Digital systems – 1- Bit memory – Flip-Flops – Shift registers – Counters and its applications.

Books for Study and References:

1. Millman and Halkias, Integrated Electronics, TMH.
2. Malvino, Electronic principles, TMH.
3. Malvino Leach, Digital Principles and Applications- 7th Edition, TMH.
4. Vijay Baru, Rajendra Kaduskar, Sunil T. Gaikwad, Basic Electronics Engineering, Wiley

15PGPHY C07 **STATISTICAL MECHANICS**

UNIT -I **The Fundamentals of Statistical Physics**

Objective of statistical mechanics: macrostates, microstates, phase space and ensembles- Density of states- Density distribution in phase space- Ergodic hypothesis- Postulate of equal a priori probability and equality of ensemble average and time average- Boltzmann's postulate of entropy- Classical ideal gas- Entropy of ideal gas: Gibbs' paradox- Liouville's theorem.

UNIT - II **Theory of Ensembles**

Classification of ensembles- Micro canonical, Canonical and Grand canonical ensembles- Partition function of canonical ensemble- Thermo dynamical quantities by partition function- expression of entropy- Helmholtz free energy- fluctuation of internal energy- chemical potential of ideal gas.

UNIT –III **Quantum Statistics**

Introduction- Postulates of quantum statistical mechanics- Density matrix- Ensembles in Quantum statistical mechanics- Quantum Liouville theorem- Maxwell law of distribution of velocities- Ideal quantum gases- Bosons- Fermions- BE, FD, MB distributions using GCE partition functions.

UNIT - IV **Approximate Methods**

Classical Cluster expansion- Quantum Cluster expansion- Virial equations of states, Ising model in one, two, three dimensions- exact solutions.

UNIT - V **Phase Transitions**

Photon gas- Equation of state- Bose-Einstein condensation- Equation of state of ideal gas- Specific heat from lattice vibration- phase transitions- first and second order phase transitions- critical points- Landau’s theory- Phonon gas- Theory of Super fluidity- Liquid helium.

Books for Study and References:

1. B.B. Laud, Fundamentals of Statistical Mechanics, New Age International Publishers.
2. Kerson Huang, Statistical Mechanics, John Wiley & Sons.
3. C. Kittel, Elementary Statistical Physics, John Wiley & Sons.
4. R.P. Feynman, Statistical Mechanics, Addison Wesley.
5. R.K. Pathria, Statistical Physics, Pergamon, Oxford.
6. F. Reif, Statistical and Thermal Physics, McGraw Hill.

15PGPHY C08 **ADVANCED PRACTICAL-II**

(Practical at the end of II Semester)

Electronics Experiments

(Any twenty Experiments)

1. JFET – Characteristics and Design of amplifier.
2. UJT- Characteristics & Design of Relaxation Oscillator
3. Design of square wave generator (Astable) using IC 741 and 555 timers
4. Design of monostable multivibrator using IC 741 and 555 timers
5. Design of Schmidt's trigger using IC 741 and 555 timers
6. Phase locked loop using IC 556.
7. Design and Study of Phase shift Oscillator
8. Photo Transistor characteristic
9. Photo Diode characteristic
10. Binary addition and subtraction (4 bits)- 7483 IC
11. Study of multiplexer and Demultiplexer
12. Study of Encoders and Decoders
13. Study of Flip Flops using IC 7400
14. Design of Counters and shift Registers using 7476/7473 IC
15. BCD Counters – Seven Segment display
16. Design of R/2R ladder and Binary weighted method of DAC using 741 IC
17. Construction of ADC using DAC Comparator.
18. Study of Modulation and Demodulation.
19. Arithmetic Operations using Op- amp IC 741 (Addition, Subtraction, Multiplication & Division)
20. Printed Circuit Board – Designing and testing.
21. Study of TV trainer Kit – Demonstration.
22. Design of Active filters (Low pass, High pass and Band pass filters)
23. Solving Simultaneous equations using Op- amp.
24. Analog Computer circuit design – solving simultaneous equation.
25. Computer assembling and testing.

15PGPHY C09 QUANTUM MECHANICS-II

UNIT -I Approximation Methods for Time Independent Problems

Time independent perturbation theory – stationary theory- Non-degenerate case: first and second order-Normal Helium atom– Zeeman effect without electron spin –Degenerate case: Energy correction- stark effect in hydrogen atom.

Variation method: Variation Principle – upper bound states- ground state of Helium atom – Hydrogen molecule-WKB approximation - Schrodinger equation-Asymtotic solution-validity of WKB approximation-solution near a turning point – connection formula for penetration barrier – Bohr-Summer field quantization condition- tunneling through a potential barrier.

UNIT –II 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 –III 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 – non-resonant scattering-scattering length and effective range– Ramsauer-Townsend effect – scattering by square well potential.

UNIT -IV Relativistic Quantum Mechanics

Schrodinger relativistic equation- Klein-Gordan equation-charge and current densities – interaction with electromagnetic 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.

Quantisation of the Field

Electromagnetic wave as harmonic oscillators – quantisation: classical e.m.wave –quantisation of fields oscillators- Photons- number operator – creation and annihilation operators of photons.

UNIT –V 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.

Molecules: Born –Oppenheimer approximation – An application : the hydrogen molecule Ion (H_2^+) – Molecular orbital theory: LCAO- Hydrogen molecule.

Books for Study and References:

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

15PGPHY C10 **OPTICS AND SPECTROSCOPY**

UNIT – I **Modern Optics**

Rigorous diffraction theory- Diffraction of a Gaussian beam- Fresnel and Fraunhofer diffraction- Application to different apertures. Fourier optics-Fourier transforming property of a thin lens- Spatial frequency filtering and its applications. Electro-optic effects in different crystals- Acousto-optic effects- Raman-Nath diffraction and Acousto-optic devices. Nanoscale Light-Matter interaction (Basic ideas only).

Detection of optical radiation- Human eye- thermal detector (Bolometer, pyro-electric) - photo detector (photoconductive detector, photo voltaic detector and photoemissive detector) - p-i-n photodiode- APD photodiode.

UNIT-II **Infrared and Raman Spectroscopy**

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

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 from Raman and IR spectroscopy – General features of electronic spectra of diatomic molecules – Franck-Condon principles – electronic states – configuration of some typical molecules.

UNIT – III **NMR and ESR Spectroscopy**

Interaction of spin and applied magnetic field - Quantum mechanical description – Relaxation times - spin-spin and spin lattice –Chemical shift – Spin-spin coupling between two and more nuclei – NMR spectrometer – quantum mechanical theory of ESR– Hyperfine structure study – Triplet states study of ESR – application of ESR to solid state physics (Crystal defects and Biological studies) – design of ESR spectrometer.

UNIT – IV **NQR and Mossbauer Spectroscopy**

General principles of NQR – energy levels of quadruple transitions for half-integral spins – design of NQR Spectrometer – Application of NQR (Molecular Structure). Principle of Mossbauer effect – Schematic arrangement of Mossbauer spectrometer – Isomer shift – Quadrupole interaction – magnetic hyperfine interactions – applications of Mossbauer spectroscopy (Biological applications)

UNIT – V **Laser Spectroscopy**

Basic Principles of Laser - Einstein coefficients of radiation - Types of Laser: Nd:YAG laser, He-Ne Laser – CO2 Laser, Semiconducting Laser – Dye Laser – Laser Applications – Holography - Time Resolved Laser Spectroscopy: Time Profiles of Pulsed Lasers - Q Switching lasers – Generation of Femtosecond Pulses – Titanium - Sapphire Laser – OPCPA - Applications Femtosecond Laser Spectroscopy.

Books for Study and References:

1. Sergery Gaponenko, Introduction to Nanophotonics, Cambridge University Press.

2. Lukas Novotny & Bert Hecht, Principles of Nano-optics, Cambridge University Press.
3. C.N.Banwell, Fundamentals of Molecular Spectroscopy, Tata Mc Graw Hill.
4. B.P.Straughan and Walkar.S, Spectroscopy Vol.2, Chapman & Hall.
5. Atta-Ur-Rahman, Nuclear Magnetic Resonance, Springer Verlag.
6. E.Wertz and R.Bolton, Electron Spin Resonance, Chapman and Hall Co.
7. B.P.Straughan & T.C.Gibb., Mossbauer Spectroscopy, Chapman & Hall.
8. T.P.Das and E.L.Hehn., NMR spectroscopy, Academic press.
9. J.E.Wertz and J.R.Boulton, EPR Elementary theory and Practical applications Mc Graw Hill.
10. W.T.Dixon, Theory and Interpretation of Magnetic resonance spectra, Plenum press.
11. Norman B.Colthup, Lawrence H.Daly & Stephen E. Wiberly, Introduction to IR and Raman
1. Spectroscopy, Academic press.
12. D.A.Long, Raman Spectroscopy, Mc Graw Hill – International Book Company.
13. B.B. Laud, Laser and Non-Linear Optics, New Age International Publishers.
14. W. Demtroder, Laser Spectroscopy Basic Concepts and Instrumentation 3rd Edition,
2. Springer – Verlag Berlin Heidelberg.
15. Joseph T. Verdeyen, Laser Electronics, Prentice – Hall Inc.
16. William Silfvast, Laser Fundamentals, Cambridge University Press.
17. C. C. Davis, Laser & Electrooptics, Cambridge University Press.

15PGPHY C11 MICROPROCESSORS AND MICROCONTROLLER

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 set of 8085-Timing and sequencing : Instruction cycle, machine cycle, halt state, wait 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 8086

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

UNIT – III Applications of Microprocessors

Microprocessor based process control – closed loop control – open loop 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 program 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 References:

1. Aditya P.Mathur, Introduction to Microprocessors, Tata Mc Graw Hill Company, II edition.
2. Ramesh S.Gaonkar, Microprocessor Architecture, Programming and Application with 8085, Wiley Eastern.
3. Douglas V.Hall, Microprocessors and Interfaces, Tata Mc Graw Hill Company.
4. Aditya P.Mathur , Introduction to Microprocessors, Tata Mc Graw 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.

15PGPHY C12

ADVANCED PRACTICAL-III
(Practical at the end of III Semester)
Microprocessors and Microcontroller
(Any twenty experiments)
Microprocessors 8085

1. Arithmetic operations- 8 bit
2. Arithmetic operations-16 bit
3. Code conversion (BCD to Binary, Binary to BCD)
4. Arranging numbers in ascending and descending orders
5. Temperature Conversions (F to C & C to F)
6. Determination of factorial of the given number
7. Decimal counter
8. Display and roll of a message
9. Solving simple expressions
10. Square and square root of the given number
11. Factorial of 'n' numbers
12. Sum of the 'n' numbers
13. PPT 8225 Interfacing
14. Stepper motor interfacing
15. Temperature controller measurements
16. ADC interfacing
17. DAC interfacing
18. Traffic light Controller
19. Arithmetic operations using 8086 microprocessors

Microcontroller 8051

20. Arithmetic operations- 8 bit
21. Arithmetic operations-16 bit
22. Solving simple expressions
23. Array operations (Biggest and Smallest number)
24. Square and square root of the given number
25. Temperature Conversions (F to C & C to F)
26. Arranging numbers in ascending and descending orders
27. Stepper motor interfacing 28. Hex key board interfacing
29. Seven segment display interfacing 30. ADC interfacing

15PGPHY C13 CONDENSED MATTER PHYSICS

UNIT –I Crystal Structure

Elementary concepts of crystals- Density- Graphical representation- Reciprocal lattice- Miller indices- Brillouin zones- properties- Point groups and Space groups- Bravais lattice- Crystal symmetry- Crystal structure of BCC, FCC, and NaCl- Crystal diffraction- Bragg's law- Ewald's sphere construction- Atomic scattering factor- Laue, Powder, Rotation methods- Electron density distribution.

UNIT –II Lattice Dynamics and Thermal Properties

Vibrational modes- monoatomic and diatomic basis- harmonic approximation- dispersion modes- acoustical and optical, transverse and longitudinal modes- Phonon quantization- Neutron diffraction by lattice vibrations- thermal conductivity- Umklapp process- Specific heat capacity of solids- Einstein, Debye model- Density of mode in one-dimensional and three dimensional.

UNIT –III Band Theory of Solids

Heat capacity of electron gas- Fermi- Dirac distribution- Electron gas in three dimensions- Nearly free electron model- review of electron in a periodic potential-Kronig Penny model- Limitations-3-Dimensional approach-Elements of Density Functional Theory.
Semiconductors- Band theory of pure and doped semiconductors- Carrier concentrations- intrinsic carrier- Hall effect- Physics of Nano science.

UNIT –IV Superconductivity

Occurrence of superconductivity- destruction of superconductivity by magnetic fields- Meissner effects- Type I and Type II superconductors-Heat capacity- electron-phonon interaction- Cooper pairs and BCS theory- London equation- Coherence length- Flux quantization in superconducting ring- duration of persistent currents- Quantum interference- Josephson effect and applications- SQUIDS- High temperature superconductivity.

UNIT – V Electric and Magnetic Properties

Polarization- Classification of polarization- macroscopic electric field- local electric field at an atom- Lorentz field- Dielectric constant and polarizability- Clausius-Mossotti relation- Ferro electric crystals- Ferro electric domains- Polarization catastrophe- Landau theory of phase transition- Langevin theory of Diamagnetism and paramagnetism- Quantum theory of paramagnetism- Curie law- Ferromagnetism-Weiss molecular field theory- Domain theory- Neel temperature- Ferrimagnetism- Ferrites- Spin waves.

Books for Study and References:

1. C. Kittel, Introduction to Solid State Physics, Wiley Eastern.
2. A.J. Dekker, Solid State Physics, Macmillan, India.
3. S.O. Pillai, Solid State Physics, Wiley Eastern Ltd.
4. B.S. Saxena, R.C. Gupta & P.N. Saxena, Solid State Physics, Pragati Prakashan.
5. A.R. Verma and O.N. Srivastava, Crystallography for Solid State Physics, Wiley.
6. L.V. Azaroff, Elements of X-ray crystallography McGraw-Hill.
7. Rita John, Solid state Physics, Tata Mchraw Hill.

8. P.M.Chaikin, T.C. Lubensky, Principle of Condensed Matter Physics, Cambridge University Press.
9. Leonard M. Sender, Advanced Condensed Matter Physics, Cambridge University Press.

15PGPHY C14 NUCLEAR AND PARTICLE PHYSICS

UNIT- I Nuclear Structure

Nuclear radius, charge distribution, spin and magnetic moment – Determination of nuclear mass – Binding energy – Semiempirical mass formula – Nuclear stability – Mass parabolas – Nuclear shell model –Liquid drop model – Optical model – Collective model - Nuclear Forces-Exchange forces – Yukawa's meson theory – Yukuwa potential – Ground state of deuteron – Magnetic moment – Tensor forces – Scattering length, Phase shift, scattering amplitude – Low energy n-p scattering – Effective range – Spin dependence and charge independence of nuclear forces

UNIT- II Radioactive Decays

Alpha decay – Gamow's theory – Geiger Nuttal law – Neutrino hypothesis – Fermi's theory of beta decay – Selection rules – Non conservation of parity in beta decay – Gamma decay - Selection rules – Internal conversion – Nuclear isomerism. Detection of Nuclear Radiation Interaction of charged particles and X-rays with matter – Basic principles of particle detectors – Proportional counters and Geiger-Muller counters – BF3 counters – Solid state and semiconductor detectors – Scintillation counters.

UNIT- III Nuclear Fission

Characteristics of fission – Mass and energy distribution of nuclear fragments – Nuclear chain reactions – Four factor formula – Bohr Wheeler's theory of nuclear fission – Fission reactors – Power and Breeder type reactors. Nuclear Fusion- Basic fusion processes – Solar fusion – Cold fusion – Controlled thermonuclear reactions – Pinch effects – Laser fusion techniques.

UNIT- IV Nuclear Reactions

Energetics of reactions – Q-equation – Level widths in nuclear reaction – Nuclear reaction cross sections – Partial wave analysis – Compound nucleus model – Resonance scattering – Breit Wigner one level formula –Direct reactions – Stripping and pick up reactions. Scattering Process The scattering cross section – scattering amplitude – Expression in terms of Green's function – Born approximation and its validity – Screened Coulomb potential – Alpha particle scattering – Rutherford's formula.

UNIT- V Elementary Particles

Four types of interactions and classifications of elementary particles – Isospin – Isospin quantum numbers – Strangeness and hyper charge – Hadrons – Baryons – Leptons – Invariance principles and symmetries – Invariance under charge-parity(CP), time(T) and CPT – CP violation in neutral K-meson decay – Quark model – SU(3) symmetry – Gell-Mann Nishijma formula – Gauge theory of weak and strong interactions – Charm, bottom and top quarks.

Books for Study and References:

1. R.R.Roy and B.P.Nigam, Nuclear Physics, Wiley Eastern Ltd.
2. B.L.Cohen, Concepts of Nuclear Physics, Tata McGraw Hill.
3. H.A.Enge, Introduction to Nuclear Physics, Addision Wesley.
4. H.Semat, Introduction to Atomic and Nuclear Physics, Chapman and Hall.
5. D.Griffiths, Introduction to Elementary particles, Wiley International Edition.
6. W.S.C.Williams, Nuclear and Particle Physics, Clarendon Press.
7. K.S.Krane, Introductory Nuclear Physics, John Wiley.
8. K.S.Krane, Modern Physics, John Wiley and Sons, Inc.

15PGPHY C15 NUMERICAL METHODS AND PROGRAMMING

UNIT-I FORTRAN Statements

Operating systems-Programming languages- Fortran constants and variables- assignment and arithmetic expressions- Logical expressions and control statements- DO loop, array, input and output statements (I/O and O/P)- Stop, END and DATA statements- function subprogram-subroutine.

UNIT-II FORTRAN Programming

Evolution of Fortran language- Different Fortran compilers- Free source format and character set- Format directed I/O- numerical integration- numerical differentiation- roots of an equation- Procedure arguments- Optional arguments- Keyword arguments- Recursive procedures- Modules- Array processing- Terminology and Specifications- Whole array operations- Vector subscripts- Array assignment- Array constructor- Allocatable dynamic array- Pointers and Dynamic Data Structures- Concept of pointers- Example programs.

UNIT-III Numerical Methods for Solving Arithmetic Equations

Multiplication of matrices- Newton-Raphson- Successive approximation method- Solution of linear simultaneous algebraic equations- Solution of quadratic equations- Example programs.

UNIT-IV Numerical Differentiation and Integration

Numerical integration by Trapezoidal and Simpson's rules, algorithms- Numerical solution of differential equations- Euler method - Runge-Kutta third order method- Runge-Kutta fourth order method.

UNIT-V Introduction to C

Introduction- Algorithms- Control structures- if selection statement- if-else statement- do-while repetition statement-GOTO statement- Nested Control statements- Assignment Operators- Increment and decrement operators- break and continue statements- Logical Operators- Arrays- Declaring arrays- Examples using Arrays- Formatting input/output statement.

Books for Study and References:

1. V. Rajaraman, FORTRAN Programming, Prentice-Hall of India.
2. E. Balaguruswamy , Numerical methods, Tata McGraw-Hill Education.
3. V. Rajaraman, Computer Oriented Numerical Methods, PHI Learning Pvt. Ltd.
4. J.B. Scarborough, Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt.
5. P.L. DeVries, A first course in Computational Physics, Wiley.
6. S. Chandra, Computer Applications in Physics, Narosa Publishers.

15PGPHY C16 **ADVANCED PRACTICAL-IV**

(Practical at the end of IV Semester)

Computer Programming (Any twenty)

1. Write a program to find the sum of the series for a given small 'x' correct to four decimal places

$$1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^2}{6!} + \cdots$$

2. Write a program to read the value of 'x' and print 'y' as given

$$y = \frac{(x+1)}{(x-1)} \quad \text{if } x > 1$$

$$= 2 \qquad \text{if } x = 1$$

$$= \frac{(x+1)}{(x-1)} \quad \text{if } x < 1$$

3. Write a program to get the value of np_r and nc_r using

$$np_r = (n(n-1)(n-2) \ldots . (n-r+1)$$

$$nc_r = \frac{(n(n-1)(n-2)\ldots.(n-r+1))}{1.2.3\ldots.r}$$

4. Program for finding the maximum and minimum number in a given array
5. Program for finding the numbers which are divisible by n
6. Write a program to read a set of 'n' numbers and find their
    1. Arithmetic mean
    2. Geometric mean and
    3. Harmonic mean
7. Write a program to find Eigen values and Eigen vectors of a matrix
8. Write a program for matrix multiplication and division
9. Write a program for matrix inversion and diagonalization
10. Solving simultaneous linear algebraic equation – Gauss elimination method
11. Solving simultaneous linear algebraic equation – Gauss seidel iteration method
12. Interpolation – Lagrange method
13. Numerical integration – Composite Trapezoidal rule
14. Numerical integration – Composite Simpson 1/3 rule
15. Numerical integration – Composite Simpson 3/8 rule
16. Numerical differentiation – Euler method
17. Least square curve fitting – Straight line fit
18. Least square curve fitting – Exponential fit
19. Roots of algebraic equations – Newton-Raphson method
20. Solving ordinary differential equations using Runge-Kutta 3rd and 4th order methods
21. Evaluation of definite integrals – Monte Carlo method
22. Uniform random number generation – Park and Miller method
23. Uniform random number generation – Box and Muller method
24. Numerical simulation of wave functions of simple harmonic oscillator

25. Computer simulation of Kroning-Penney model
26. Computer simulation of Leneard-Jones potential, binding parameters, elastic constants
27. Computation of wave functions and their interpretation for various potentials
28. Simulation of a wave functions for a particle in a critical box
29. Write a program to solve heat equation – finite difference method
30. Monte Carlo of 2D Ising model on a square lattice

PGPHY C17 **PROJECT WORK**

(Topics to be decided by Student/Supervisor)

15PGPHY E01 **X-RAY CRYSTALLOGRAPHY**

UNIT –I **X-rays**

X-rays sources – conventional generators-construction and geometry-sealed tube–rotating anode generators–choice of radiation-Synchrotron radiation – X-ray optics: filters– monochromators–collimators-mirrors- safety.

Diffraction of X-rays

Lattice–Lattice planes-Miller indices–X-ray diffraction reciprocal lattice–relation between direct and reciprocal space–Bragg's law in reciprocal lattice–sphere of reflection – limiting sphere.

Symmetry of crystals

Crystal systems and symmetry – unit cell – space lattices- nonprimitive lattices – point groups–space groups–screw axes–glide planes-equivalent positions–matrix representation of symmetry-intensity weighted reciprocal lattice – analysis of space group symbols.

Crystals and their properties

Crystallization – growing crystals – choosing a crystal –mosaic structure-absorption- crystal mounting–alignment – measurement of crystal properties.

UNIT-II **Data collection techniques for single crystals**

Laue method–single crystal diffraction cameras: rotation and oscillation method – Ewald construction – Weissenberg method – Precession method. Single crystal diffractometers and data collection strategy: Instrument geometry–crystal in a diffracting position–determination of unit cell–orientation matrix–Intensity Data collection–Unique data–equivalent reflections – selection of data–Intensity measurement methods: Film methods–counter methods: Point detector–Area detectors–CCD's–Image plates–Low temperature single crystal diffractometry.

UNIT-III **Data Reduction**

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

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 effect– Calculation of structure factors and Fourier syntheses.

UNIT-IV **Phase Problem**

Methods of solving Phase Problem: Direct methods – Patterson methods – Heavy atom methods – molecular replacement- search methods – completing the structure.

UNIT-V **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.

Errors and Derived results

Random and systematic errors–derived results – molecular geometry – absolute configuration–thermal motion.

Books for Study and References:

1. Stout and Jensen, X-ray Structure Determination (2nd Edition), John Wiley Publications.
2. C. Giacovazzo, Fundamentals of Crystallography (2nd Edition), Oxford Press.
3. Ladd and Palmer, Structure Determination by X-ray Crystallography (2nd Edition), Plenum Publishing Corporation.
4. Woolfson, X-ray Crystallography, Cambridge University Press Publications.
5. Leonid V. Azaroff, Elements of X-ray Crystallography, McGraw; Hill Publications.
6. Glusker, Lewis and Rossi, Crystal Structure analysis for Chemist and Biologist VCH Publishers Inc.
7. Sherwood, Crystal, X-ray and Proteins, Longman group Ltd.
8. Phillips, An Introduction to crystallography, John Wiley Publications.
9. International table for Crystallography.

15PGPHY E02 **ENERGY PHYSICS**

UNIT- I

Introduction to energy source - Energy sources and their availability - Types of energy - Prospects of renewable energy - Extraterrestrial solar radiation - Effect of earth's atmosphere - Measurement and estimation of solar radiation.

UNIT- II

Renewable energy: Wind energy – basic principle and components of wind energy conversion system - types of wind machines – scheme of electric generation – application of wind energy – Hydrogen energy – hydrogen production – storage – utilization of hydrogen gas – hydrogen as an alternative fuel for motor vehicles – safety and management.

UNIT - III

Energy from Biomass: Biomass conversion Technologies – wet and dry process – Photosynthesis. Biogas Generation: Introduction – basic process and energetic – methods for maintaining biogas production – advantage of anaerobic digestion – factors affecting bio digestion and generation of gas. Classification of Biogas plants: continuous and batch type – the dome and drum types of Biogas gas plants – biogas from wastes fuel – properties of biogas – utilization of biogas.

UNIT – IV

Solar energy: 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. Applications of Solar Energy: solar distillation-solar water heating-solar pumping - solar furnace-solar cooking-solar green house.

UNIT – V

Additional alternate energy sources: introduction and principles of Magneto hydro dynamic(MHD) – open and closed cycle systems – materials for MHD generators –MHD design problems and developments – electrical conditions – advantages of MHD systems.

Books for Study and References:

1. John Twidell & Tony Weir, Renewable Energy Resources, Taylor & Francis Group.
2. Kreith and Kreider, Principles of Solar Engineering, McGrew Hill Pub.,
3. A.B.Meinel and A.P.Meinal, Applied Solar Energy.
4. M.P.Agarwal, Solar Energy, S.Chand & Co.
5. S.P.Sukhatme, Solar Energy, TMH.
6. G.D.Rai,Non-conventional Energy sources, Khauna Publications.

15PGPHY E03 **NONLINEAR DYNAMICS-I**

UNIT- I

Introduction to nonlinear dynamical systems- The notion of nonlinearity- superposition principle and its validity- linear and nonlinear oscillators- autonomous and nonautonomous systems- equilibrium points- phase space- classification of equilibrium points- stability of fixed points.

UNIT - II

Chaos- simple bifurcations-saddle node, pitchfork, transcritical bifurcation- the logistic map- period doubling phenomenon- onset of chaos- other routes to chaos- quasi periodic route to chaos- intermittency route to chaos- bifurcation scenario in Duffing oscillator- chaos in conservative systems.

UNIT - III

Solitons- Nonlinear dispersive systems- cnoidal and solitary waves- Scott Russel phenomenon and KdV equation- Fermi-Pasta-Ulam lattice problem- FPU recurrence phenomenon- asymptotic analysis- numerical experiment of Zabusky and Kruskal- birth of soliton.

UNIT - IV

Integrability and methods to soliton equations- The notion of integrability- Painleve analysis and its application to KdV equation, nonlinear Schrödinger equation- Lax pair for KdV equations- Inverse Scattering Method and its application to KdV equation- Hirota's bilinearization method- examples: KdV and nonlinear Schrödinger equation.

UNIT - V

Applications- Chaos and secure communications- role of soliton in condensed matter systems- nonlinear optics and biological systems.

Books for Study and References:

1. M. Lakshmanan and S. Rajasekar, Nonlinear Dynamics, Integrability, Chaos and Patterns, Springer-Verlag.
2. P.G. Drazin, Nonlinear systems, Cambridge University Press, Cambridge.
3. P.G. Drazin and R.S. Johnson, Solitons: An introduction Cambridge University Press, Cambridge.
4. M.J. Ablowitz and P.A. Clarkson, Solitons, Nonlinear Evolution Equations and Inverse Scattering, Cambridge University Press, Cambridge.
5. R. Dodd, J. Eilbeck, J. Gibbson and H. Morris, Solitons and Nonlinear Wave Equations, Academic.

15PGPHY E04 CRYSTAL GROWTH AND CHARACTERIZATION

UNIT- I Basis of Crystal 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 – Adsorption at Growth surface – Statistical theory of nucleation – Free energy of formation of nucleus considering translation, vibration and rotation energies. Nucleation concept: Homogeneous and heterogeneous nucleation.

UNIT- II Solution Growth

Solution - Choice of solvents - Preparation of solution – Solubility and super solubility - Saturation and Super Saturation – Measurement and expression of super saturation - Meir's Solubility diagram - Constant temperature bath and crystallizer – Seed preparation and mounting Low temperature solution growth - Slow cooling and solvent evaporation methods – Temperature gradient method - Gel growth – various types – Structure of gel – Importance of gel technique – single and double diffusion method – Advantages of gel method – High temperature solution growth – Hydrothermal growth.

UNIT- III Growth from Melt and flux

Fundamentals of melt growth – Phase diagram and phase rules – Bridgman method – various crucial design – Vertical Bridgman technique – Experimental arrangement - Czochralski technique – Experimental arrangement – Growth process – Growth rate – Liquid Encapsulated Czochralski technique - Verneuil method – Kyropolous Method – Zone melting method. Flux growth – Choice of flux – Growth kinetics – Growth techniques – Slow cooling method – Solvent evaporation technique – Temperature gradient method – High pressure method – Accelerated crucible rotation technique – Top seeded solution growth.

UNIT- IV Vapour Growth and Epitaxy

Basic principle – Methods – Physical vapour deposition – Evaporation and sublimation process – sputtering – Chemical vapour deposition – Advantages and disadvantages – Physical vapour transport – Chemical vapour transport – reaction types – Transported materials and transporting agents –Epitaxy – Vapour phase epitaxy (VPE) – Liquid phase epitaxy (LPE) – Molecular beam epitaxy (MPE) – Vapour Phase Epitaxy (MOVPE) – Chemica Beam Epitaxy (CPE).

UNIT- V Characterization Methods

X-ray powder diffraction method-Single crystal method-Debye scherrer method – Electron microscopy techniques-SEM, EDAX and TEM – Optical methods-UV-Vis spectroscopy studies-Band gap calculation-Fluorescence and Photoluminescence studies-Z scan technique – Thermal studies-TGA, DTA and DSC – Vicker hardness - Vibrational studies-Infrared spectroscopy

spectrophotometers-Fourier Transforms Interferometer-Sample handling – Raman spectroscopy-theory-Resonance spectroscopy – Comparision of Raman with Infrared spectroscopy. Electrical properties-DC conduction mechanism-Low field and high field conduction-AC conduction mechanism-Temperature dependence of conductivity.

Books for Study and References:

1. K.Sangawal, Elementary Crystal Growth – Sahan Publisher.
2. M.M.Flaktor, I.Garret, Growth of Crystals from Vapor, Chapmann and Hall.
3. P.Santhana Ragavan, P.Ramasamy, Crystal Growth And Processes, KRU Publications.
4. P.Ramasamy, ISTE Summer school Lecture Notes, Crysatl Growth Centre, Anna University, Chennai.
5. J.C.Brice, Crysatl Growth Process, John Wiley Publications.
6. A.A.Chernov, Modern crystallography:III,-Crysatal Growth in Solid State, Springer Series.
7. B.R.Pamplin, Progress in Crystal Growth Characterization, Pergamon Press Ltd.
8. X.F.Zong, Y.Y.Wang, J.Chen, Material and Process characterization for VLSI, World Scientific.
9. M. William and D. Steve, Instrumental Methods of Analysis (CBS Publishers.
10. H. H. Williard, L. L. Merritt, J. Dean, and F. A. Settle, Instrumental Methods of Analysis – Sixth Edition, CBS Publishers & Distributors.

15PGPHY E05 THIN FILM GROWTH AND TECHNOLOGY

UNIT- I Basics of Thin Films

Steps in thin film growth process- sticking coefficients, surface bombardment rate; Thin film growth models- adsorption, thermal accommodation, Van der Waals forces, lifetime of adsorbed species, surface diffusion, chemisorption; Film growth modes- capillary theory of nucleation and growth, coalescence processes; Thermodynamics and Kinetics of thin film formation – Film growth – five stages – Nucleation theories – Incorporation of defects and impurities in films – Deposition parameters and grain size – structure of thin films.

UNIT- II Properties of Thin Films

Mechanical properties of thin films: Elastic and plastic behavior of thin films. Theories of size effect, Optical properties of thin film: optical constants, reflectance, transmittance and absorbance. Magnetism in thin metal films, ferromagnetic and antiferromagnetic properties of thin films, surfaces and interfaces of ferromagnetic metals, spin dependent current, some thin film magnetic devices. Electric properties to films: Conductivity in metal, semiconductor and insulating films. Discontinuous films. Superconducting films. Dielectric properties.

UNIT - III Preparation of Thin Films

Physical methods: Vacuum evaporation - Study of thin film vacuum coating unit - Construction and uses of vapour sources-wire, sublimation, crucible and electron bombardment heated sources. Resistance heating method – Electron beam method - Arc and Laser evaporation. Chemical methods: chemical bath deposition – Electrodeposition – Spray pyrolysis deposition. Sputtering - Study of glow discharge - Physical nature of sputtering - Sputtering yield - Experimental set up for DC sputtering, AC sputtering and RF sputtering.

UNIT – IV Thickness measurement

Electrical methods – optical interference methods – multiple beam interferometry – Fizeau – FECO methods – Quartz crystal thickness monitor.

Characterization Techniques

X-ray diffraction, electron microscopy, high and low energy electron diffraction, Auger emission spectroscopy. Photoluminescence(PL) – Raman Spectroscopy, UV-Vis-IR Spectrophotometer – AFM – Hall effect – SIMS – X-ray Photoemission Spectroscopy (XPS) - Dynamic light scattering – ellipsometry method.

UNIT-V Applications

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 - quantum dot - Applications of ferromagnetic and super conducting films: Data storage, Giant Magnetoresistance (GMR).

Books for Study and References:

1. L I Maissel and R Clang, Hand book of thin films Technology, McGraw-Hill.
2. George Hass, Physics of thin films, vol. 12, Academic Press.
   K. L. Chopra, Thin Film Phenomena, McGraw - Hill.
3. J. L. Vossen and W. Kern, Thin Film processes, Academic Press.
4. T. J. Coutts, Active and Passive Thin Film Devices, Academic Press.
5. M. Grasserbauer and H. W. Werner, Analysis of Microelectronic Materials and devices, John Wiley and Sons.
6. M. Ohring, The Materials Science of Thin Films, Academic Press.
7. A Wagendristel and Y. Wang, An introduction to Physics and Technology of Thin Films,World Scientific.
8. K.L. Chopra, Thin Film Phenomena, McGraw-Hill.
9. K.L. Chopra and and I.J. Kaur, Thin Film Solar Cells, Plenum Press.
10. J.C. Anderson, The Use of Thin Films in Physical Investigation, Academic Press.
11. R.W. Berry, P.M. Hall and M.T. Harris, Thin Film Technology, Vn Nostrand.
12. Ludminla Eckertova, Physics of Thin Films, Plenum press.
13. A. Goswami, Thin Film Fundamentals, New Age internatiol (P) Ltd. Publishers.

15PGPHY E06 NANOSCIENCE

UNIT- I Introduction to the Nanoworld

Definition – Historical perspective - Classification of Nanomaterials – Bulk to nano significant effect – Surface to volume ratio – Quantum confinement – Qualitative and quantitative description – Density of states (DOS) in reduced dimension– Properties of nanomaterials - preparation of quantum nanostructures (lithography) – size and dimensionality effects – single electron tunneling.

UNIT - II Metals, Semiconductors and Ceramics Nanocrystals

Reduction of size – Synthesis of metal nanoparticles and structures – Routes to arrangements – Background on Quantum Dot semiconductors - background on reverse Micellar solution – Synthesis of Semiconductors – Cadmium Telluride Nanocrystals – Cadmium sulfide Nanocrystals – Alloy Semiconductors – 2D and 3D Superlattices of Silver Sulfide Nanocrystals – Synthesis of Ceramics – Bondings and defects - Chemical, Physical and Mechanical properties of Ceramics.

UNIT - III Nanoparticles and Magnetism

Magnetism in particles of reduced size and dimensions – variations of magnetic moment with size – magnetism in clusters of non magnetic solids – magnetic behavior of small particles – diluted magnetic semiconductors (DMS) – Fe – DMS and II-VI Mn DMS and their applications – intermetallic compounds – binary and ternaries and their magnetic properties. Importance of nanoscale magnetism.

UNIT –IV Chemical and Catalytic Aspects of Nanocrystals

Nanomaterials in Catalysis – Nanostructured Adsorbents – Nanoparticles as new Chemical reagents – Nanocrystal Superlattices.

Specific Heat and Melting Points of Nanocrystalline Materials

Specific Heat of Nanocrystalline materials – melting points of Nanoparticle materials.

UNIT - V Application of Nanomaterials

Molecular Electronics and nano electronics, nanoboats, Biological applications, band gap engineered quantum devices – nanomechanics – carbon nanotube emitters, photoelectrochemical cells – photonic crystal and Plasmon wave guides - Structural and Mechanical materials – Colorants and Pigments.

Books for Study and References:

1. Rita John, Solid State Physics, Mcgraw Hill Education (India) Private Limited, New Delhi, 2014.
2. Kenneth J.Klabunde, Nanoscale materials in Chemistry, A John Wiley & Sons, Inc.,Publication, 2001.
3. Charles P.Poole, Frank J. Owens, Introduction to nanotechnology, Wiley – India 2009.
4. Guozhong Gao, Nanostructures and nanomaterials synthesis, properties and applications, Imperial College Press, London 2004.

5. J.de Jongh, Physics and Chemistry of Metal Cluster Compounds, Kluwer Academic Publishers, Dordrecht, 1994.
6. V. Henrich, P.A.Cox, Metal Oxides, Cambridge University Press, New York, 1994.
7. Ed. George C. Hadjipanyis and Gary A.Prinz, NATO ASI Series, Science and Technology of Nanostructured Magnetic Materials, Plenum Press, New York, 1991.
8. D. Jiles, Introduction to Magnetism and Magnetic Materials, Chapman and Hall, London, 1991.

15PGPHY E07 BIOMEDICAL INSTRUMENTATION

UNIT -1

Cells and their structure – transport of ions through the cell membrane – Resting and action potentials – Bioelectric potential – electrodes – Hall cell potential – various types of electrodes.

UNIT –II

Fifty Hertz interference – magnetic and electric components – lead as a path of least resistance – basic line shift. Pen recorders – Thermal recorders – Recording transients digital readent.

UNIT –III

Characteristics of recording systems – Electrocardiography – Electroence – Phalography – Electromyography – Electroretino graphy - Electroculography – Principles of CAT scanning – MRI and digital radiography (qualitative).

UNIT –IV

Blood pressure measurement – Sphygmomanometer – electronic blood pressure unit – Blood flowmeter – Pacemakers – Defibrillators – stimulators – Heart lung machine – Diathermy – shortwave, microwave and ultrasonic Diathermy.

UNIT –V

Elements of advanced biomedical instrumentation – Ultrasonic imaging systems – Lasers in medicine – Optical fibers and endoscopy – computers in medicine – biotelemetry (basic principle only).

X-ray radiography – biological effects of radiation exposure and safety dose equivalent limits.

Books for Study and References:

1. M.Arumugam, Biomedical Instrumentation, Anuradha Publications.
2. L.Gromwell, Biomedical Instrumentation and measurements, Prentice Hall.
3. B.C Nakra and K.K Choudhry, Instrumental Analysis and Techniques, TMH Publications.
4. John R. Cameran and James G. Skofronick, Medical Physics, John Wiley & Sons.
5. E.L Aplen, Radiation Physics,Prentice Hall.

15PGPHY E08 **MOLECULAR BIOPHYSICS**

UNIT-I

Chemical Binding: Quantum mechanics-Pauli exclusion Principle – Ionisation energy – electron affinity – chemical binding – electro negativity – strong bonds – secondary bonds.

Energies, Forces and Bonds: Interatomic potentials for strong bonds – weak bonds – non-central forces – bond energies – spring constants.

Rates of reaction: Free energy – Internal energy – thermodynamics – statistical mechanics – reaction kinetics – water, acids, bases and aqueous reactions – radiation energy.

Separation Techniques: Chromatography- methods- HPLC -thin layer , paper, absorption, partition, gas liquid, ion exchange and affinity – electrophoresis.

Transport processes: Diffusion – viscosity- thermal conduction.

Techniques and methods: X-ray crystallography, Spectroscopy–Electron microscopy- NMR spectroscopy-Molecular modeling.

UNIT –II

Cell: Its organells and molecules: Prokarytes and Eukaryotes molecular components of cell carbohydrates-lipids-proteins-nucleic acids-Hetromacromolecules.

Macromolecular structure: Proteins: Amino acid and primary structure – peptide bond and secondary structure- α-helix and β-plated sheet - tertiary and quaternary structure of proteins-protein folding-Virus structure- Nucleic acid: chemical structure-conformation –monomers and polymers – Double helical structure of DNA- Polymorphism –RNA.- Polysaccharides: Starch-cellulose.

UNIT –III

Physics of Biomolecules: Molecular forces-weak and strong intermolecular forces- molecular mechanism of Genetic information transfer-Genetic code – transfer of Genetic information – molecular mechanism of Protein synthesis - Principle of molecular recognition.

Physics of Biological Membranes: Cell membrane –Structure of membranes-transport through membrane – Passive transport – diffusion – active transport-molecular reception.

UNIT –IV

Bioenergetics: Energy consumption - cellular respiration-photosynthesis –photosystem I & II ATP synthesis.

Movement of Organisms: Bacterial motion – chemical memory in primitive organisms – muscular moment – Human performance.

Excitable membranes: diffusion and mobility of Ion Resting potential .

Nerve signals: Passive response – Nerve impulses (Auction Potentials) –the nervous system.

UNIT –V

Memory: Hebbian learing – Neural network – Auto-association.

Control of movement: The Primacy of movement – Ballistic control in a simplified visual system – more sophistical modes of control – the Heterogeneous structures of muscle fibers – central pattern generators – conditional reflexes – volition and tree will – what purpose does consciousness serve – passive verses active in mental processing – the relevant anatomy and physiology – intelligence and creativity.

Books for Study and References:

1. Rodney M.J.Cotterill, Biophysics An Introduction, John Wiley Publication.
2. Vasantha Pattabhi and N.Gautham, Biophysics, Narosa Publishing House.
3. Roland Glacer, Biophysics, Pringer Publications.
4. P. K. Srivastava, Elementary Biophysics An Introduction, Narosa Publishing House.
5. M. V. Volkenshtein, Biophysics, Mir Publications.

15PGPHY E09 **PHOTOVOLTAIC SCIENCE**

UNIT- I **Introduction to Photovoltaics**

Introduction - History of photovoltaics - Silicon P-N junction – Types and adaptations of photovoltaics - Photovoltaic circuit properties - Applications. Solar Cell Fundamentals: solar cell boundary condition - generation rate - solution of the minority carrier diffusion-terminal characteristics – solar cell I-V characteristics –properties of efficient solar cell – life time and surface recombination effects.

UNIT –II **The Physics of Solar cells**

Introduction - Fundamental Properties of Semiconductors: crystal structure - energy band structure - conduction and valence band density of states - equilibrium carrier concentrations - light absorption - recombination carrier transport semiconductor equations - minority carrier diffusion equation - PN-Junction Diode Electrostatics.

UNIT –III **Amorphous Silicon Solar cell**

Amorphous silicon: The first bipolar amorphous semiconductor- designs for amorphous silicon solar cells - Staebler-Wronski Effect - Atomic and Electronic Structure of Hydrogenated Amorphous silicon: Atomic structure - defects and metastability - electronic density of states - bandtails, bandedges, and band gaps-defects and gap states-doping - alloying and optical properties - Depositing Amorphous Silicon: Deposition Techiniques - RF glow discharge deposition - Glow discharge deposition at different frequencies - Hot wire chemical vapor deposition.

UNIT –IV **Cadmium Telluride Solar Cells**

Introduction - CdTe Properties and Thin-film Fabrication Methods - Condensation/Reaction of Cd and Te_2 Vapors on a Surface- Galvanic Reduction of Cd and Te Ions at a Surface-Precursor Reaction at a Surface-Window Layers - CdTe Absorber Layer and $CdCl_2$ Treatment - CdS/CdTe Intermixing - Back Contact - Solar Cell Characterization - CdTe modules.

UNIT –V **Dye sensitized Solar cells**

Introduction to Dye-Sensitized Solar Cells - Structure and Materials - Mechanism and charge transfer kinetics – Characteristics - DSSC Fabrication - preparation of TiO_2 Colloid - Preparation of TiO2 electrode - Redox Electrolyte - Counter electrode - Assembling the cell and cell performance.

Books for Study and References:

1. Antonio Luque, Steven Hegedus, Hand book of Photovoltaic Science and Engineering.
2. John Twidell, Tony Weir,Renewable Energy Resources.
3. C. J. Brabec, J.Parisi,V.Dyakonov, N.S. Sariciftci, Organic Photovoltaics .
4. A.P.Agarwal, Solar Energy, S.Chand & Co.

15PGPHY E10 NONLINEAR DYNAMICS-II

UNIT- I General methods to solve nonlinear equations

Algebraic methods- traveling wave solution- tangent hyperbolic- Jacobi elliptic function- sine-cosine function- space curve mapping- stereographic method- classical spin Poisson bracket- Inverse Scattering Method- Hirota bilinearization-reductive perturbation method.

Applications of Nonlinear dynamics

UNIT-II Spin wave excitations in magnetic materials

Magnetism- ferro/antiferro magnetism- nonlinear magnetization dynamics-nonlinear spin wave excitation- soliton based magnetization reversal, logic gates- electromagnetic wave modulation and electromagnetic soliton- spin ladder.

UNIT –III Modulational instability in magnetic system

Modulational instability-intrinsic localized mode (ILM) - discrete breather (DB) - Fourier method- localized excitation- molecular dynamical simulation.

UNIT- IV Liquid crystal

Introduction to liquid crystal- symmetry and classification of liquid crystal- macroscopic and microscopic order parameters- Frank elastic theory of nematic phases- electric field induced soliton in nematic phase, ferroelectric and dielectric contributions-flexoelectric-dielectric-magnetic effects-soliton switching-modulational instabilities.

UNIT- V Biological system

Nonlinear DNA and protein dynamics-Solitons in microtubule and hydrogen bonded systems-modulational instability.

Books for Study and References:

1. B.A. Rosenfeld and N.D. Sergeeva, Stereographic Projection, Mir Publishers.
2. P.G. de Gennes, The physics of Liquid Crystals, Clarendon Press, Oxford.
3. Lui Lam and Jacques Prost, Solitons in liquid crystals, Springer-Verlag.
4. R. Lai and A.J. Sievers, Nonlinear Nanoscale Localization of Magnetic Excitations in Atomic Lattices, Physics Reports, 314 (1999) 147.
5. M. Lakshmanan and S. Rajasekar, Nonlinear Dynamics, Integrability, Chaos and Patterns, Springer.
6. Tao Pang, An Introduction to Computational Physics, Cambridge University Press.
7. Jianke Yang, Nonlinear Waves in Integrable and Nonintegrable, SIAM.
8. E. Racker, A New Look at Mechanism in Bioenergetics, Academic Press.
9. Ludmila V. Yakushevich, Nonlinear Physics of DNA, Wiley-VCH-Verlag.

15PGPHY E11 INSTRUMENTAL METHODS OF ANALYSES

UNIT-I Errors and Analysis of Experimental Data

Types of errors – Mean, variance and standard deviation, standard deviation of standard deviation – sampling techniques – Chi square test.

Experimental Stress Analysis: Stress analysis by strain gauging- high temperature strain gauge techniques – photoelasticity and holography.

UNIT-II Thermal Analysis

Introduction – thermo gravimetric analysis – instrumentation of weight loss and decomposition products – differential scanning calorimetric – instrumentation – specific heat capacity measurements – determination of thermo chemical parameters – differential thermal analysis – basic principles – melting point determination and analysis.

UNIT-III X-ray Analysis

Single Crystal and powder diffraction – Diffractometer – interpretation of diffraction patterns – indexing – unknown and phase identification – double and four crystal Diffractometer for epitaxial characterization – lattice mismatch – tetragonal distortion – thin film characterization – X-ray fluorescence spectroscopy – uses.

UNIT- IV Optical Methods and Electron Microscopy

Photoluminescence – light-matter interaction – fundamental transitions – excitons – instrumentation – electroluminescence – instrumentation – photo reflectance-electronic transitions – behavior of electronic transitions as a function of electric field. Principles of SEM, TEM, EDAX, AFM, EPMA – Instrumentation – sample preparation – analysis of materials – study of dislocations – ion implantation – uses – Nanolithogrphy.

UNIT-V Electrical Methods

Hall Effect – carrier density – resistivity – two probe and four probe methods – scattering mechanism – van der pauw method – CV characteristics – Schottky barrier capacitance – impurity concentration – electrochemical CV profiling – limitations.

Books for Study and References:

1. Willard.M, Steve.D, Instrumental Methods of Analysis, CBS Publishers, New Delhi, 1986.
2. Stradling, R.A, Electron Microscopy and Microanalysis of Crystalline materials, Applied Science Publishers, London, 1979.
3. Belk.J.A, Electron microscopy and Microanalysis of Crystalline Materials, Applied Science Publishers, London, 1979.
4. Philips V.A, Modern Metallographic Techniques and their Applications, Wiley Interscience, 1971.

15PGPHY S01 LASER PHYSICS AND ITS APPLICATIONS

UNIT – I Basic Physics on the Operation of Lasers

Einstein's theory – Interaction of radiation with matter – Theory of some simple processes.

UNIT – II Laser Characteristics Gaussian beam and its properties

Stable two mirror optical resonators, Longitudinal and Transverse Modes of Laser cavity – Mode selection - gain in a Regenerative Laser cavity – Threshold for 3 and 4 level laser systems – Q Switching Mode locking pulse shortening _ Pico second & femto second operation – Spectral narrowing and stabilization.

UNIT – III Laser Systems

Laser systems involving low density gain media – Nitrogen Laser, Carbondioxide Laser and Eximer laser. Laser systems involving high density gain media – Ruby Laser, Nd-Yag Laser, Semiconductor Laser, Diode Pumped solid state Laser, Dye Laser High power semiconductor diode Laser systems.

UNIT – IV Laser Spectroscopic Techniques and other Applications

Laser fluorescence and Raman scattering and their use in Pollution studies, Non-linear interaction of light with matter, Laser induced multi photon processes and their applications, Ultra high resolution spectroscopy with laser and its applications, Propagation of light in a medium with variable refractive index, Optical Fibres. Light wave communication. Qualitative treatment of medical and Engineering applications of Lasers.

UNIT-V Meteorological Application

Distance and range measurement – Lidar for range findings and tracking – pulsed laser sources – Configuvation of a pulsed range finder – Range finding equation – Energy and power relation – signal detectalsility – Switched lidars , Satellite and Lunar Range finders.

Books for Study and References:

1. Grazio Svelto, Principle of Lasers, Plemum Press.
2. William Silfvast, Laser Fundamentals, Cambridge University Press.
3. B.B.Laud, Lasers and Non-linear Optics, Wiley Eastern Ltd.
4. Lengyel, Lasers, Wiley Inter Science.
5. Ghatak and Thyagarajan, Lasers.

PGPHY SO2 **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 dib- earth's magnetic field – Diurnal, annual and secular variations – magnetosphere.

UNIT – III **EISMOLOGY**

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**

Fundamentals concept of Thermal conductivity – heat flow measurement of 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 -
Mammond and Faller method of absolute gravity measurement – principle and working.

Books for Study and References:

1. J.SEHGAL, Pedology – Concept and applications, Kalyani publishers.
2. George G. Garland, Introduction to geophysics (mantle, core and crust), W.B.Saunder's company.
3. Jacobbs , Russel and Wilson, Physics and Geology, International Students Edition, Tata McGraw Hill.
4. Nagata, Rock Magnetism, McGraw Hill Publications.
5. Debrin, Geology, McGraw Hill Publications.
6. A.J.Aitken, Physics and Geology, Tata McGraw Hill Publications.
7. George Gamove, Biography of the earth (Its past, present and future), Macmillon company Ltd.

PGPHY SO3 ELECTRONICS IN DAILY LIFE

UNIT – I

Electrical and Electronic Symbols Resistors – Capacitors – Resistance wale – Capacitor wale – Electrical quantities – Electrical formulas – Magnetism – Meters – Fuse wire Transistors – Integrated chips.

UNIT – II Electrical appliances

Switch board – Main box – Metal circuit breakers (MCB) – AC – DC currents – Two Phase – Three Phase electrical connections – generators – un intrepid power supply (UPS)- stabilizer – voltage regulators – Electrical devices – Iron box – Fan – Electrical Oven – water Heaters Air conditioners – Refrigerators – washing machines.

UNIT – III Electronic home appliances

Radio – Audio taper veaulem, speaker- televisions – VCR – CD Players – DVD – calculators – Computers – scanner – Printer – Digital Camera – LCD Projectors – Display devices.

UNIT – IV Communications Electronics

Principles of optical fiber Cables (OFC) – Telephone – Mobile phones – wireless phone - Antenna - Internet - Intranet.

UNIT - V Safety Mechanism

Handling Electrical appliances - Power saving methods – Hazards Prevention Methods - Protection of Hi –Fi- electronic devices.

Books for Study and References:

1. S.S. Kamble – Electronics and Mathematics Data book – Allied publishers Ltd.