SAKTHI COLLEGE OF ARTS AND SCIENCE FOR WOMEN, ODDANCHATRAM

(Recognized Under Section 2(f) and 12(B) of UGC Act 1956)

(Affiliated to Mother Teresa Women's University, Kodaikanal)

PG AND RESEARCH DEPARTMENT OF PHYSICS

CURRICULUM FRAMEWORK AND SYLLABUS FOR

OUTCOME BASED EDUCATION IN

SYLLABUS FOR

M.Sc., PHYSICS

FRAMED BY

MOTHER TERESA WOMEN'S UNIVERSITY, KODAIKANAL

UNDER

CHOICE BASED CREDIT SYSTEM

2015 - 2018

M.SC., PHYSICS

(WITH SPECIALIZATION IN MATERIAL SCIENCE AND ASTROPHYSICS)

SYLLABUS & COMMON STRUCTURE

S.No	Subject Code	Subject	Type Of Paper	Total Credits	Hrs/ Week	Formative	Summative	Total
1	PHY011C	Mathematical Physics I	C	5	5	40	60	100
2	PHY012C	Classical Mechanics	C	5	5	40	60	100
3	PHY013C	Applied Electronics	C	5	5	40	60	100
4	PHY014C	Practical I	C	5	8	40	60	100
5	PHY015E	Astrophysics	E	5	5	40	60	100
		TOTAL		**25**	**28**			
6	PHY021C	Mathematical Physics II	*C*	*5*	*5*	40	60	100
7	PHY022C	Quantum Mechanics I	C	5	5	25	75	100
8	PHY023C	Statistical Mechanics and Thermodynamics	C	5	5	25	75	100
9	PHY024C	Practical II	C	5	8	40	60	100
10	PHY025E	Materials Characterization	E	5	5	40	60	100
		TOTAL		**25**	**28**			
11	PHY031C	Electromagnetic Theory and Plasma Physics	C	5	5	40	60	100
12	PHY032C	Quantum Mechanics II	C	5	5	40	60	100

13	PHY033C	Solid State Physics	C	5	5	40	60	100
14	PHY034C	Practical III	C	5	8	40	60	100
15	PHY035E	Materials Science	E	5	5	40	60	100
		TOTAL		**25**	**28**			
16	PHY041C	Spectroscopy	C	5	5	40	60	100
17	PHY042C	Nuclear and Particle Physics	C	5	5	40	60	100
18	PHY043C	Project & viva-voce	C	5	14	60 (Project)	40 Viva-voce	100
		TOTAL		**15**	**24**			**1800**
Grand Total				**90**				

PHY011C MATHEMATICAL PHYSICS I

Unit I:

Fourier Transform Theory: Fourier's Integral Theorem- Fourier Transform of a time dependent function-Some important theorems-The Parseval's theorem-The Linearity theorem-Fourier transform of the derivative and the double derivative-The shifting of origin-The convolution theorem-The Sampling theorem-The use of Fourier Transforms in solving Differential equations-The sine and cosine transforms-Spatial frequency filtering.

Laplace Transform: Introduction-Examples of Laplace transform-Inverse Laplace transform-Laplace transform rules- convolution-Solution of a system of Linear Differential equations with constant coefficients-Evaluation of integrals.

Unit II:

Infinite series: Fundamental concepts, convergence tests-Alternating series, algebra of series, series of functions, Taylor's expansion and power series.

Unit III:

Partial differential equations: Introduction-Definitions-Method of separation of variables-General solution of the one dimensional wave equation-Transformation and classification of PDEs-Characteristic coordinates-Determination of characteristic coordinates-Canonical forms-Hyperbolic form: B^2-4AC>0-Parabolic form: B^2-4AC>0-Elliptic form: B^2-4AC>0

Unit IV:

Differential Equations I: Introduction-Classification of differential equations-general solution-Linear differential equations of the first order- Linear differential equations with constant coefficients- Equations reducible to the form with constant coefficients.

Differential Equations II: Limitations and procedure-The solution by using the power series expansion-Apparent singularity-Solution in descending powers-Summary of the Frobenius method.

Unit V:

Legendre functions: Introduction-The polynomial solution of the Legendre's equation-The generating function-An important identity-Rodrigue's formula-Orthogonality.

Bessel Functions: Introduction-Series solution and Bessel function of the first kind-Recurrence relations-The generating function-Deviation of the Recurrence relations from the generating function-$J_n(x)$ as an integral-Bessel functions as a complete set of Orthonormal functions.

Book for study:

1. A.K. Ghatak, I.C. Goyal and S.J. Chua, Mathematical Physics, Macmillan India Ltd.

Books for Reference:

1. Mathematical Physics, E. Butkov, (Addison- Weley)
2. Mathematical Physics for Engineers and Physicists, L.A. Pipes & L.R. Harvil III edn.
3. Advanced Engineering Mathematics, E. Kreyszig, V edn (New Age Publishers, New Delhi 1996)

PHY 012C CLASSICAL MECHANICS

Unit: 1 Constrained motion in cartesian coordinates

Constraints and their classification, Examples of constraints, Principle of virtual work, D'Alembert's principle and Lagrange's equation.

Unit 2: Lagrangian formulation in generalised coordinates

Change of notation, Degrees of freedom, Generalised co-ordinates, Lagrange's equation of motion of the second kind, Theorem of total energy, Linear generalised potentials, Generalised momenta and Energy, Lagrangian for free particle motion.

Unit 3: Rotating frames of references and central force

Internal forces in the rotating frame, Effects of Coriolis force, Definition and properties of the central force, Two-Body central force Problem, Kepler's problem in velocity space and Virial theorm.

Unit 4: Hamilton's equation of motion and canonical transformations

Legendre's dual transformation, Hamilton's function and Hamilton's equation of motion, Hamilton's principle and characteristic function, Properties of canonical Transformations.

Unit 5: Poisson brackets and Hamilton-Jacobi theory

Definition,some useful identities, Jacobi-poisson theorem, solution to the time dependent Hamilton-jacobi equations and jacobi's theorem and its application to the harmonic oscillator problem.

Books for Study:

1. Classical Mechnaics by N.C. Rana & P.S Joag
2. H.Goldstein, Classical Mechanics, II Edition

Books for reference:

1. L.D. Landau and E.M.Lifshitz, Mechanics
2. T.W.B.Kibble, Classical Mechanics
3. N.C.Rana and P.S. Joag, Classical Mechanics
4. K.R.Symon, Mechanics
5. J.L.Synge and B.A.Griffith, Principles of Classical Mechanics

PHY013C APPLIED ELECTRONICS

Unit I:

Differential DC amplifier – Peak detector, Zero crossing detector – Stable AC Coupled amplifier – Analogue integration and differentiation – Solution to simultaneous and differential equations using Op Amps- Active Filters – Comparator- Sample and hold circuit – Logarithmic amplifiers – Wave form generators – Regenerative comparator – Rectifier circuits – Phase shifting circuit - 555- timer IC and its applications

(12 hrs)

Unit II:

Counters and registers: Synchronous counters – Designs of Counters of different modulus – Shift Registers and their applications

Semiconductors Memories: ROM, EPROM, EEPROM – Static and Dynamic Ram

(9 hrs)

Unit III: D/A and A/D Converters

Binary weighed resistor D/A converter - R-2R ladder D/A converter – Flash counter type, Successive approximation and dual slope A/D converters – Resolution and accuracy

(9hrs)

Unit IV: Digital Integrated Circuits

Introduction – Bipolar transistor characteristics – RTL and DTL circuits – Integrated injection –logic- transistor- transistor logic – emitter – Coupled logic – Metal Oxide Semiconductor – Complementary MOS (CMOS)

(9hrs)

Unit V:

Schottky Diode - Tunnel Diode – Gunn diode –Impact diodes- Photo diode- Solar cell-Laser diode-Phototransistor

(9 Hrs)

Books for Study:

1. Millman and Halkias, Integrated Electronics (Tata McGraw-Hill Publishing company Ltd)
2. V. Vijayendran, Introduction to Integrated Electronics (Viswanathan Printers, 2007)

Books for reference:

1. R.F. Coughlin and F.F. Driscol, Opamp and linear integrated circuits

2. A.Ghatak and K.Thyagarajan, Optical electronics(Cambridge Press)
3. M.S.Tyagi, Introduction to Semiconductor Devices (Wiley, NY)
4. M.Sayer and A.Mansingh, Measurement, Instrumentation and Experimental Design in Physics and Enginnering (Prentice- Hall India, New Delhi)
5. S.M.Sze, Semiconductor Devices – Physics and Technology (Wiley, NY)
6. B. Somnath Nair, Digital Electronics and Logic Design (Prentice hall of India, New Delhi)
7. P.Bhattacharya, Semiconductor Optoelectronic Devices, 2nd edition (Printice Hall of India , New Delhi.)
8. A. Kapoor, L.K.Maheshwari, Digital Electronics Principles and Practices (Macmillan India)

PHY014C PRACTICAL – I / C PROGRAMMING

(1) Number Processing

   a. Prime Number or Not
   b. Sum of Digits

(2) Manipulate the following process in Matrix

   a. Matrix Multiplication
   b. Matrix Subtraction
   c. Matrix Multiplication

(3) Write a programme for binary numbers

(4) Prepare the student mark list using structure in C

(5) Write a program to prepare the pay slip using files in C

'C++' PROGRAMMING

1. Number Processing
   a. Factorial Number
   b. Fibonacci Series
2. Sting Processes
   a. Concatenation
   b. Palindrome Checking
3. Write a program for Bubble sort using Object, Class and Member function in Arrays
4. Pay Slip Generation using constructor
5. Mark list preparation using Inheritance

PHY015E / ASTROPHYSICS

Unit I: Radio Astronomy

Radio window, Rayleigh Jeans law optical Thickness, Brightness temperature, Radio telescopes, resolution , sensitivity, noise temperature, synthesis of telescopes, interferometry, radio sources, their spectra, thermal and non thermal mechanism

(9 hrs)

Unit II: Space Astronomy

Transparency of Earth's atmosphere, X-ray Astronomy, X- Ray telescopes, X-ray emission mechanism, X-ray detection techniques, Scintillation and production mechanism, loss mechanism, Cerenkev radiation detection (9 hrs)

Unit III: The Milky way galaxy & Extra galactic Astronomy

The Morphology of the galaxy, interstellar dust, mass distribution, total mass, kinetics of the milky way, the galactic centre

General characteristic of galaxy classification, surface brightness, masses and rotation curves, dark matter , clusters of galaxies, active galaxies, radio galaxies, quasars, physical processes in active galactic nuclei (AGN), Structure and evolution of AGNs

(10hrs)

Unit IV: Cosmology & General Relativity and its applications

Elements of Newtonian Cosmology – Elementary account of BigBang Theory

Elements of Tensor analysis, The equivalence Principle, Christofell's symbol, Curvature tensor, Einstein's Equations, Schwarzschild solution, The Newtonian limit, Classical tests of general relativistic stellar structure

(10 hrs)

Unit V: Relativistic Cosmology

Space Time curvature, Robertson – Walker Metric, Open, flat and closed universes-, Big-Bang theory, Elements synthesized in hot big bang, Inflationary cosmology (qualitative)

(10 hrs)

Books for Reference

1. Kraus,J.d., Radio Astronomy, Signet Press
2. Kartunenn, Fundamental Astronomy, Springer Verlag
3. Ian Robson, Active Galactic Nuclei
4. Caroll and Ostile, An Introduction to Modern Astronomy, Addison Wesley.
5. Heller.P. Computational Astronomy, Willman Bell

6. Shu F, The physical Universe, University of Science Press
7. Adler, Bazin and Schiffer, Introduction to General Relativity, Mc Graw Hill
8. Ramanamurthy, P.V. & Wolfandale, A.W. , Gamma ray Astronomy, Cambridge University Press
9. Narlikar J.V. Introduction to Cosmology, CUP
10. Chen F.F. Introduction to Plasma Physics, Plenum Press
11. Tannenbaum B.S: Plasma Physics, Mc.Graw Hill
12. Kristen Rlhlf: Tools of radio Activity
13. Kembhavi A.K.& Narlikar J.V., Quarsars and Active galactic nuclei

PHY021C MATHEMATICAL PHYSICS II

Unit I:

Vector analysis: Vector differential operator and vector integration in Cartesian, cylindrical and spherical co-ordinate systems-Gauss theorem and Stokes theorem.

Matrices: Differential type of matrices and diagonalisation of matrices-Cayley-Hamilton theorem.

Unit II:

The Dirac Delta function: Introduction-Representation of the Delta function as limiting form of the Rectangle function-Gaussian representation of the Delta function-Integral representation of the Delta function-Derivative at a Discontinuity-Some properties of the Delta function- The completeness condition in terms of the Delta function.

The Sturm-Liouville Equation: Introduction-Eigen values and Eigen functions-The Hermitian nature of the operator L-The Eigenvalues are real-The Eigenfunctions are orthogonal-Completeness condition for the Eigenfunctions of the Sturm- Liouville operator-Boundary conditions.

Unit III:

The gamma function (factorial function): definitions, simple properties, Beta functions. Special functions:

Hermite Polynomials: Introduction-The generating function-Rodrigue's formula-Orthogonality.

Laguerre Polynomials: Introduction-The generating function-Rodrigue's formula-Orthogonality-Some important results involving Laguerre Polynomials.

Unit IV:

Functions of a complex variable I; Analytic properties, complex algebra, Cauchy Riemann conditions, Cauchy's integral theorem, Cauchy's integral formula, Laurent series expansion-Functions of a complex variable II: Calculus of residues and singularities.

Unit V:

The Green's function: Introduction-The solution of the Sturm-Liouville Equation-Boundary conditions-Solution of the Equation $\psi''(x)+k^2\psi(x)=f(x)$ using Green's function-Bilinear formula- Bilinear formula for $L\psi-\lambda\psi= f(x)$-Green's function in the generalized sense-Periodic boundary conditions- Green's function for the ∇^2 operator.

Book for Study

A.K. Ghatak, I.C. Goyal and S.J. Chua, Mathematical Physics, Macmillan India Ltd.

PHY022C QUANTUM MECHANICS I

Unit I: Basic Formalism

Matter waves-Debroglie hypothesis-Schrodinger wave equation-Interpretation of the wave function-Normalizable and non normalizable wave functions-Box normalization-Admissibility conditions on the wave function-Equation of continuity-Postulates of Quantum Mechanics-Ehrenfest theorem-Stationary states-Representation of dynamical variables-Inner product-commutators-Basic commutation relations-Expectation value-Adjoint of an operator-Eigen values and Eigen functions-Simultaneous eigen functions-completeness-Closure-Physical Interpretation of eigen values and eigen functions- Momentum wave functions-Uncertainty principle-Evolution of system with time

Unit II: One Dimensional Problems

Square well potential with Rigid walls- Square well potential with Finite walls- Square potential Barrier-Alpha emission-Bloch waves in a periodic potential-Kronig Penney square well periodic potential-Linear Harmonic Oscillator: Schrodinger method-Linear Harmonic Oscillator: Operator method

Unit III: Three Dimensional Problems

Particle moving in a spherically symmetric potential-System of two interacting particles-Rigid rotator-Hydrogen atom-Hydrogenic orbitals-The free particle-Three dimensional square-well potential-The Deuteron

Unit IV: General Formalism

Linear Vector Space-Linear Operator-Eigen functions and Eigen values-Hermitian Operator-Postulates of Quantum Mechanics-Simultaneous Measurability of Observables-General Uncertainty Relation-Dirac's Notation-Equation of Motions-Momentum Representation

Unit V: Approximation Methods

Basic Concepts-Nondegenerate Energy Levels-Anharmonic Oscillator: First-order Correction-The Ground State of Helium-Effect of Electric Field on the Ground State of the Hydrogen-Degenerate Energy Levels-Effect of Electric Field on the n=2 State of Hydrogen-The Variational Principle-Rayleigh-Ritz Method-Variation Method for Excited States-The WKB method-The Connection Formulas-The validity of WKB Method

Book for Study

1. P.M. Mathews and K. Venkatesan, A textbook of Quantum Mechanics.

2. G. Aruldhas, Quantum Mechanics, 2nd edition, Prentice Hall.

PHY 023C STATISTICAL MECHANICS AND THERMODYNAMICS

Unit I: Fundamental of Classical Statistical Mechanics

Define Phase Space, Postulates of Classical statistical mechanics, Thermodynamic potential, Liouville therorem. (8 hrs)

Unit II: Gibbs and Grand Canonical Distribution

Classical canonical distribution, Partition function and thermodynamic function, Maxwell velocity distribution, Classical grand canonical distribution, grand canonical partition function and thermodynamic functions- Problems (11 hrs)

Unit III: Flucuations

The Gaussian distribution, Canonical ensemble, Theory of canonical ensemble, Canonical and Microcanonical ensembles, Grand canonical and canonical ensemble. (9 hrs)

Unit IV: Ideal Fermi Gas and Ideal Bose-Gas and Non-Equlibrium States

The Bose Einstein and Fermi Dirac distributions- Bose – Einstein condensation – Black Body radiation, Boltzmann transport equation, Theory of Brownian motion, Random walk in one dimensional, Diffusion. (9 hrs)

Unit V: Time dependence of fluctuations

Fourier analysis of fluctuation:– Wiener-Khinchin theorem, Nyquist formula and fluctuations- Dissipation therorem, Irreversible Transport phenomena and Onsager principle, Dielectric Relaxation.

(10 hrs)

Books for study:

R.K. Srivastava and J. Ashok, Statistical Mechnaics.

E.S.R. Gopal , Statistical Mechanics and properties of Matter (Theory and Applications) (Ellis Horwood Ltd, Chichester)

M.K.Zemansky, Heat and Thermodynamics

Books for reference:

1. B.K.Agarwal and M.Einser, Statistical mechanics, Second Edition (New Age international , Delhi)
2. C.Kittel, Thermal Physics
3. R.K. Pathtria, Statistical Mechanics
4. L.D. Landau and E.M. Lifshitz, Statistical Mechanics
5. J.K.Bhattacharjee, Statistical Mechanics: An Introductory Text
6. W.Greiner., L.Neise and H.Stoecker, Thermodynamics and Statistical Mechanics

7. A.B.Gupta, H.Roy, Thermal physics (Booksand Allied, Kolkata)
8. C.Kalidas, M.V. Sangaranarayanan, Non – Equilibrium Thermodynamics (Macmallan India, New Delhi)
9. M.Glazer and J.Wark, Statistical Mechanics (Oxford University Press)
10. L.P. Kadanoff, Statistical Physics – Statics, Dynamics and Renormalization. (World Scientific, Singapore)

PHY024C GENERAL PRACTICAL

1. Young's Modulus by Elliptic fringes
2. Thickness of the enamel coating on a wire – By Diffraction
3. Solar Spectrum – Hartmann's Interpolation formula
4. Electrical resistance of a metal / an alloy by four probe method – as a function of temperature
5. Measure of numerical aperture (NA) of a telecommunication-grade Optic fibre
6. Fibre attenuation of a given optical fiber
7. Laser Experiments
8. Zeeman effect
9. Band Gap of Thermistor
10. Determination of Solar Constant
11. Michelson Interferometer – Wavelength and separation of wavelengths
12. Michelson Interferometer- Thickness of a mica sheet / thin film
13. Susceptibility – Quinke's or Gouy's method
14. Hall Effect
15. Molecular Spectra – CN band
16. Spectral analysis of a salt
17. Absorption spectra
18. Ultrasonics – Compressibility of a liquid
19. Ultrasonics – Compressibility of a solid
20. B-H curve using CRO
21. Calibration of a Gamma ray spectrometer and determination of the energy of unknown source
22. Best operating voltage of the Gamma ray spectrometer and mass Attenuation coefficient for Gamma rays

(Other experiments on Astrophysics to be recommended by **IIA**)

PHY025E MATERIALS CHARACTERIZATION

Unit I: Thermal Analysis

Introduction- thermo gravimetric analysis- instrumentation – determination of weight loss and decomposition products- Differential scanning Calorimetry- instrumentation- specific heat capacity measurements- determination of thermochemical parameters- Differential thermal analysis-basic techniques. (8 hrs)

Unit II: X-Ray Analysis and Optical Methods

Single and powder diffraction- Diffractometers-interpretation of diffraction patterns-indexing- phase identification- thin film characterization- X-ray fluorescence spectroscopy-uses. FTIR-UV- Visible spectroscopy- Photoluminescence- light matter interaction-fundamental transitions- excitations- instrumentation- electroluminescence- instrumentation-photo reflectance. (14 hrs)

Unit III: Electron Microscopy

Principles of SEM, TEM, EDAX, AFM, EPMA-instrumentation-sample preparation and analysis of materials- study of dislocations-ion implantation- uses. (8hrs)

Unit IV: Electrical Methods

Hall effect – Carrier density – resistively – two probe and four probe methods – scattering mechanism- Vander paw method – CV characteristics- schottky barrier capacitance- impurity concentration – electrochemical CV profiling – Limitations (8 hrs)

Unit V: Instrumentation for Nanoscience

Instrumentation of Followers methods – heterodyne method – scanning method – holographic methods – diffraction method – stylus method

Instrumentation of Ultrasonic sensors – introduction – piezo electric transducers – electromagnetic and electrostatic devices – total instrumentation systems. (10 hrs)

Books for study:

1. Willard, Merritt, Dean, Settle, Instrumental Methods and Analysis, CBS Publishers, New Delhi
2. R.A.Stradling, P.C.Klipstain, Growth and Characterization of Semiconductors, Adam Hulger, Bristal
3. J.A.Belk, Electron Microscopy and microanalysis of crystalline materials, Applied Science Publishers, London
4. J.W. Gardner, H.T. Hingle, From Instrumentation to Nanotechnology, Gordon and Breach Science Publishers.

PHY031C ELECTRO MAGNETIC THEORY AND PLASMA PHYSICS

Unit 1: Electrostatics

The Electric field, Coulomb's law, Continuous charge Distributions, Gauss's law, Applications of Gauss' law, Poisson's Equation and Laplace's Equation, work and Energy in Electrostatics, Conductors and Capacitors.

Unit 2: Magnetostatics and magnetic fields in matter

The Lorentz force law, Biot – Savert law, Magnetic field a steady current, Magnetic vector and Scalar potential, Multipole expansion of the vector potential, Magnetization and Bound currents, Magnetic susceptibility and permeability.

Unit 3: Electrodynamics and conservation laws

Electromotive force, Faraday's law of induction, Maxwell equation, Maxwell displacement current, Maxwell's eqn in matter, Boundary conditions and continuity equation.

Unit 4: Electromagnetic waves

The wave equation, electromagnetic waves in vacuum, propagation in linear media, Reflection and Transmission at normal incidence, Reflection and Transmission at oblique incidence and retarded potentials.

Unit 5: Plasma physics

Magneto hydro dynamic flow between boundaries with crossed and magnetic field, Plasma confinement, Pinch effect, Alfven waves, Plasma oscillation, Debye screening.

Book for study

1. David J. Griffiths Introduction to Electrodynamics (third edition).
2. B.B.Laud, Electromagnetic 2nd Edition- New age international publishers

Books for reference:

1. J.R.Reitz, F.J.Milfordnad R.W.Christy, Foundation of electro magnetic theory
2. W.Panofsky M.Phillips, Classical Electricity and Magnetism
3. J.D.Jackson, Classical Electrodynamics- 2 nd edition – Wiley Eastern Limited, New Delhi
4. B.B.Laud, Electromagnetic – 2 nd Edition – New age international publishers

QUANTUM MECHANICS-II

Unit I: Angular momentum

The angular momentum operators-Angular momentum commutation relations-Eigen values and Eigen functions of L^2 and L_Z-General angular momentum-Eigenvalues of J^2 and J_Z-Angular momentum matrices-Spin angular momentum-Spin vectors for spin-(1/2) system-Addition of angular momentum

Unit II: Scattering Theory

Scattering Cross-Section-Scattering amplitude-partial waves-Scattering by a central potential: Partial Wave Analysis-Significant number of partial waves-Scattering by an attractive square well potential-Breit-Wigner Formula-Scattering length-Expression for phase shifts-Integral equation-The Born approximation-Scattering by screened coulomb potential-Validity of born approximation-Laboratory and centre of mass coordinate systems

Unit III: Perturbation Theory

Introduction-First-Order Perturbation-Harmonic Perturbation-Transitions to Continuum States-Absorption and Emission of Radiation-Einstein's A and B coefficients-Selection rules

Unit IV: Relativistic Quantum Mechanics

Klein-Gordon equation-Interpretation of the Klein-Gordon equation-Particle in a Coulomb Field- Probability density-Plane wave solution-Interpretation of Negative energy states

Unit V: Dirac Equation

Dirac's Equation for a free particle- Dirac matrices-Covariant form of Dirac equation-properties of gamma matrices-Traces-relativistic invariance of Dirac equation-Feyman's theory of positron (elemental analysis only)

Book for Study:

G. Aruldhas, Quantum Mechanics, 2nd edition, Prentice Hall.

PHY033C SOLID STATE PHYSICS

Unit I: Crystal Lattices

Periodic Arrangements of atoms – concept of a lattice – lattice translation vectors – primitive lattice cell – two and three dimensional lattice types. Miller indices of crystal plane- simple crystal structure like sodium chloride type – cesium Chloride type hexagonal and face centered- close packed structures. Diamond structure and cubic zinc sulphide structure- Diffraction of waves by crystals: Bragg's law – reciprocal lattice vectors- Laue equations- Brillouin zones- Reciprocal lattices to sc, bcc, fcc lattices (9hrs)

Unit II: Lattice Dynamics

Vibrations of linear monoatomic and diatomic chains - quantisation of elastic waves - phonon momentum. Plank distribution for a system of identical harmonic oscillators. Periodic boundary conditions and density of states in one and two dimensions. Einstein and Debye's theories of specific heat. Anharmonicity of lattice vibrations, Thermal expansion. Thermal conductivity and Umklapp process (11hrs)

Unit III: Free electron theory

Energy levels in one dimensions. Fermi- Dirac distribution for a free electron gas. Periodic boundary condition and free electron gas in three dimensions. Heat capacity of the electron gas. Ohm's law, Mattiessen's rule and Umklapp process. Hall effect, Wiedmann- Franz law – Nearly free electron model and the origin and the magnitude of the energy gap. Bloch functions. Motion of an electron in a periodic potential, Kronig-Penny model, Bloch Theorem. Approximate solution near a zone boundary (9hrs)

Unit IV: Superconductivity

Occurrence of super conductivity, Destruction of superconductivity by magnetic fields, Meissner Effect, Heat Capacity, Energy gap, Microwave and infrared properties, Isotope effect, Thermodynamics of the superconducting transition , (Stabilization energy of the super conductor), London equation, Coherence Length, BCS theory of superconductivity, BCS ground state, Flux quantisation in a super conduction ring, duration of persistence currents, type II superconductors, Vortex state, Estimation of Hc_1 and Hc_2, single particle tunneling, DC Josephson effect, AC Josephson effect, macroscopic quantum interference , High temperature superconductors (9hrs)

Unit V: Magnetism of Solids

Ferro magnetic order, Curie point and exchange integral, Temperature dependence of the saturation magnetization at absolute zero, Magnons, Quantisation of spin waves, Thermal excitations of magnons, Ferri magnetic order, Curie temperature and susceptibility below the

Neel temperature, Ferromagnetic domains, Anisotropy energy, Transition region between domains, Origin of domains, Coercivity and Hysterisis (10 hrs)

Book for Study:

1. C. Kittel , Introduction to Solid State Physics
2. S.O. Pillai, Solid State Physics

Books for reference:

1. R.Asokamani, Solid State Physics
2. A.J.Dekker, Solid State Physics
3. N.W.Ashcroft and N.D.Mermin, Solid State Physics
4. J.M.Ziman, Principles of the Theory of Solids
5. D.M. Martin, Magnetism in Solids
6. J.D. Patterson, Introduction to the Theory of Solids

PHY034C ELECTRONICS PRACTICAL

1. Operational Amplifier – Design – Phase – Shift Oscillator, Wein Bridge Oscillator
2. Operational Amplifier – Square wave, saw tooth wave , Triangular wave generators
3. Operational Amplifier – Design of Schmitt Trigger , Construction of Monostable Multi vibrator
4. Timer IC NE 555 Schimitt Trigger
5. Clock Generators using 7400 and 7413 Ics
6. Up- Down Counters – Design of modulus counters
7. Arithmetic operations using IC 7483
8. 7490 as modulus counters and display using 7447
9. Study of Multiplexer and Demultiplexer
10. Active Filters using IC 741
11. Digital Comparators

PHY 035E MATERIAL SCIENCE

Unit I: Nanomaterials

Grains in solids, measurement of grain size, nanomaterials, methods of preparation – Electro deposition, Sol-gel, Spark discharge and other methods, characterization and applications, Hetrojunction – Quantum well, wire and dots (15 hrs)

Unit 2: Polymers

Structural features of polymer material – Mechanisms of polymerization and types of Polymers- Thermoplastics – rubbers and elastomers- mechanical physical and chemical properties- Cellular plastics- Liquid crystal polymers (8 hrs)

Unit 3: Dielectrics

Electrical polarization – Mechanisms of polarization – Optical, molecular and interfacial polarizability- some dielectric materials – piezoelectric materials – pyroelectric and ferro electric material – Applications of these materials (8 hrs)

Unit 4: Electronic Materials

Purification of electronic materials – Crystal growth and doping techniques (an over view)- Epitaxial growth – Impurity Diffusion- Ion Implantation – Junction Formation – Metallisation – Lithography (an over view) – contact formation (8 hrs)

Unit 5: Magnetic materials

Classification of magnetism – Concept of magnetic domain structure – Soft magnetic materials iron and iron based materials, permalloys Ni-Zn and Mn-Zn ferrite- Microwave ferrite and garnets- Amorphous magnets (metgalsses) Hard magnetic materials High Carbon steel AlNiCo alloys – Structure and magnetic properties of Barium ferrite, Sm-Co and Nd_2Fe_4B magnets- Rare earth element magnets- Effects of 3^{rd} transition elements – Application of hard vs soft magnets (9 hrs)

Books for Study

1. J.C.Anderson, K.D.Leaver, R.D.Rawlings and J.M.Alexander, MAterilas Science. 4 th edition (Chapman – Hall , London)
2. V.Ragavan, Materials Science and Enginnering 3 rd Ed. (Prentice- Hall India, New Delhi)(For Units 2,3, & 5)
3. C.M.Srivata and C.Srinivasan , Science of Enginnering MAterilas , Wiley – Eastern Ltd,New Delhi(For Units 1,2, & 5)

Books for Reference

1. G.K.Narula, H.S.Narula and V.K.Gupta, Materials Science (Tata McGraw- Hill , 1988)

2. Z.D.Jaberezk, The Nature and Propertoes of Engineering Materilas (Wiley eastern)
3. E.P.Wolhlfarth, Ferromagnetic Materials Vols, 1,2, &3 (North Holland)
4. H.Ibach and H.Luth , Solid State Physics- An Introduction to Principles of Material Science 2nd Ed
5. R.K.Gupta (Editor) Physics of Particles Nucleus and Materials – Recent trends (new Horozon of Physics Series , Narosa, New Delhi)

PHY 041C SPECTROSCOPY

Unit I: Infrared spectroscopy

Vibrational energy of a diatomic molecule- Infrared selection rules-Vibrating diatomic molecule-Diatomic vibrating rotator- Vibrations of polyatomic molecules-Fermi resonance-Rotation vibration spectra of polyatomic molecules-Normal modes of vibration in crystal-Interpretation of vibrational spectra-Group frequencies-IR spectrophotometer-Instrumentation-Sample handling techniques-Fourier Transform Infrared spectroscopy-Applications

Unit II: Raman spectroscopy

Introduction-Theory of Raman scattering-Rotational Raman spectra-Vibrational Raman spectra-Mutual Exclusion principle-Raman spectrometer-Sample handling techniques-Polarization of Raman scattered light-Structure determination using IR and Raman spectroscopy-Raman investigation of phase transitions-Resonance Raman scattering-Nonlinear Raman phenomena-Preliminaries-Hyper Raman effect-Stimulated Raman scattering-Inverse Raman effect-Coherent Anti-Stokes Raman scattering

Unit III: Electronic spectroscopy

Introduction-Vibrational Coarse structure-Vibrational analysis of band systems-Deslandres table-Progression and sequences-Information derived from vibrational analysis-Franck-Codon principle-Intensity of vibrational electronic spectra-Rotational fine structure of electronic vibration spectra-The Fortrat parabolae-Dissociation-Predissociation-Electronic angular momentum in diatomic molecules-Photoelectron spectroscopy

Unit IV: NMR Techniques:

Magnetic properties of Nuclei-Resonance condition-NMR instrumentation-Relaxation processes-Bloch equations-Dipolar interaction-Chemical shift-Indirect spin-spin interaction-High resolution Hamiltonian-Matrix elements of the High resolution Hamiltonian-NMR spectrum of a spin ½ AB systems-NMR spectra of solids-Magic angle spinning NMR-Resonance of other Nuclei-Nuclear quadrupole effects-Intermolecular exchange-Hindered rotation-NMR imaging-Interpretation of certain NMR spectra

ESR Techniques:

Introduction-Principle of ESR-ESR spectrometer-Total Hamiltonian-Hyperfine structure-ESR spectra of free radicals in solution-Anisotropic systems-System in Triplet states-EPR of Transition metal ions

Unit V: NQR Techniques:

Introduction-Principle of Nuclear quadrupole resonance-Transitions for axially symmetric systems-Transitions for non-axially symmetric systems-NQR instrumentation-Crystallographic inequivalence-Chemical bonding-Halogen quadrupole resonance-Quadrupole resonance of minerals- Nitrogen Quadrupole resonance-NQR group frequencies-Hydrogen bonding

Mossbauer Techniques:

Recoilless emission and absorption-Experimental techniques-Isomer shift-Quadrupole interaction-Magnetic hyperfine interaction-Applications

Book for Study:

1. G. Aruldhas, Molecular structure and spectroscopy, Prentice Hall.

Books for Reference:

1. Schroedinger and Berstin, High Resolution NMR, people, McGraw Hill.
2. Introduction to ESR, Assenheim Plenum Press.
3. T.P.Das and Hahn, Nuclear Quadrupole Resonance spectroscopy ELL, Academic Press.
4. Mossbauer Effect and its application to chemistry Vol.I Goldanskill, Von Nastrond.
5. Principles of Magnetic Resonance (Chap.6), Slitcher, Harper and Row.
6. Straw and Walker, Spectroscopy, Vols. I and II, Chapman and Hall.
7. Bhagavantham, Scattering of light and Raman effect, chemical publishing company.
8. Townes and Schawlow, Microwave Spectroscopy, McGraw Hill.

PHY042C NUCLEAR PHYSICS AND PARTICLE PHYSICS

Unit I: General Properties of nuclei

Charge-Mass-Radius-Angular momentum (Spin)- Magnetic dipole moment- Electric Quadra pole moment- Parity- Isobaric spin (isospin) – statistics- Nuclear forces (8 hrs)

Unit II: Nuclear models

Liquid Drop Model- Shell Model: Explanation of Magic Numbers-Single particle model-individual particle model-Collective Mode (10hrs)

Unit III: Experimental Techniques:

Alpha Decay: Properties of α Particles-Gamow's Theory of α Decay-Geiger Nuttal Law- α Ray Energies-Fine Structure of α Rays- α Disintegration Energy-Long Range α Particles.

Beta Decay: Properties of β Particles-General Features of β Ray Spectrum-Fermi's Theory of β Decay-Forms of Interactions and Selection Rules.

Gamma Decay: Absorption of γ Rays by Matter-Interaction of γ Rays with Matter-Measurement of γ Ray Energies-Internal Conversion. (10 hrs)

Unit IV:

n-p,p-n,n-n reactions – Formalism – Compound nuclear reactions- The Optical model of particle induced nuclear reactions (8 hrs)

Unit V: Elementary Particle Physics

Classification of elementary particles -Leptons-Hadrons-Mesons-Hyperons-Pions-Meson Resonances-Strange Mesons and Baryons- Gell-Mann Okuba Mass formula for Baryons-CP Violation in Neutral Kaons (K0) Decay-Symmetry and Conversion Laws-Quark Model-Reaction and Decays. (12 hrs)

Books for study:

1. Nuclear Physics- S.N. Ghoshal, S. Chand & Company
2. Concepts of Nuclear Physics-Bernard L. Cohen-Tata McGraw Hill- New Delhi.
3. Nuclear Physics-T.C. Tayal

Books for reference:

1. Introductory Nuclear Physics-Kenneth S. Krane-John Wiley & Sons
2. Nuclear Physics- D.C. Sharma-K.Nath & Co-Meerut 1600
3. Nuclear and Particle Physics-Pandya and Yadav
4.M.P.Kanna, Introduction to elementary particles

PHY043P PROJECT and VIVA-VOCE

Each Candidate will submit a project report on a topic in Physics/ Material Science/ Astrophysics after carrying out the project work under the supervision of a guide. The project may be theoretical or experimental or even a compilation of literature on a current topic. The duration of the project will be roughly two months (including the vacation of one month) in the final semester.

The project report will be evaluated by an external examiner and viva voce will be conducted by a committee consisting of the external examiner, guide and the department faculty.