MOTHER TERESA WOMEN'S UNIVERSITY
KODAIKANAL

DEPARTMENT OF PHYSICS

M.Sc. PHYSICS

SYLLABUS (for candidates admitted from 2018 onwards)

ELIGIBLITY: B.Sc. Physics, Applied Physics, with Mathematics as allied subject at the UG level

MEDIUM: English

S. No.	Subject Code	Subject	Hrs/ Week	Total Credits	Int	Ext	Total
First Semester							
1	PPHT11	Mathematical Physics I	6	5	25	75	100
2	PPHT12	Classical Mechanics	6	5	25	75	100
3	PPHT13	Applied Electronics	6	5	25	75	100
4	PPHP11	Electronics Practical I	6	5	25	75	100
5	PPHE11	Astrophysics/ Numerical methods	6	5	25	75	100
		Total	***30***	***25***			**500**
Second Semester							
6	PPHT21	Mathematical Physics II	*6*	*5*	25	75	100
7	PPHT22	Quantum Mechanics I	6	5	25	75	100
8	PPHT23	Statistical Mechanics and Thermodynamics	6	5	25	75	100
9	PPHP22	General Practical II	6	5	25	75	100
10	PPHE22	Materials Characterization/ Microprocessor	6	5	25	75	100
		Total	***30***	***25***			**500**
Third Semester							
11	PPHT31	Electromagnetic Theory	*6*	*5*	25	75	100
12	PPHT32	Quantum Mechanics II	*6*	*5*	25	75	100
13	PPHT33	Solid State Physics	*6*	*5*	25	75	100
14	PPHP33	Practical III	*6*	*5*	25	75	100
15	PPHE33	Materials Science/Solar Cells	*6*	*5*	25	75	100
		Total	***30***	***25***			**500**
Fourth Semester							
16	PPHT41	Spectroscopy	*6*	*5*	25	75	100
17	PPHT42	Nuclear and Particle Physics	*6*	*5*	25	75	100
18	PPHP44	Project & viva-voce	*18*	*5*	25	75	100
		Total	***30***	***15***			**300**
Grand Total			***120***	**90**			**1800**

PPHT11 **Mathematical Physics I** **6hrs/5credit**

Objective:

- Different order ODE's are introduced and solved problems in Physics.
- Learn special functions.
- Laplace transform are introduced
- It will be applied in all mathematical concepts in various courses.

Unit 1 First-Order ODEs
Basic Concepts. Modeling - Geometric Meaning of y' = f(x, y). Direction Fields - Separable ODEs - Exact ODEs. Integrating Factors - Linear ODEs. Bernoulli Equation. Population Dynamics - Orthogonal Trajectories. Optional - Existence and Uniqueness of Solutions

Unit 2 Second-Order Linear ODEs
Homogeneous Linear ODEs of Second Order - Homogeneous Linear ODEs with Constant Coefficients - Differential Operators. Optional –Modeling: Free Oscillations. (Mass-Spring System) - Euler-Cauchy Equations - Existence and Uniqueness of Solutions. Wronskian - Nonhomogeneous ODEs - Modeling: Forced Oscillations. Resonance -Modeling: Electric Circuits - Solution by Variation of Parameters.

Unit 3 Higher Order Linear ODEs
Homogeneous Linear ODEs - Homogeneous Linear ODEs with Constant Coefficients - Nonhomogeneous Linear ODEs

Unit 4 Series Solutions of ODEs. Special Functions
Power Series Method - Theory of the Power Series Method - Legendre's Equation. Legendre Polynomials - Frobenius Method - Bessel's Equation. Bessel Functions - Bessel Functions of the Second Kind - Sturm-Liouville Problems. Orthogonal Functions - Orthogonal Eigenfunction Expansions

Unit 5 Laplace Transforms
Laplace Transform. Inverse Transform. Linearity. s-Shifting - Transforms of Derivatives and Integrals. ODEs -Unit Step Function. t-Shifting - Short Impulses. Dirac's Delta Function. Partial Fractions - Convolution. Integral Equations - Differentiation and Integration of Transforms. - Systems of ODEs -Laplace Transform: General Formulas.

Text Book
Unit 1-5 - Chapter 1-3,5,6-Advanced Engineering Mathematics – Erwin Kreyszig, 9th Edition, John Wiley and Sons, Inc. 2006.

Books for Reference

1. Mathematical Methods for Physicist - George B. Arfken, Hans J. Weber, 6th Edition, Elsevier Academic Press, 2005.
2. Mathematical Physics – P.K. Chattopadhyay – Wiley Easter, (1990)

3. Introduction to Mathematical Physics – Charlie Harper – Prentice Hall India (1987) New Delhi
4. Applied Mathematics for Engineers and Physicists, III Edn. – Pipes & Harveill McGraw Hill
(1971)

PPHT12 **CLASSICAL MECHANICS** **6hrs/5credit**

Objectives:

- Familiarization of elementary principles
- Clear understanding of symmetry properties
- Vivid knowledge of kinematics of rigid body motion.
- Deep insight into oscillation and canonical transformation.

Unit I: Survey of elementary Principles
Mechanics of a particle and a system of particles, Constraints, D'Alembert's Principle and Lagrange's equation, Velocity dependent potential and dissipation function, Simple application of the lagrangian formulation, Variational principle and Lagrange's equation, Hamiltonian principle, Basic techniques of calculus of variations, Derivation of Lagrange's equations from Hamiltonian's Principle

Unit II: Symmetry Properties, two body central force problem
Reduction to the equivalent one body problem, the equations of motion and first integrals, the equivalent one dimensional problem and classical of orbits, virial theorem, differential equation for the orbit and integrable power law potentials, the Kepler problem

Unit III: The Kinematics of rigid body motion
The independent coordinate of a rigid body, The Euler angles, Euler's theorem on the motion of rigid body, finite and infinitesimal rotation, rate of change of a vector, coriolis force, angular momentum and kinetic energy of motion about a fixed point, Moment of inertia tensor and its diagonalization, equation of torque – free motion, concepts of precession and nutation.

Unit IV: Small Oscillations
Formulation of the problem, Eigen value equation and the principle axis transformation, frequencies of free vibrations on normal coordinates, free vibrations of a linear triatomic molecule. Legendre transformation and Hamiltonian's equations of motion, cyclic coordinates and conservation theorems

Unit V: The equations of canonical transformation
Examples, The sympletic approach to canonical transformation, Poisson brackets and other canonical invariants, equations of motion, Infinitesimal canonical transformation and conservation theorem in the Poisson bracket formation, Hamiltonian Jacobi equation and its application to the harmonic oscillator problem

Text Book

1. H.Goldstein, Classical Mechanics, II Edition, Narosa Publishing House, New Delhi, Chennai, Mumbai and Kolkata, 2000. (Unit I-V, Chapter 1-10).

References

1. Naranya Chandra Rana, Classical Mechanics- Tata McGraw-Hill Publishing Company Limited, New Delhi, 1991.
2. T W. B. Kibble, Classical Mechanics- Longman, 1985
3. J.L.Synge and B.A.Griffith, Principles of Mechanics, McGraw- Hill, New York, 1942.

PPHT13 APPLIED ELECTRONICS 6 hrs/5 credit

Objectives:

- Deep knowledge of Op-amps and its application is acquired.
- Analytical study of the circuits and working of counters, registers
- Basic introduction of various D/A and A/D converters
- Better insight on optical devices

Unit I:
Differential DC amplifier– Stable AC Coupled amplifier – Analogue integration and differentiation – Solution to simultaneous and differential equations using Op Amps- Active Filters – Comparator-Zero crossing detector – Regenerative comparator – Clippers- Half wave Recifier- peak detector – Clampers- Logarithmic amplifiers – Wave form generators - 555- timer IC and its applications

Unit II: (9 hrs)
Flip Flops: SR Flip flop-D Flip flop - JK flip flop- T flip flop
Registers and Counters: Shift Registers – Ring Counter- Shift Counter- Asynchronous Counter-Synchronous counters – Designs of Mod -3, Mod- 16, Random sequence generator
Semiconductors Memories: ROM, EPROM, EEPROM – Static and Dynamic Ram

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

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)

Unit V:
Optical Devices: Optical absorption- Photon Absorption Coefficient- Electron –Hole Pair Generation rate- Solar Cells- pn junction solar cell- Conversion efficiency and solar concentration- nonuniform absorption effects- heterojunction solar cells- amorphous silicon solar cell- Photodetectors- Photoconductor- photodiode- PIN photodiode- Avalanche photodiode- phototransistor- LED-Generation of lights- Internal Quantum efficiency- external quantum efficiency-LED devices- Laser diodes- Stimulated emission and population conversion-optical cavity-threshold current-device structures and characteristics.

Text Book
1. G.K. Mithal, Electronic devices and Circuits (22nd Edition), Khanna Publishers, Delhi, 1999 (Unit I)
2. V. Vijayendran, Introduction to Integrated Electronics, Viswanathan Printers, 2007. (Unit- II, III, IV)

3. Donald A. Neamen, Semiconductor Physics and devices (3rd edition), Tata Mc. Graw, 2003. (Unit V)

Books for reference:

1. R.F. Coughlin and F.F. Driscol, Opamp and linear integrated circuits (6th Edition), Pearson,2001
2. A.Ghatak and K.Thyagarajan, Optical electronics, Cambridge Press, 1989.
3. M.S.Tyagi, Introduction to Semiconductor Devices Wiley, NY, 1991
4. S.M.Sze, Physics of Semiconductor Devices (2nd Edition), Wiley, NY, 1981
5. M.Sayer and A.Mansingh, Measurement, Instrumentation and Experimental Design in Physics and Enginnering, Prentice- Hall India, New Delhi, 2000.

PPHP11 **ELECTRONICS PRACTICAL** I 6hrs/5 credit

Objectives:

This paper aims at providing an in- depth knowledge of the operational amplifier. The students will also get the opportunity to practically work out during the lab sessions.

1. Operational Amplifier – Design – Phase – Shift Oscillator,
2. Operational Amplifier – Design – Wein Bridge Oscillator
3. Operational Amplifier – Square wave generator
4. Operational Amplifier – saw tooth wave generator
5. Operational Amplifier – Triangular wave generator
6. Operational Amplifier – Design of Schmitt Trigger
7. Operational Amplifier – Construction of Monostable Multi vibrator
8. Timer IC NE 555 Schmitt Trigger
9. Clock Generators using 7400 and 7413 ICs
10. Up- Down Counters – Design of modulus counters
11. Arithmetic operations using IC 7483
12. 7490 as modulus counters and display using 7447
13. Study of Multiplexer and Demultiplexer
14. Active Filters using IC 741

PPHE11 **ASTROPHYSICS** **6hrs/5credit**

Objectives:

- Renewal of the concepts of coordinate system and stellar spectra
- Clear understanding of astronomical instruments
- Broad idea on the cosmology
- Familiarization of the concept of stellar evolution

Unit I: Basic Concepts & Celestial Mechanics
Coordinate systems, systems of time, parallaxes, distances, Luminosity, Apparent and absolute magnitudes, stellar radial velocities, masses, Binary stars, stellar spectra, spectral classification, HR diagram, Variable stars (definition only)

Unit II: Astronomical Instruments and Observational Techniques & Solar Physics
Types of optical telescopes, Characteristics, Photometers, UBV System, color index, atmospheric effects, CCD camera.
Solar Interior structure (Pressure Density, temperature, generation of energy, radiative and convective zones), Solar Neutrino
Solar Atmosphere: Photosphere, Model of solar photosphere, Chromosphere, corona, sunspots, their properties, cyclic variation, connection with magnetic fields, solar prominences, solar flares, active regions, heliose ismology

Unit III: Interstellar Medium
Stellar Structure: Physical processes in solar system, the terrestrial planets, Jupiter, Saturn, Uranus and Pluto, Comets, Asteroids, Meteoroid – formation of the system

Unit IV: Cosmology
Hubble's Law: Newtonian Cosmology, Cosmic Background radiation, cosmological red shifts, Observational techniques

Unit V: Stellar Evolution, White dwarfs, Neutron Stars and Black Holes
Vogt-Russel Theorem, mass luminosity relation - Proto stars, Premain sequence evolution, main sequence evolution, last stage of stellar evolution, fate of massive stars, discovery of Sirius – B, White dwarfs, Quantum mechanics of degenerate matter, mass radius relation for neutron stars, pulsars, crab nebula pulsar, stellar and super massive black holes

Text Book

1. Shu F.H: The Physical Universe – An Introduction to Astronomy, 1981,

Books for Reference:

1. B.W.Carroll & D.A.Ostlie: An Introduction to Modern Astrophysics, 2nd Edn, Cambridge University Press, 2017
2. Karttunen, H., Kröger, P., Oja, H., Poutanen, M., Donner, K.J. : Fundamental Astronomy, Springer Verlag 2007

3. Astrophysics II: Interstellar Matter and Galaxies 1st Edition, Richard Bowers, Terry Deeming, 1984, Jones & Bartlett Pub.
4. Abhayankar K.D: Astrophysics of the Solar System, Cambridge university Press, 1999
5. Abhayankar K.D: Astrophysics; Stars and Galaxies, Cambridge university Press, 2001

PPHE11 **NUMERICAL METHODS** **6hrs/5credit**

Objectives:

- Curve fitting methods are introduced
- The methods of solving algebraic equations and transcendental equations learnt.
- Simultaneous equations and interpolation problems familiarized.
- Good exposure of Numerical Differentiation and Integration

Unit I : Curve Fitting
Introduction-Linear Law-Method of Group Averages-Method of Moments-Method of Least Squares.

Unit II : Algebraic and Transcendental Equations
Introduction-Errors in Numerical Computation-Iteration Method-Bisection Method-Regular Falsi Method-Newton-Raphson Method-Horner's Method.

Unit III: Simultaneous Equations
Introduction-Simultaneous Equations-Back Substitution-Gauss Elimination Method-Gauss-Jordan Elimination Method-Calculation of Inverse of a Matrix-Crout's Method-Iterative Methods-Gauss Jacobi Iteration Method-Gauss-Seidel Iteration Method-Relaxation Method-Newton-Raphson method for Simultaneous Equations.

Unit IV: Interpolation
Introduction-Newton's Interpolation Formulae-Central Difference Interpolation Formulae-Lagrange's Interpolation Formula-Divided Differences-Newton's Divided Differences Formula-Inverse Interpolation-Hermite's Interpolating Polynomial.

Unit V: Numerical Differentiation and Integration
Introduction-Derivatives using Newton's Forward Difference Formula-Derivatives Using Newton's Backward Difference Formula-Derivatives Using Central Difference Formulae-Maxima and Minima of the Interpolating Polynomial-Numerical Integration-Gaussian Quadrature Formula-Numerical Evaluation of Double Integrals.

Book for Study:

1. S. Arumugam, A. Thangapandi Issac, A. Somasundaram, Numerical Methods, Scitech (2002).

Book for References:

1. R.L. Burden, J.D. Faires, Numerical Analysis, Thomson Asia, 2002
2. P.B. Patil, U.P. Verma, Numerical Computational Methods, Narosa, 2006.

PPHT21 **MATHEMATICAL PHYSICS II** **6hrs/5credit**

Objective:

- Clear understanding of Fourier series, Power series, Laurent series and problems related to them.
- PDE are learnt.
- Complex variables, Fourier series and integrals of various Physics problems are understood.
- Mathematical concepts learnt here are applied to various courses.

Unit 1 Fourier Series, Integrals, and Transforms
Fourier Series - Functions of Any Period p = 2L - Even and Odd Functions- Half-Range Expansions - Complex Fourier Series. - Forced Oscillations - Approximation by Trigonometric Polynomials -Fourier Integral - Fourier Cosine and Sine Transforms - Fourier Transform. Discrete and Fast Fourier Transforms

Unit 2 Partial Differential Equations (PDEs)
Basic Concepts -Modeling: Vibrating String, Wave Equation - Solution by Separating Vatiables. Use of Fourier Series - D' Alembert's Solution of the Wave Equation. Characteristics - Heat Equation: Solution by Fourier Series- Heat Equation: Solution by Fourier Integrals and Transforms - Modeling: Membrane, Two-Dimensional Wave Equation.

Unit 3 Complex Numbers and Functions
Complex Numbers. Complex Plane - Polar Form of Complex Numbers. Powers and Roots - Derivative. Analytic Function - Cauchy-Riemann Equations. Laplace's Equation - Exponential Function - Trigonometric and Hyperbolic Functions - Logarithm. General Power.

Unit 4 Complex Integration
Line Integral in the Complex Plane - Cauchy's Integral Theorem - Cauchy's Integral Formula - Derivatives of Analytic Functions.

Unit 5 Power Series, Taylor Series, Laurent Series. Residue Integration
Sequences, Series, Convergence Tests - Power Series - Functions Given by Power Series - Taylor and Maclaurin Series- Laurent Series - Singularities and Zeros. Infinity - Residue Integration Method - Residue Integration of Real Integrals.

Text Book
Unit 1-5 - Chapter 11-16-Advanced Engineering Mathematics – Erwin Kreyszig, 9th Edition, John Wiley and Sons, Inc. 2006

Books for Reference

Mathematical Methods for Physicist - George B. Arfken, Hans J. Weber, 6th Edition, Elsevier Academic Press, 2005.
Mathematical Physics – P.K. Chattopadhyay – Wiley Easter, (1990)
Introduction to Mathematical Physics – Charlie Harper – Prentice Hall India (1987) New Delhi
Applied Mathematics for Engineers and Physicists, III Edn. – Pipes & Harveill McGraw Hill (1971)

PPHT22 **QUANTUM MECHANICS I** **6Hrs/5credit**

Objective:

- Detailed knowledge on Schrödinger's Equation and its applications
- Familiarization of the concepts of Wave Mechanics
- Broad idea on the 1-3D problems
- New insight on the Angular momentum operators

Unit I: Wave Mechanical Concepts

Wave Nature of Particle – The Uncertainty Principle - The Principle of Superposition – Wave Packet – time dependent Schrodinger Equation – Interpretation of the Wave Function – Ehrenfest's Theorem – Time independent Schrodinger Equation – Stationary States – Admissibility Condition on the Wave function

Unit II: General Formalism of Quantum Mechanics

Linear Vector Space – Linear Operator – Eigen function and Eigenvalue – Hermitian Operator – Postulates of Quantum Mechanics – Simultaneous Measurability of Observables – General Uncertainty Relation – Dirac's Notation – Equation of Motion – Momentum Representation.

Unit III: 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 IV: 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 V: 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

Text Book

1. Unit I-V; Chapter 2-5,8, G.Aruldhas, Quantum Mechanics, 2nd edition, Prentice Hall of India, New Delhi, 2008.

Book for Reference

1. P.M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw-Hill, New Delhi. 2nd Edn, 2017
2. I.L. Schiff, Quantum Mechanics, 3rd Edition, 2017, McGraw Hill, New York.
3. B.K. Agarwal, H. Prakash, Quantum Mechanics, 2004, Prentice Hall of India, New Delhi.

PPHT23 **STATISTICAL MECHANICS AND THERMODYNAMICS 6hrs/5credit**

Objective:

- Concepts of Ensembles are introduced.
- Clear understanding of Bose Einstein and Fermi Dirac statistics
- Familiarization on the properties of gases
- Broad idea on the Time dependence of fluctuations

Unit I: Phase Space, Concept of ensembles
Canonical ensembles – Thermo dynamical relation in a canonical ensemble, Micro canonical ensemble and Grand Canonical ensemble – Information theory and statistical mechanics problems

Unit II: Properties of gases
Partition function for the system and for the particles Translation partition function – Gibb's paradox: Sackur Tetrode Equation, Boltzmann equipartition theorem, Rotational partition function, Vibrational contributions to thermodynamic quantities, Electronic partition function, Maxwell's distribution of velocities – Problems

Unit III: Bose-Einstein and Fermi-Dirac Statistics
Symmetric and anti symmetric wave function Bose Einstein and Fermi Dirac distributions- Weak and strong degeneracy of perfect gases, Bose – Einstein condensation – Black Body radiation, Photons

Unit IV: Kinetic Theory of gases
Mean free path – Viscosity of gases- Heat conduction in gases – Effusion Phenomena
Energy fluctuations in a canonical ensemble – Fluctuations in a grand canonical ensemble, Brownian motion , Langevin equation for random motions – Random walk problem – Diffusion, Einstein relation for mobility

Unit V: Time dependence of fluctuations
Power spectrum of fluctuations – Persistence and correlation of fluctuations – Wiener-Khinchin theorem – Johnson noise: Nyquist theorem, Shot noise problem- Irreversible Thermodynamics: Onsager reciprocity relations-Derivation of the Onsager relations- Thermo electric phenomena – Linear response theory – Kubo relations fluctuations dissipation theorem

Text Book:
1. E.S.R. Gopal, Statistical Mechanics and properties of Matter (Theory and Applications) Ellis Horwood Ltd, 1974. (Unit I- V, Chapter 1-6)
2. R.K. Srivasta and J. Ashok, Statistical Mechanics, Prentice-Hall of India Private Limited, New Delhi, 2006. (Unit III, IV Chapter 6, 12).

Books for reference:

1. B.K.Agarwal and M.Eisner, Statistical mechanics, Second Edition, New Age international Private Limited, Delhi, 2016.
2. R.K. Pathtria, Statistical Mechanics-Second Edition, Butterworth- Heinemann, 1972.
3. L.D. Landau and E.M. Lifshitz, Statistical Mechanics- Third Edition, Publisher by Robert Maxwell M.C, 1959.
4. J.K.Bhattacharjee, Statistical Mechanics: An Introductory Text, Allied Publsihers Pvt. Ltd, ISBN : 4567149629
5. W.Greiner., L.Neise and H.Stoecker, Thermodynamics and Statistical Mechanics, 1995.
6. C.Kalidas, M.V. Sangaranarayanan, Non – Equilibrium Thermodynamics, Macmallan India Limited, New Delhi, 2002.
7. M.Glazer and J. S. Wark, Statistical Mechanics, First Edition, Oxford University Press.
8. L.P. Kadanoff, Statistical Physics – Statics, Dynamics and Renormalization, World Scientific Publishing Co Pte Ltd, Singapore, 2000.
9. Suresh Chandra and Mohit Kumar Sharma, A Textbook of Statistical Mechanics- Second Edition, CBS Publishers & Distributors Pvt Ltd, New Delhi, 2008

PPHP22 **GENERAL PRACTICAL II** **6hrs/5credit**

Objectives: The course aims at exposing the students to the intricacies of handling general equipments and analysis of results. This laboratory session also aim the students to analysis the data given by Indian Institute of Astrophysics, Kodaikanal.

1. Solar Spectrum – Hartmann's Interpolation formula
2. Electrical resistance of a metal / an alloy by four probe method – as a function of temperature
3. Measure of numerical aperture (NA) of a telecommunication-grade Optic fibre
4. Fibre attenuation of a given optical fiber
5. Laser Experiments
6. Zeeman effect
7. Band Gap of Thermistor
8. Determination of Solar Constant
9. Michelson Interferometer – Wavelength and separation of wavelengths
10. Michelson Interferometer- Thickness of a mica sheet / thin film
11. Susceptibility – Quinke's or Gouy's method
12. Hall Effect
13. Spectral analysis of a salt
14. Absorption spectra
15. Ultrasonics – Compressibility of a liquid
16. Ultrasonics – Compressibility of a solid
17. B-H curve using CRO
18. Calibration of a Gamma ray spectrometer and determination of the energy of unknown source
19. Any 4 experiments on Astrophysics to be recommended by **IIA**

PPHE22 **MATERIALS CHARACTERIZATION 6hrs/5credit**

Objectives:

- Principles involved in the working of thermal analysis instruments are understood.
- Knowledge of the working of different parts of X-ray and spectral analysis instruments is acquired.
- Overall view of the usage of microscopy techniques are provided.
- Analysis of various instruments are known

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.

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.

Unit III: Electron Microscopy

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

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.

Unit V: Magnetic and Mechanical properties

Magnetic measurements using vibrating sample magnetometer (VSM) - magnetic force microscopy (MFM) - Electron Paramagnetic Resonance (EPR)-Nuclear Magnetic Resonance (NMR) spectroscopy – Mechanical properties-micro hardness - nano indentation- elastic and plastic deformation- fracture toughness – Superplasticity.

Text Book

1. Willard, Merritt, Dean, Settle, Instrumental Methods and Analysis- Seventh Edition, CBS Publishers, New Delhi, 1986. (Unit I-III, V, Chapter- 6,11,13, 25)
2. Jasprit Singh, Semiconductor Devices- Basic Prinicples, John Wiley & Sons (ASIA) Pvt. Limited, 2001. (Unit IV, Chapter- 3, 4, 6)

3. V. Raghavan, Materials Science and Engineering-Fourth Edition, Prentice-Hall of India Private Limited, New Delhi, 2001. (Unit- III, V, Chapter 6, 10, 11)
4. G. Aruldhas, Molecular Structure and Spectroscopy- Second Edition, PHI Learning Private Limited, New Delhi, 2017. (Unit-V, Chapter-11)
5. William D. Callister, Jr. Materials Science and Engineering an Introduction- Sixth Edition, Wiley International Edition, 2003. (Unit-IV, Chapter-8)
6. Douglas A. Skoog, F. James Holler, Timothy A. Nieman, Principles of Instrumental Analysis- Fifth Edition, Thomson Business Information India Private Limited, India, 2006. (Unit- III, Chapter 21- Section-C)

References:

1. J.A.Belk, Electron Microscopy and microanalysis of crystalline materials, Applied Science Publishers, London, 1979.
2. J.W. Gardner, H.T. Hingle, From Instrumentation to Nanotechnology, Gordon and Breach Science Publishers, 1990.

PPHE22 **MICROPROCESSOR** **6hrs/5credit**

Objectives:

- Microprocessor architecture memory and i/o (8085μP) is understood.
- Skill in software development using microprocessors is developed.
- Concepts of peripheral devices learnt
- Concept of interfacing and execution of simple projects are understood.

Unit I: 8085 Microprocessor – Architecture

Intel 8085-ALU-Timing and Control Unit-Registers-Data and Address Bus- Pin Configuration-Intel 8085 Instructions-Opcode and Operands- Instruction Word size-Instruction cycle- Fetch operation-Execute operation- Machine cycle and state-Instruction and data flow-Timing Diagram-Timing Diagram for Opcode Fetch Cycle-Memory read-I/O read-Memory write-I/O write.

Unit II: 8085 Microprocessor – Instruction Set

Instruction and data format-Addressing modes-Direct addressing-Register addressing - Register Indirect addressing-Immediate addressing-Implicit addressing-Status Flags.

Unit III: 8085 Microprocessor – Programming

Assembly language-High-level language-Areas of applications of various language-Machine language-Assembly language-High-level language-Stacks- Subroutine.

Unit IV: 8085 Microprocessor – Peripheral devices

Address space partitiononing-Memory Mapped I/O scheme-I/O mapped I/O scheme-Memory and I/O interfacing-Memory interfacing-I/O Interfacing-Synchronous data transfer-asynchronous data transfer-interrupt driven data transfer-multiple interrupts.

Unit V: Interfacing memory and its application

Keyboard interface, Seven segment display interface. Stepper motor interface- Interfacing Digital to Analog Converters (DAC) and Analog to Digital Converters (ADC)

Text Book

1. Ramesh Goanker: Microprocessor Architecture, Programming & Application with the 8085/8080A (2nd Edition) - Wiley Eastern Ltd ,1993.

Books for Reference

1. A.P. Mathur, Introduction to Microprocessors (3rd edition), Tata Mc.Graw, Delhi, 1989.
2. Walter A. Triebel & Avtar Singh : 16 bit Microprocessor – Architecture , software & interface techniques, 1st Edn, 1990 – Printice – Hall Inc
3. Badri Ram, Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai Publications 1990.

PPHT31 **ELECTROMAGNETIC THEORY** **6hrs/5credit**

Objectives:

- Deep knowledge about electrostatics.
- Clear understanding of magnetostatics
- Understanding of Maxwell equation and wave propagation
- Introducing to the concepts of electromagnetic radiation.

Unit I: Electrostatics

Introduction to Electrostatics- Gauss law- electrostatic potential- Poisson's and Laplace's equation – Green's theorem – Green's functions – Potential with Dirichlet and Neumann boundary conditions – Solution of Laplace's equation in rectangular box – Solution by separation in spherical polar coordinates – Multiple expansion, electrostatic field in matter – Dielectrics – Polarization – Polarization vector – Field outside polarized dielectric – Bound charges- Electric displacement vector – Gauss law in presence in dielectrics – linear dielectrics – Boundary conditions in dielectric media – Electrostatic energy in presence of dielectrics- Alignment of polar molecules – Dielectric sphere in uniform electric field – Molecular polarizability and electrical susceptibility

Unit II: Magneto Statics

Introduction to Magneto statics – Conservation of charge and equation of continuity – Biot – Savart's law- Magnetic field due to a localized current distribution – Ampere's law – Magnetic vector potential – Magnetic scalar potential – Magnetic moment, force and torque on a current distribution in an external field – Magnetization – Field of a magnetized object – Bound Currents – Auxiliary field H- Ampere's law – linear media – Magneto static theory – Uniformly magnetized sphere – Multipole expansion

Unit III: Maxwell Equations

Equation of continuity in electro dynamics- Faraday's law of induction – Maxwell equation – Maxwell displacement current – Maxwell's equation in free space and matter – Physical significance – Boundary conditions

Unit IV: Wave Propagation

Plane wave in non-conducting media – Poynting Vector, electromagnetic waves in conducting media – Reflection and refraction of EM waves at a plane interface – laws of reflection and refraction for EM waves – Fresnel formulae – Polarization of EM waves – Brewster's angle and degree of polarization – Total internal reflection –Propagation of EM waves between parallel and perfectly conducting planes – Rectangular wave guide.

Unit V: Electromagnetic Radiation

Inhomogeneous wave equation and retarded potentials – Oscillating electric dipole – Energy radiated by an oscillating electric dipole- Jefimenko's Equation, Lienard- Wiechert Potentials- The fields of a moving point Charge.

Text Book

1. B.B.Laud, Electromagnetic 2nd Edition- New age international publishes, 1987. (Unit I-V, Chapter 1-7).
2. David J. Griffiths Introduction to Electrodynamics, Third edition, Prentice- Hall of India Private Limited, New Delhi, 2002. (Unit-V, Chapter 10).

References:

1. W.Panofsky M.Phillips, Classical Electricity and Magnetism- Second Edition, Addition Wesley Publishing Company, Inc. 1962.
2. J.D.Jackson, Classical Electrodynamics- 2 nd edition – John Wiley & Sons, Inc. New Delhi, 1962.
3. B.B.Laud, Electromagnetic 2nd Edition- New age international publishes, 1987.

PPHT32 **QUANTUM MECHANICS-II** **6hrs/5credit**

Objective:

- Clear understanding on Perturbation Theory
- Vivid knowledge on the concepts of variation method, WKB
- Broad idea on Scattering
- Familiarization on applications of quantum mechanics

Unit I Time Independent Perturbation Theory

Basic concepts – Nondegenerate Energy Levels – Anharmonic Oscillator: First Order Correction-The Ground State of Helium-Effect of Electric Field on the Ground State of Hydrogen – Degenerate Energy Levels – effect of electric Field on the n=2 State of Hydrogen – Spin-Orbit Interaction.

Unit II The Variation Method

The Variation Method – Rayleigh Ritz Method – Variation Method for Excited States – The Hellmann Feynman Theorem – the Ground State of Helium – The Hydrogen Molecule Ion – the Ground State of Deuteron.

Unit III WKB Approximation

The WKB Method – The Connection Formula – Validity of WKB Method – Barrier Penetration – Alpha Emission – Bound States in a Potential Well.

Unit IV Time Dependent Perturbation Theory

Introduction – First order Perturbation – Harmoic Perturbation – Transition to Continuum States – Absorption and Emission of Radiation – Einstein's A and B Coefficients- Selection Rules.

Unit V Scattering

Scattering Cross-section – Scattering Amplitude – Partial Waves-Scattering by Central Potenials: 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.

Text Book

1. Unit I-V; Chapter 9-12,14,G.Aruldhas, Quantum Mechanics, 2nd edition, Prentice Hall of India, New Delhi 2008.

Book for Reference

1. P.M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw-Hill, New Delhi 2nd Edn, 2017.
2. I.L. Schiff, Quantum Mechanics, 3rd Edition, 2017, McGraw Hill, New York.
3. B.K. Agarwal, H. Prakash, Quantum Mechanics, 2004, Prentice Hall of India, New Delhi.

PPHT33 **SOLID STATE PHYSICS** **6hrs/5credit**

Objective:

- Basic concepts about crystal structure
- Deep knowledge of lattice dynamics and free electron theory.
- Clear understanding of superconductivity.
- Theoretical knowledge of magnetic properties of materials.

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

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

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

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

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

Text Book

1. C. Kittel, Introduction to Solid State Physics (8^{th} Edition), John Wiley & Sons (2005) (Unit I-V).

Books for reference:

1. S.O. Pillai, Solid State Physics (7^{th} Edition), New Age International Publishers Ltd. 2010.
2. R.Asokamani, Solid State Physics, Anamaya Publishers, 2006
3. A.J.Dekker, Solid State Physics, Macmillan (1965).
4. N.W.Ashcroft and N.D.Mermin, Solid State Physics, Harcourt College Publishers (1976)

PPHP33 **PRACTICAL III** **6hrs/5credit**

Objectives:

The course aims at exposing the students to solve different numerical equation by C programming.

1. Ascending and descending order of numbers and characters
2. Matrix addition, subtraction and multiplication
3. Transpose of a matrix
4. Evaluating a root of non-linear equation by Newton-Raphson method using external function
5. Program to solve system of linear equations using simple Gaussian elimination method
6. Program for straight line fit using the method of least squares for a table of data points
7. Program for polynomial curve fitting
8. Program to integrate any function or tabulated data using trapezoidal rule
9. Program to integrate any function or tabulated data using Simpson's rule
10. Program to compute the solution of a first order differential equation of type y'=f(x,y) using the fourth order Runge-Kutta method
11. Program to compute the interpolation value at a specified point, given a set of data points using Lagrangian interpolation representation
12. Program to compute the interpolation value at a specified point, given a set of data points using Newton's interpolation representation
13. Program to calculate and print the mean, variance and standard deviation of set of N numbers
14. Program to solve the quadratic equation
15. Program to read a set of numbers, count them and find and print the largest and smallest numbers in the list and their positions in the list

PPHE33 **MATERIALS SCIENCE** **6hrs/5credit**

Objectives:

- Preparational methods of nanomaterials are known.
- Properties of different materials are studied.
- Applications of new materials are known.
- Motivate students to research carrier

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

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

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

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

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

Text Book

1. J.C.Anderson, K.D.Leaver, R.D.Rawlings and J.M.Alexander, Material Science. 4th edition (Chapman – Hall , London) 1990
2. V.Ragavan, Materials Science and Engineering 3rd Ed. 2011 (Prentice- Hall India, New Delhi)(For Units 2,3, & 5)
3. C.M.Srivata and C.Srinivasan, Science of Engineering Materials and Carbon Nanotubes, Wiley – Eastern Ltd, New Delhi 2010 (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 Properties of Engineering Materials (Wiley eastern) 1987

3. H.Ibach and H.Luth, Solid State Physics- An Introduction to Principles of Material Science 2nd Ed 2009
4. R.K.Gupta (Editor) Physics of Particles Nucleus and Materials – Recent trends (new Horozon of Physics Series, Narosa, New Delhi) 2002

PPHE33 **SOLAR CELLS** **6hrs/5credit**

Objective:

- Basic knowledge about basic concepts of sunlight
- Understanding about physics of semiconductor materials
- Familiarization of design and fabrication of solar cells
- Better insight of third and fourth generation solar cells

Unit I

Introduction to Solar cells and Sun light

Outline of solar cell developments – Physical sources of sunlight – solar intensity at the Earth's Surface – direct and diffused radiation – apparent motion of the sun – solar insolation data – Types of solar energy converter – Photons in, electrons out – Basic principles of Photo-voltaic.

Unit II

Semiconductor Materials, properties and its characteristics

Basics of crystal structure and orientations - Basic concepts – electron states in semiconductors – semiconductor in equilibrium – impurities and doping - semiconductor under bias- drint and diffusion – semiconductor transport equations – photo-generation – recombination – formulation of the transport problem

Unit III

Junction Investigations

Orgin of photovoltaic action – work function and types of junction –Homo-junctions - metal semiconductor junction – semiconductor-semiconductor junctions – electrochemical junction – organic material junctions – surface and interface states – p-n junction – dark and illuminated current — effect of temperature – efficiency loss - short circuit current-open circuit voltage – introduction to various resistance .

UNIT IV

Design, fabrication and characterization of silicon Solar cells

Basic silicon Solar cells - Basic theoretical performance – Major considerations for solar cell fabrication – doping of the substrate – Back surface fields – top layer limitations – top contact design – optical design – spectral response – cell fabrication process – surface treatment – etching – doping and diffusion – contact formation – solar cell measurement (IV) – analysis of the output- future direction in silicon cell design.

Unit V

Towards Third and fourth generation solar cells

Introduction to nanoparticles – concepts of quantum dot solar cells – dye sensitized solar cell – organic solar cells - hybrid solar cell-other types of advanced solar materials and solar cell devices.

Text Book:

1. Solar Cells (operating Principles, Technology and System applications) by Martin A. Green (Published by The University of New South Wales).1986
2. The Physics of Solar cells by Jenny Nelson (Published by Imperial college press) 2003
3. Light-Induced Redox Reactions in Nanocrystalline Systems, Anders Hagfeldtt and Michael Gratzel, Chem, Rev.1995,95, 49-68.

Books for Reference:

1. Third Generation Photovoltaics: Advanced Solar Energy Conversion (Springer Series in Photonics) 1st ed. 2003. 2nd printing 2005 Edition, by Martin A. Green
2. Physics of Solar Cells: From Basic Principles to Advanced Concepts 2nd Edition by Peter Warfel 2004

PPHT41 **SPECTROSCOPY** **6hrs/5credit**

Objectives:

- Detailed Knowledge of IR and Raman spectroscopy and its application
- Clear understanding of electronic spectroscopy
- Familiarization of NMR and ESR techniques
- Understanding NQR and Mossbauer Techniques.

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 (10 hrs)

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

Text Book

1. G. Aruldhas, Molecular structure and spectroscopy (Second Edition), PHI Learning Private Ltd, 2017. (Unit I-V)

Books for Reference

1. Colin N. Banwell, Elaine M. McCash, Fundamentals of Molecular Spectroscopy (Fourth Edition), Tata McGraw-Hill Publishing Company Ltd, 1995.
2. J.D. Graybeal, Molecular Spectroscopy, McGraw-Hill, New York, 1988.
3. Hollas, Michael, Modern Spectroscopy (Fourth Edition) John Wiley, New York, 2004.
4. R.P Straughen, S.Walker, Spectroscopy Vols.I,II and III, Chapman & Hall, London, 1976

PPHT42 **NUCLEAR PHYSICS AND PARTICLE PHYSICS** **6hrs/5credit**

Objective:

- Different properties of nucleus learnt
- Detailed knowledge on nuclear models.
- Familiarization of the experimental tecniques.
- Understanding the concept of Elementary Particles.

Unit I: General Properties of nuclei

Charge-Mass-Radius-Angular momentum (Spin)- Magnetic dipole moment- Electric Quadra pole moment- Parity- Isobaric spin (isospin) – statistics- The nuclear level spectrum - Nuclear forces

Unit II: Nuclear models

Types of models- The liquid drop model, Shell model – Empirical evidence for the regularity of nuclear properties- The single particle shell model- The collective Model –Collective vibration & rotation – Single Particle motion in a deformed potential – Decay of unstable nuclei- Electromagnetic transitions – General properties and selection rules- the lifetime- energy relation- internal conversion- determination of transistion probalities- angular correlation-β decay –General prosperities- Neutrinos and antineutrinos- The Fermi theory – selection rules- electron capture- Alpha decay- general properties- barrier penetration of alpha decay- Spontaneous fission decay

Unit III: Experimental Techniques:

Passage of charged particles and radiation through matter – Energy loss by collision- Energy loss by radiation- Absorption of electromagnetic radiation-Detectors for nuclear structure studies – Gaseous detector- Solid state detector-Detectors for particle physics studies- Bubble chamber- Multiwire proportional chambers and drift chambers- streamer chamber- spark chamber- Cherenkov and transition radiation detectors- total absorption calorimeters

Unit IV: Nuclear reactions

Disintegration of nitrogen by alpha particles & proton- induced activity & fission– Formalism – Compound nuclear reactions- origin- discrete resonanace-continuum states- The Optical model of particle induced nuclear reactions

Unit V: Elementary Particle Physics Classification of elementary particles – Leptons, Hadrons and Quarks – Fundamental interactions and their unification

Symmetry Transformations and conservation laws: The group SU (2) and isospin symmetry an example of the SU(2) group - charge conjugation – Time reversal – The CPT theorem – SU(3) symmetry, Nucleon doublet and pion triplet – Meson octet, Baryon octet and decuplet.

Text Book

1. W.E.Burcham and M.Jobes, Nuclear and Particle Physics, International student edition, Addison Wesley Longmen, Inc (1998) (Unit I-V)

Books for reference

1. D,C, Tayal, Nuclear Physics (2^{nd} Edition), Himalayan Publishing House, Bombay (2009)
2. K.S. Krane, Introductory Nuclear Physics (John - Wiley, New York, 1987.
3. M.L.Pandya and R.P.S. Yadav, Elements of Nuclear Physics, Kedar Nath Ram Nath, Meerut, 2004.

PPHP44 **PROJECT and VIVA-VOCE** **18hrs/5 credit**

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.