NEW SCHEME
CHOICE BASED CREDIT SYSTEM

FOR

M.Sc. (PHYSICS)

JULY-2022

Department of Physics,
Sri Sai University
Palampur
Himachal Pradesh
176081

Course Structure

Course Code	Title of the Paper	L	P	Contact Hours / Week	Credits
Semester-I					
PHY-CC-411	Mathematical Physics	4	0	4	4
PHY-CC-412	Classical Mechanics	4	0	4	4
PHY-CC-413	Electronics	4	0	4	4
CA-AE-414	Fundamentals of Information Technology	4	0	4	4
PHY-415	Physics Laboratory-I	0	6	12	6
CA-AE-414(P)	Fundamentals of Information Technology laboratory	0	4	2	2
					24
Semester-II					
PHY-CC-421	Quantum Mechanics-1	4	0	4	4
PHY-CC-422	Condensed Matter Physics	4	0	4	4
PHY-CC-423	Electrodynamics	4	0	4	4
PHY-CC-424	Spectroscopy	4	0	4	4
PHY-OE-001	Elements of nano science and nano technology	2	0	2	2
PHY-425	Physics Laboratory-II	0	6	12	6
					24
Semester-III					
RM-CC-022	Scientific Research Methodology	4	0	4	4
PHY-CC-431	Quantum Mechanics-1I	4	0	4	4
	Any one of the following subjects				
PHY-EC-432A	a) Materials Sciences-I	4	0	4	4
PHY-EC-432B	b) Electronics-I	4	0	4	4

PHY-EC-432C	c) Nuclear & Particle Physics-I	4	0	4	4
	Any one of the following subjects				
PHY-EC-433 A	a) Solid State Physics-I	4	0	4	4
PHY-EC-433B	b) Plasma Physics-I	4	0	4	4
PHY-EC-433C	c) Nano Physics-I	4	0	4	4
PHY-OE-002	Radiation Physics	2	0	2	2
PHY -434	Physics Laboratory-III	0	6	12	6
PHY-501	Seminar	2	0	4	2
					26
Semester-IV					
PHY-CC-441	Statistical Mechanics	4	0	4	4
PHY-CC-442	Advanced Quantum Mechanics	4	0	4	4
	Any one of the following subjects				
PHY-EC-443A	a) Materials Sciences-II	4	0	4	4
PHY-EC-443B	b) Electronics-II	4	0	4	4
PHY-EC-443C	c) Nuclear & Particle Physics-II	4	0	4	4
	Any one of the following subjects				
PHY-EC-444A	a) Solid State Physics-II	4	0	4	4
PHY-EC-444B	b) Plasma Physics-II	4	0	4	4
PHY-EC-444C	c) Nano Physics-II	4	0	4	4
PHY-502	Dissertation	6	0	12	6
					22

Total marks of all four semesters

Semester	Marks	Credits
Semester I	**550**	**24**
Semester II	**550**	**24**
Semester III	**600**	**26**
Semester IV	**500**	**22**
Total	**2200**	**96**

***Core Courses (CC)-11, Ability enhancement courses (AE)-01, Open Elective Courses (OE)-02, Elective courses (EC)-06**

Semester I

PHY-CC-411: MATHEMATICAL PHYSICS

Course Objectives	• To expose the students to the fascinating world of real and complex numbers • To make the students learn about special functions essential in solving physics problems • To make them understand about Fourier series and Fourier transforms
Course Outcomes	• Able to differentiate a function of complex variable, will be familiar with contour integration, expansion of a complex function and evaluation of residue at a pole • Familiar with Fourier and Laplace transformations and their applications • To obtain series solution of differential equation and will be familiar with Legendre and Hermit polynomials • Able to compute determinants, Eigen value problems, diagonalization of matrices in several areas of physics

DETAILED CONTENT

Module I Complex variables
Analyticity of the function of a complex variable, Cauchy integral theorem and formula, Expansion of an analytic function; Taylor and Laurent series, Residue theorem, contour integration, Applications in evaluation of definite integrals.

Module II Vector spaces
Vector Spaces and Matrices; linear independence, Bases; dimensionality; inner product; linear transformations, Matrice Inverse; Orthogonal and Unitary matrices, Independent elements of a matrix; Eigen-values and Eigen-vectors, Diagonalization, Complete ortho-normal set of functions.

Module III Special and orthogonal functions
Partial differential equations, separation of variable technique in Cartesian, spherical, cylindrical coordinates, special functions related to these equations (Laguerre, Bessel's, Legendre and Hermite) and their applications to boundary value problems, Sturm-Liouville theory and orthonormal Eigen-functions. Beta and gamma functions, Fourier and Laplace transforms and their properties, Applications of Laplace Transforms to solve differential equations.

Module IV Functions of a complex variable
Complex algebra, Functions of a complex variable, Cauchy's integral theorem, Cauchy's integral formula; Taylor and Laurent expansions; Singularities; Cauchy's residue theorem, Cauchy principle value, Singular points and evaluation of residues, Jordan's Lemma; Green Function, Cauchy's residue theorem

Module V Group Representation

Group's representation by matrices, reducible and irreducible representations, great orthogonality theorem and its geometric interpretation, character of a representation, construction of character table with illustrative examples of symmetry groups of equilateral triangle, rectangle and square. Decomposition of reducible representation, the regular representation.The elements of the group of Schrodinger equation

Text Books:

1) Applied Mathematics for Engineers and Physicist: Pipes
2) Advanced Engineering Mathematics: Kreyszig
3) Schaum Series for Transforms, Complex Variables and Tensors

Reference Books:

1) G. Arfken: Mathematical Methods for Physicist 4th edition (Academic Press).
2) J. Mathews and R. L. Walker: Mathematical Methods of Physics (I. B. House Pvt. Ltd.).
3) Harper: Introduction to Mathematical Physics (Prentice Hall of India).
4) A. W. Joshi: Vectors & Tensors (Wiley Eastern Limited).
5) A. W. Joshi: Elements of Group Theory (Wiley Eastern).

PHY-CC-412 CLASSICAL MECHANICS

Course Objectives	• Able to deals with Newton's laws of motion and several of its later metamorphoses like Euler Lagrange formulations, Hamilton Jacobi equations • It imparts knowledge on different formulations of mechanics; more importantly the Hamiltonian formulation with Poisson bracket prepares the students for quantum mechanics • The subject of nonlinear dynamics and chaos has enormous scope for both basic and applied research
Course Outcomes	• Familiar with the application of Lagrangian formulation • Familiar with the variational principle, central force problem, virial theorem • Familiar with small oscillations and rotation of rigid body

DETAILED CONTENT

Module I Variational principles and Lagrangian formulation of mechanics
D'Alembert's Principle and Lagrange's equations, Constraints and generalize coordinates, Calculus of variations, Hamilton's principle and derivation of Lagrange's equation from it, Extension to nonholonomic and non-conservative systems, Symmetry properties of space and time and the corresponding theorems (with reference to cyclic coordinates), Simple applications of Lagrangian formulation for a single particle and a system of particles, Lagrangian formulation of relativistic mechanics.

Module II Central force problem
Equations of motion and first integrals, Equivalent one dimensional problem and classification of orbits, The virial theorem, Differential equation for a orbit with a general power law potential, Applications: Kepler problem; scattering in c.m. and lab coordinates.

Module III Kinematics of rigid bodies
Generalized coordinates of a rigid body, orthogonal transformations and the transformation matrix, The Euler's angles and Euler's theorem on motion of rigid bodies, infinitesimal rotations, motion in a rotating frame of reference.

Module IV Dynamics of rigid bodies
Coriolis force on (i) air flow on the surface of earth (ii) projectile motion (iii) atomic nuclei, Angular momentum and Kinetic energy of motion about a point, Moment of inertia tensor, the principle axis transformation, Euler's equation of motion, Torque free motion of a rigid body, Heavy symmetric top with one point fixed.

Module V Hamiltonian Formulation of Mechanics
Legendre's transformations and Hamilton's equations of motion, Derivation of Hamilton's equations from variational principle, The principle of least action, Canonical transformations, Poisson's and Lagrangian brackets, their invariance under a canonical transformation, equations of motion in the Poisson's bracket notation; infinitesimal canonical transformations, constants of motion and symmetry properties.

Text Books:

1) I.C. Percival and D. Richards, Introduction to Dynamics.
2) J.V. Jose and E.J. Saletan, Classical Dynamics: A Contemporary Approach.
3) E.T. Whittaker, A Treatise on the Analytical Dynamics of Particles and Rigid Bodies.
4) Upadhyaya J C, Classical Mechanics, Himalaya Publishing House.

Reference Books:

1) J. B. Marion, Classical Mechanics (Academic Press).
2) L. D. Landau and E. M. Lifshitz, Mechanics 3rd ed. (Pergamon).
3) R. G. Takwale & P. S. Puranik, Introduction to Classical Mechanics (Tata McGraw Hill)
4) K C. Gupta, Classical Mechanics of Particles and Rigid Bodies (Wiley Eastern).
5) N. C. Rana and P. S. Joag, Classical mechanics (TMH).

PHY-CC-413: ELECTRONICS

Course Objectives	• To make the students familiar about the concepts of components used in various electronic devices • To make the students learn the basics of digital electronics which will be useful to them in understanding the concept behind Digital India
Course Outcomes	• Able to understand the fundamentals and to analyze various electronic circuits • Able to understand differential and operational amplifier, and their applications. • Familiar with SCR, registrar, multivibrator and microprocessors

DETAILED CONTENT

Module I Electronic devices

MESFETs and MOSFETs, charge coupled (CCDs) devices, unijunction transistor (UJT), four layer (PNPN) devices, construction and working of PNPN diode, semiconductor controlled rectifier (SCR) and thyristor.

Module II Amplifier models, feedback and biasing

Two port network analysis: active circuit models, gain in decibels, equivalent circuit for BJT, the transconductance model for BJT, analysis of CE, CB, and CC amplifiers; An amplifier with feedback, effect of negative feedback on gain and its stability, distortions, input and output impedances of amplifiers, Analysis of amplifiers with voltage series, voltage shunt, current series and current shunt negative feedbacks; Location of quiescent (Q) point, biasing circuits for amplifiers: fixed bias, emitter feedback bias & voltage feedback bias, bias sources for integrated circuits, Circuits for stabilization of Q-Point.

Module III Electronic circuits

Multivibrators (bistable, monostable and astable), differential amplifier, operational amplifier (OP-AMP), OP-AMP as inverting and non-inverting, scalar, summer, integrator, differentiator

Module IV Digital principles

Binary and hexadecimal number system, binary arithmetic, logic gates, Boolean equation of logic circuits, Karnaugh map simplifications for digital circuit analysis and design, encoders & decoders, multiplexers and demultiplexers, Parity generators and checkers, adder-subtraction circuits, Flip flops.

Module V Microprocessors

Basic architecture of INTEL 8085 microprocessor, assembly language (AL), Machine language (ML), Programming of 8085 microprocessor, instructions for simple mathematical operations: addition, subtraction, multiplication and division.

Text Books:

1) Electronic Devices and Circuits- Millman and Halkias-Tata Mc Graw Hill, 1983.
2) Solid State Electronic Devices - Ben G Streetman- Prentice Hall, New Delhi, 1995.
3) Digital Principles and Applications- A.P. Malvino & D.P. Leach-Tata McGraw Hill, New Delhi, 1986.

Reference Books:

1) Digital Computer Electronics- A. P. Malvino-Tata Mc Graw Hill, New Delhi, 1986
2) Microelectronics - Millman-Tata Mc Graw Hill, London, 1979.
3) Digital Electronics -W.H. Gothmann-Prentice Hall, New Delhi, 1980.

CA-AE-414: FUNDAMENTALS OF INFORMATION TECHNOLOGY

Course Objectives	• This course introduces the concepts of computer basics & programming with particular attention to examples • Fundamental computational concepts underlying most programming languages • A range of problem solving techniques using computers • The role of programming within the overall software development process • The clear expression of solutions at different levels of abstraction
Course Outcomes	• On completion of the course students will be able to understanding the concept of input and output devices of computers and how it works and recognize the basic terminology used in computer programming. • Techniques for solving problems. • The main activities of software development and their interactions, and some of the major problems of software development.

DETAILED CONTENT

Module I Computer Organisation
What are computers?, evolution of computer, classification of computers, block diagrm, input-output devices, description of computer input units, other input methods, and computer output units, Computer memory: memory cell, memory organisation, read only memory, serial access memory, physical devices, use to construct memories, magnetic hard disk, floppy disk drives, compact disk read only memory, magnetic tape drives.

Module II
Low level and high level languages, assembles, compilers, interpreters, linkers, algorithms, flow charting, decision tables, pseudo code, software concepts: system and application software packages.

Module III Computer Generation & Classifications
First generation of computers, the second generation, the third generation, the fourth generation, the fifth generation, classification of computers, distributed computer system, parallel computers.

Module IV Operating System Concepts
Different types of operating systems, structure of operating system, DOS/UNIX/LINUX commands, working with windows, windows 9x/NT/XP, data processing , file systems,and data base manegment systems,different types of data base manegment system.

Module V Basic Elements of a Communication System

Data transmission modes, data transmission speed, data transmission media, digital and analog transmission,network topologies, network types (LAN,WAN & MAN),OSI & TCP/IP model, internet:network, client and servers, host and terminals, TCP/IP ,World Wide Web, hyper text, Uniform Resource Locator, Web Browsers, IP Address, domain name ,internet service provider, internet security, internet requirements, web search engine, net surfing, internet services, internet

Text Books:

1) P.K. Sinha, Priti Sinha, Computer Fundamentals, BPB Publications.
2) Vikas Gupta, Comdex Computer Kit, Wiley Dreamtech, Delhi.
3) Alex Leon & Mathews Leon, Fundamentals of Information Technology, Leon Techworld.

Reference Books:

1) V. Raja Raman, Introduction to Computers, PHI.
2) Alex Leon & Mathews Leon, Introduction to Computers, Vikas Publishing House.
3) Norton Peter, Introduction to Computers, TMH.

PHY -415: PHYSICS LABORATORY-I

Course Objectives	• To make the students to understand experimental physics • To apply the theoretical knowledge for developing new devices
Course Outcomes	• Comprehend the concepts through simple experiments. • Design and develop the instruments for advanced studies. • Evaluate theoretical calculations using experimental observations. • Will be capable of handling sophisticated instruments besides learning the Physics concepts behind these experiments

DETAILED CONTENT

1. To determine Planck's constant using photocell.
2. Kelvin double bridge: Determination of low resistance.
3. Anderson Bridge: determination of self-inductance.
4. To study SR and JK flip flop circuits using logic gates.
5. Study of characteristics of BJT
6. Study of characteristics of SCR
7. Study of characteristics of UJT
8. Study of characteristics of FET
9. Study of Op-Amplifier
10. Millikan's oil drop experiment.
11. To study quantized excitation energy in argon using Frank Hertz experiment.
12. To Measure reverse saturation current in pn junction diode at various temperatures and to find the approximate value of energy gap.

***Text Books**:*
1) A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal

***Reference Books**:*
1) Advanced Practical Physics for Students, B.L. Worsnop, H.T. Flint
2) BSc Practical Physics, Geeta Sanon, R. Chand & Co.

CA-AE-414(P): FUNDAMENTALS OF INFORMATION TECHNOLOGY LABORATORY

Course Objectives	• To make the students learn essential aspects of a programming language their applications in a variety of problems • A range of problem solving techniques using computers • The role of programming within the overall software development process • The clear expression of solutions at different levels of abstraction
Course Outcomes	• Techniques for solving problems. • The main activities of software development and their interactions, and some of the major problems of software development. • Able to write program to implement different computational technique.

DETAILED CONTENT

1. Practical Based on operating system (windows/unix)
2. Use of word processing software, spread sheet software and presentation software
3. Keywords and Identifiers: introduction, purpose
4. Variables and constants: data types, Initialization, declaration, scope, memory limits
5. Input-output statements: formatted and non-formatted statements
6. Operators: Arithmetic, logical, conditional, assignment, bitwise increment/decrement operators
7. Decision Making: switch, if-else, nested if, else-if ladder, break, continue, goto
8. Loops: while, do-while, for
9. Functions: definition, declaration, variable scope, parameterized functions,
10. Pre-processor Directives: Pre-processor directives like INCLUDE, IFDEF,DEFINE, etc
11. Header Files: STDIO.H, MATH.H, STRING.H, PROCESS.H etc
12. Arrays: Array declarations, Single and multi-dimensional, memory limits, strings and string functions
13. Pointers: Pointer declarations, pointer to function, pointer to array/string,
14. Files: Creation and editing of various types of files, closing a file (using functions and without functions)

Text Books:
1) Computer graphics by Newman

Reference Books:
1) Computer graphics by S. Harrington
2) Computer graphics by D. Heam and P. M. Baker

SEMESTER-II

PHY-CC-421 QUANTUM MECHANICS-I

Course Objectives	• Familiar with the fundamentals of quantum mechanics • To learn how to apply Perturbation Theory (Time Independent) in non-degenerate and degenerate situations • To apply approximate method in Quantum Mechanics to treat molecule
Course Outcomes	• Able to solve and analyse various quantum mechanical problem related to Time Independent Perturbation Theory • Able to treat molecules quantum mechanically

DETAILED CONTENT

Module I Basic formalism
Wave functions for a free particle-Interpretation and conditions on the wave function - Postulates of quantum Mechanics and the Schroedinger equation - Ehrenfest's theorem - Operator formalism - Linear operators - Self adjoint operators - Expectation Value - Stationary States - Hermitian Operators for dynamical variables - Eigen values and eigen function - Orthonormality - Uncertainty Principle.

Module II Applications
Ladder operators and simple harmonic oscillator - Rigid rotator - Step Potential - Particle in a central potential - Particle in a periodic potential - Orbital angular momentum and spherical harmonics - Central forces and reduction of two body problem - Particle in a Spherical well - Hydrogen atom.

Module III General formalism
Hilbert's space - Dirac notation - Representation theory - Co-ordinate and momentum representations - Time evolution - Schroedinger, Heisenberg and Interaction pictures - Symmetries and conservation laws - Unitary transformations associated with translations and rotations.

Module IV Approximation methods
Time-independent perturbation theory for non- degenerate and degenerate levels - Application to ground state of an harmonic oscillator and Stark effect in Hydrogen - Variation method - Application to ground state of Helium atom - WKB approximation - WKB quantization rule - Application to simple Harmonic Oscillator.

Module V Angular momentum and identical particles
Commutation rules for angular momentum operators - Eigen value spectrum from angular momentum algebra - Matrix representation - Spin angular momentum - Non-relativistic Hamiltonian including spin - Addition of two angular momenta - Clebsch - Gordan coefficients - Symmetry and anti symmetry of wave functions - Pauli's spin matrices.

Text Books:
1) L. I. Schiff, Quantum Mechanics (McGraw Hill).
2) Eugan Merzbacher, Quantum Mechanics, Johan Wiley & Sons Inc.
3) P. M. Mathews and K. Venkatesan, A Text-Book of Quantum Mechanics (TMH)

Reference Books:
1) J. J. Sakurai, Modern Quantum Mechanics (Addison-Wesley).
2) A. K. Ghatak and S. Lokanathan, Quantum Mechanics 3rd edition (Mac Millan).
3) C. Cohen-Tannoudji, Bernard Diu, Franck Loloe, Quantum Mechanics Vol-I & II (John Wiley).

PHY-CC-422 CONDENSED MATTER PHYSICS

Course Objectives	• To make the students familiar with Dia, para and ferromagnetic material • To understand superconductivity and defect in solids
Course Outcomes	• Familiar with antiferromagnetism & ferrimagnetism • Familiar with superconductivity and defect in solids

DETAILED CONTENT

Module I Dia-Para and ferromagnetism
Classification of magnetic materials, origin of permanent magnetic dipoles, diamagnetic susceptibility, classical theory of paramagnetism, quantum theory of paramagnetism, quenching of orbital angular momentum, cooling by adiabatic demagnetization, paramagnetic susceptibility of conduction electrons, ferromagnetism, the Weiss molecular field, the interpretation of the Weiss field, ferromagnetic domains, spin waves, quantization of spin waves, Thermal excitations of magnons.

Module II Antiferro-ferrimagnetism
The two sub lattice model, super exchange interaction, the structure of ferrites, saturation magnetization, Neel's theory of ferrimagnetism, Curie temperature and susceptibility of ferrimagnets.

Module III Superconductivity
Superconductivity, zero resistivity, critical temperature, Meissner effect, type I and type II superconductors, specific heat and thermal conductivity, BCS theory, Ginzsburg- Landou theory, Josephson effect: dc Josephson effect, ac Josephson effect, macroscopic quantum interference, high temperature superconductivity.

Module IV Defects and diffusion in solids
Point defects: impurities, vacancies- Schottky and Frankel vacancies, colour centres and coloration of crystals, F-centres, line defects (dislocations), edge and screw dislocations, Berger vector, planar (stacking) faults, grain boundaries, low angle grain boundaries, the hydration energy of ions, activation energy for formation of defects in ionic crystals, ionic conductivity in pure alkali halides.

Module V Lattice vibrations and phonons
Vibrations of one dimensional linear monoatomic lattice, normal modes of vibrations in a finite length of the lattice, the linear diatomic lattice, excitation of optical branch in ionic crystals–the infra red absorption, quantization of lattice vibrations-concept of phonons, phonon momentum, inelastic scattering of photons by phonons, inelastic scattering of neutrons by phonons.

Text Books:

1) An Introduction to Solid State Physics: C. Kittel-Wiely Estem Ltd., New Delhi, 1979.
2) Solid State Physics-A.J. Dekkar- Maemillan India Ltd., New Delhi, 2004.
3) Principles of Solid State Physics-R.A. Levy-New York Academy, 1968.

Reference Books:

1) Introduction to Solids-Azaroff-Tata Mc Graw Hill, New Delhi, 1992.
2) Elementary Solid State Physics-Omar, Addison Wesly, 1975.
3) Solid State Physics-Aschroft and Mermin-New York Holt, 1976

PHY-CC-423: ELECTRODYNAMICS

Course Objectives	• To understand how materials are affected by electric and magnetic fields. • To understand the relation between the fields under time varying situations and also the Maxwell's equations • To understand principles of propagation of uniform Plane wave
Course Outcomes	• Apply the knowledge of vector calculus and different coordinate systems to problems of electromagnetic theory • Recall the concepts of electrostatics for different charge distribution systems • Demonstrate the knowledge of electricity and magnetism to derive Maxwell's equations and be able to apply them to real electromagnetic systems

DETAILED CONTENT

Module I Electrostatics
Coulomb's law, Guass's law, Poisson's equation, Laplace equation, solution of boundary value problem: Green's function, method of images and calculation of Green's function for the image charge problem in the case of a sphere, Laplace equation, uniqueness theorem, electrostatics of dielectric media, multipole expansion, boundary value problems in dielectrics; molecular polarisability, electrostatic energy in dielectric media.

Module II Magnetostatics
Biot-Savart law, the differential equation of magnetostatics and Ampere's law, vector potential and magnetic fields of a localised current distribution, magnetic moment, force and torque on a magnetic dipole in an external field, magnetic materials, magnetisation and microscopic equations.

Module III Time-varying fields
Time varying fields, Maxwell's equations, conservation laws, Faraday's law of induction, energy in a magnetic field, Maxwell's displacement current, vector and scalar potential, Gauge transformations; Lorentz gauge and Coulomb gauge, Poynting theorem, conservation laws for a system of charged particles and electromagnetic field, continuity equation.

Module IV Electromagnetic wave
Plane wave like solutions of the Maxwell equations, polarization, linear and circular polarization, Superposition of waves in one dimension, Group velocity, illustration of propagation of a pulse in dispersive medium, reflection and refraction of electromagnetic waves at a plane surface between dielectrics, polarization by reflection and total internal reflection, Waves in conductive medium, simple model for conductivity.

Module V Method of Images & Special Theory of Relativity

Point charge near an infinite good conducting plane, Point charge in the presence of grounded conducting sphere, Point charge in the presence of charged, insulated conducting sphere, Point charge near a conducting sphere at fixed potential, Conducting sphere in a uniform electric field. Review of Four vectors and Lorentz transformation in four dimensional space, Mathematical properties of the space-time of special relativity, Electromagnetic field tensor and covariance of Electrodynamics under Lorentz transformation.

Text Books:

1) Introduction to Electrodynamics, D. J. Griffith, 4th edition, Addison-Wesley Professional, Boston, 2012.
2) Foundations of Electromagnetic Theory, J.R. Reitz., F.J. Milford and R. W. Christy, 2010, 4th edition, Pearson.

Reference Books:

1) Classical Electrodynamics - J.D. Jackson-John & Wiley Sons Pvt. Ltd. New York, 2004.
2) Introduction to Electrodynamics- D.J. Griffiths-Pearson Education Ltd., New Delhi, 1991.
3) Classical Electromagnetic Radiation - J.B. Marion-Academic Press, New Delhi, 1995.

PHY-CC-424: SPECTROSCOPY

Course Objectives	• To make the students understand various spectroscopy • To make the students understand about NMR and NQR Techniques
Course Outcomes	• The students will be able to understand Raman, microwave & infrared spectroscopy • The students will be capable to understand NMR and NQR Techniques

DETAILED CONTENT

Module I Microwave spectroscopy
Pure rotational spectra of diatomic molecules - Polyatomic molecules - Study of linear molecules and symmetric top molecules - Hyperfine structure and quadruple moment of linear molecules - Experimental techniques - Molecular structure determination - Stark effect - inversion spectrum of ammonia - Applications to chemical analysis. Module II Breadth of spectral line and effects of external fields

Module II Infrared spectroscopy
Vibrational spectroscopy of diatomic and simple polyatomic molecules- Harmonic Oscillator -An harmonic Oscillator-Rotational vibrators-Normal modes of vibration of Polyatomic molecules-Experimental techniques-Applications of infrared spectroscopy-H_2O and N_2O molecules- Reflectance spectroscopy.

Module III Raman Spectroscopy
Classical theory of Raman Scattering - Raman effect and molecular structure - Raman effect and crystal structure - Raman effect in relation to inorganic, organic and physical chemistry - Experimental techniques - Coherent anti-Stokes Raman Spectroscopy - Applications of infrared and Raman spectroscopy in molecular structural confirmation of water and CO_2 molecules.

Module IV NMR and NQR Techniques
Theory of NMR - Bloch equations - Steady state solution of Bloch equations - Theory of chemical shifts - Experimental methods - Single Coil and double coil methods -Pulse Method -High resolution method - Applications of NMR to quantitative measurements, Quadruple Hamiltonian of NQR - Nuclear quadruple energy levels for axial and non-axial symmetry - Experimental techniques and applications.

Module V ESR and Mossbauer Spectroscopy
Quantum mechanical treatment of ESR-Nuclear interaction and hyperfine structure–Relaxation effects- Basic principles of spectrographs-Applications of ESR method. Mossbauer effect- Recoilless emission and absorption - Mossbauer spectrum - Experimental methods- Mossbauer spectrometer -Hyperfine interactions - Chemical Isomer shift -Magnetic hyperfine interactions-Electric quadruple interactions-Simple biological applications.

Text Books:

1) C.N. Banwell and E.M. McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw-Hill Publications, New Delhi.
2) G. Aruldas, 2001, Molecular Structure and Spectorscopy, Prentice - Hall of India Pvt.Ltd., New Delhi.
3) D.N. Satyanarayana, 2004, Vibrational Spectroscopy and Applications, New Age International Publications, New Delhi.

Reference Books:

1) Atta Ur Rahman, 1986, Nuclear Magnetic Resonance, Spinger Verlag, New York.
2) Towne and Schawlow, 1995, Micorwave Spectroscopy, McGraw-Hill,
3) Raymond Chang, 1980, Basic Principles of Spectroscopy, Mc Graw-Hill, Kogakusha, Tokyo.
4) D.A. Lang, Raman Spectroscopy, Mc Graw-Hill International, N.Y.

PHY-OE-001: ELEMENTS OF NANO SCIENCE AND NANO TECHNOLOGY

Course Objectives	• To make the students understand Nano science and nano technology. • To make the students understand various approaches.
Course Outcomes	• The students will be able to understand the nano science and nano technology. • The students will understand the various approaches.

DETAILED CONTENT

Module I
Introduction to Nanomaterials: Bottom up and Top Down approach, Classification of nanostructures: Zero dimension, one dimension and two dimensional nanostructures, Smart materials.

Module II
Nanostructure fabrication by Physical Methods: Physical Vapor deposition: evaporation, Molecular beam epitaxy, sputtering, comparison of evaporation and sputtering, Lithography: Photolithography, Electron Beam Lithography, X-ray lithography

Module III
Structural characterization: X-ray diffraction, small angle X-ray scattering, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunneling Microscopy, Spectroscopic Techniques: UV-Visible Spectroscopy, Photo-luminescence spectroscopy, Infra-red spectroscopy, Raman Spectroscopy,

Module IV
Physical properties of nanomaterials: Melting points and lattice constants, Mechanical properties, Optical properties, Electrical conductivity, Super paramagnetism

Text Books:
1) Introduction to Nanotechnology – Charles P. Poole Jr. and Frank J. Owens, Wiley India Pvt. Ltd., 2007.
2) Nanomaterials – Guozhong Cao, Imperial College Press, 2004.

Reference books:
1) Nanotechnology Fundamentals and Applications, Manasi Karkare, I.K.- International Publishing House.
2) Nanomaterials, B. Viswanathan- Narosa.

PHY-425: PHYSICS LABORATORY –II

Course Objectives	• To make the students to understand experimental physics • To apply the theoretical knowledge for developing new devices
Course Outcomes	• Comprehend the concepts through simple experiments. • Design and develop the instruments for advanced studies. • Evaluate theoretical calculations using experimental observations. • Having a clear understanding of the subject related concepts and of contemporary issues • Having computational thinking (Ability to translate vast data into abstract concepts and to understand database reasoning)

DETAILED CONTENT

1. Determination of wavelength and difference in wavelengths of sodium lines, and thickness of mica sheet using Michelson Interferometer.
2. ESR Spectrum of DPPH and calculation of g factor.
3. To trace B-H curve for different materials using CRO and to find the magnetic parameters from these. Also calculate the energy loss per cycle.
4. To find the susceptibility of a given salt by Quinck's Method.
5. Stefan's constant.
6. Solar cell Characteristics.
7. Measurement of Hall coefficient of given semiconductor. Identification of type of semiconductor and estimation of charge carrier concentration
8. Measurement of resistivity of a semiconductor by four probe method at different temperatures and determination of band gap.
9. To study uncertainty principle using Laser.
10. To determine crystal structure of different material using X ray diffraction.
11. To determine the wavelength of given source light using diffraction grating on spectrometer.
12. To determine the charge to mass ratio (e/m) of an electron with normal Zeeman Effect
13. To determine the velocity of ultrasonic waves in a liquid using ultrasonic interferometer

Text Books:

1) A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal

***Reference Books**:*

1) Advanced Practical Physics for Students, B.L. Worsnop, H.T. Flint
2) BSc Practical Physics, Geeta Sanon, R. Chand & Co.

SEMESTER-III

RM-CC-022: SCIENTIFIC RESEARCH METHODOLOGY

Course Objectives	This course will help to: Develops Better Insight Into Topic; Provides Systematic Structure; Enhance The Research Quality; Derive Better Solutions; Aids In Decision Making; Inculcates Logical And Systematic Thinking
Course Outcomes	At the end of this course, the students should be able to: • understand some basic concepts of research and its methodologies • identify appropriate research topics • select and define appropriate research problem and parameters • prepare a project proposal (to undertake a project) • organize and conduct research (advanced project) in a more appropriate manner • write a research report and thesis • write a research proposal (grants)

DETAILED CONTENT

Module I

Foundations of Research: Meaning, Objectives, Motivation, Utility, Concept of theory, empiricism, deductive and inductive theory, Characteristics of scientific method– Understanding the language of research – Concept, Construct, Definition, Variable, Research Process.**Problem Identification & Formulation** – Research Question – Investigation Question –Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance

Module II

Research Design: Concept and Importance in Research – Features of a good research design Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.**Qualitative and Quantitative Research:** Qualitative research–Quantitative research– Concept of measurement, causality, generalization, replication, Merging the two approaches.

Module III

Measurement: Concept of measurement– what is measured? Problems in measurement in research–Validity and Reliability, Levels of measurement–Nominal, Ordinal, Interval, Ratio. **Sampling:** Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response, Characteristics of a good sample, Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling, Determining size of the sample – Practical considerations in sampling and sample size.

Module IV

Data Analysis: Data Preparation–Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis –Cross tabulations and Chi-square test including testing hypothesis of association. **Interpretation of Data and Paper Writing** – Layout of a Research Paper, Journals in Chemical Sciences, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

Module V

Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline. **Use of tools / techniques for Research:** methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism

Text Books:

1) Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2) Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.

References Books:

1) Research Methodology – C.R.Kothari
2) Select references from the Interne

PHY-CC-431: QUANTUM MECHANICS– II

Course Objectives	• To learn how to treat Two–level systems Quantum Mechanically • To learn the basics of relativistic quantum Mechanics
Course Outcomes	• Competent to take up research in frontier areas like quantum information, quantum computation, quantum entanglement, quantum fields and quantum gravity • Able to understand the central concept and principles of relativistic Quantum Mechanics. • Besides quantum mechanics for learning and appreciating phenomena in several other disciplines like condensed matter, statistical mechanics, optics

DETAILED CONTENT

Module I Quantum theory of scattering

Scattering experiments and cross-sections, Laboratory and centre-of-mass systems, Scattering amplitude and cross-section; Method of partial waves: Phase shift, Differential and total cross-sections, Relation between phase shift and scattering potential, Convergence of partial-wave series, Scattering by a finite square well, Resonances- Breit-Wigner formula, Scattering by a hard-sphere potential; Green's function method: Lippmann-Schwinger equation, Born series, First Born approximation, Scattering of an electron by a screened Coulomb potential in Born approximation and validity criterion; Scattering of two identical spinless bosons, and spin-1/2 fermions

Module II Relativistic quantum mechanics

Klein Gordon equation. Dirac Equation, Lorentz covariance of Dirac equation, positive and negative energy solutions of Dirac equation, positrons, properties of gamma matrices, parity operator and its action on states, magnetic moments and spin orbit energy.

Module III Identical particles

Brief introduction to identical particles in quantum mechanics symmetrisation postulates, application to 2-electron systems, Pauli exclusion Principle, Bose- Einstein and Fermi Dirac statistics.

Module IV Relativistic Dirac equations

Dirac equation; relativistic Hamiltonian, probability density, expectation values, Dirac gamma matrices and their properties, non-relativistic limit of Dirac equation, covariance of Dirac equation and bilinear covariance, plane wave solution, energy spectrum of hydrogen atom, electron spin and magnetic moment, negative energy sea, hole interpretation and the concept of positron, Spin-orbit coupling, hyperfine structure of hydrogen atom.

Module V Quantization of wave fields

The procedure for quantization of wave fields, quantization of non-relativistic Schrodinger equation, second quantization, N-representation creation and annihilation operators.

Text Books:

1) Modern Quantum Mechnics: J.J. Sakurai-Pearson Educaton Pvt. Ltd., New Delhi, 2002.
2) Quantum Mechanics: L I Schiff-Tokyo Mc Graw Hill, 1968.
3) Feynmann lectures in Physics Vol. III-Addison Wesly, 1975.
4) Quantum Mechanics: Powel and Craseman-Narosa Pub. New Delhi, 1961.
5) Quantum Mechanics: Merzbacher-John Wiley & Sons, New York, 1970.

Reference Books:

1) A Text book of Quantum Mechanics: P. M. Mathews and K. Venkatesan-TMH.
2) Quantum Mechanics: A. S. Davydov-Pergamon.
3) Quantum Mechanics: L. I. Schiff-McGraw Hill.
4) Relativistic Quantum Mechanics: J. D. Bjorken and S. D. Drell-McGraw Hill.
5) Advanced Quantum Mechanics: J. J. Sakurai-Addison Wesley.

PHY-EC-432A: a) MATERIAL SCIENCE I

Course Objectives	• To make the students familiar with the imperfections in solid. • To understand mechanical properties and characterisation techniques.
Course Outcomes	• Will have knowledge about material science basic concepts and properties.

DETAILED CONTENT

Module I Imperfections in Solids

Point Defects: vacancy, substitutional, interstitial, Frenkel and Schottky defects, equilibrium concentration of Frenkel and Schottky defects**;** Line Defects: slip planes and slip directions, edge and screw dislocations, Burger's vector, cross-slip, glide and climb, jogs, dislocation energy, super & partial dislocations, dislocation multiplication, Frank Read sources; Planar Defects: grain boundaries and twin interfaces; Dislocation Theory – experimental observation of dislocation, dislocations in FCC, HCP and BCC lattice.

Module II Mechanical Properties

Stress Strain Curve; Elastic Deformation: atomic mechanism of elastic deformation and anisotropy of Young's modulus, elastic deformation of an isotropic material; Anelastic and Viscous deformation; Plastic Deformation: Schmid's law, critically resolved shear stress; Strengthening Mechanisms: work hardening, recovery, recrystallization, strengthening from grain boundaries, low angle grain boundaries. yield point. strain aging, solid solution strengthening, two phase aggregates, strengthening from fine particles; Fracture: ideal fracture stress, brittle fracture-Griffith's theory, ductile fracture.

Module III Microstructure

Solid Solutions and Intermediate Phases: phase rule, unitary & binary phase diagrams, Lever rule, Hume-Rothery rule; Free Energy and Equilibrium Phase Diagrams: complete solid miscibility, partial solid miscibility-eutectic, peritectic and eutectoid reactions, eutectaid mixture; Nucleation, Growth and Overall Transformation Kinetics; Martenstic Transformation;

Module IV Iron carbon system

The Iron-Carbon System: various phases, phase diagram, phase transformations, microstructure and property changes in iron-carbon system; Ceramics: glass transition temperature, glassformers, commercial ceramics, mechanical properties. high temperature properties.

Module V Materials Processing and Characterization

Ion Implantation: introduction, ion implantation process, depth profile, radiation damage and annealing effects of trace-impurities, implantation induced alloying and structural phase transformation; Rutherford Backscattering Spectrometry (RBS): principle, kinematics of elastic collision, shape of the backscattering spectrum, depth profiles and concentration analysis, applications; Elastic Recoil Detection Analysis (ERDA): basic principle, kinematics, concentration analysis, depth profiling, depth resolution, applications; Secondary Ion Mass Spectroscopy (SIMS): basic principle, working, yield of secondary ions and applications.

***Text Books*:**
1) Material Science by J. C. Anderson, K. D. Leaver, J. M. Alexander and R. D. Rawlings
2) Mechanical Metallurgy by G. E. Dieter
3) Ion Implantation by G. Dearnally

***Reference Books*:**
1) Fundamentals of Surface and Thin Film Analysis by L. C. Feldman and J. W. Mayer
2) Surface Analysis Methods in Material Science by D. J. O'Connor, B. A. Sexton and R. St. C. Smart (Eds), Springer Series in Surface Sciences 23

PHY-EC-432B: b) ELECTRONICS I

Course Objectives	• To make the students familiar about the concepts of components used in various electronic devices • To make the students learn the basics of digital electronics which will be useful to them in understanding the concept behind Digital India
Course Outcomes	• Able to understand the fundamentals and to analyze various electronic circuits • Able to understand differential and operational amplifier, and their applications. • Familiar with SCR, registrar, multivibrator and microprocessors

DETAILED CONTENT

Module I Operational Amplifier

Differential amplifier, inverting and non-inverting inputs, analysis of inverting and non-inverting amplifier, Effect of negative feedback on input resistance, output resistance, Band width; closed loop gain and offset voltage, Voltage follower, Input bias current, input off-set current, total output offset voltage, CMRR. DC and AC amplifier, Summing, Scaling, instrumentation amplifier, integrator and differentiator, log & antilog Amplifiers, comparators, waveform generators and Regenerative comparator (Schmitt Trigger) using 741 opamp. Oscillator principles, oscillator types, frequency stability, frequency response, Phase shift oscillator.

Module II Modulation & Communication

PLL using IC, Active Filters (Butter-worth 1st and 2nd order), Amplitude Modulation, generation of AM waves, Demodulation of AM waves. Frequency modulation, Block diagram of transmitter and super hytrodyne receiver, Digital communication, basic idea about delta modulation, PCM and PWM, Block diagram of Radar and radar range equation.

Module III Digital electronics I

QM method for the simplification of Boolean functions (upto 4 variables), Exclusive OR gate, Decoder, Demultiplexer, multiplexer and encoder. Flip-flops RS, JK, MSJK, D Type Flip-flop, Analog computation, Time scaling, Amplitude sealing, ROM and its applications, Random Access Memory.

Module IV Digital electronics II

D/A Converters: Weighted resister, R-2R ladder, Specifications for D/A converter, A/D converter: Quantization and Encoding, Parallel Comparator, Successive Approximation, A/D converter using Voltage-to-Frequency conversion and Voltage-to-Time conversion, Sample and Hold circuit, Solution of linear differential equation with constant coefficient using analog computer.

Module V Microprocessor

Microcomputer systems and Hardware, Microprocessor architecture and Microprocessor system, instruction and timing diagram, introduction to 8085 basic instructions (Arithmetic operation, logic operation, branch operation), 16 bit arithmetic instructions, arithmetic operation related to memory, Rotate and compare instructions. Stack and subroutines, Programming of 8085 using instructions, Introduction to Microcontroller.

Text Books:

1) Integrated electronics - MiIlman & Halkias.
2) Microprocessor and Interfacing - D. V Hall.
3) Microprocessor Architecture Prog. & Appls. - S. Gaonkar, Wiley-Estern
4) Micro Electronics - Millman & Grabel.

Reference Books:

1) Digital Computer Electronics - AP. Malvino.
2) Advanced Electronic Communication System-Wayne Tomasi Phi. Edn.
3) Electronic communication system by Kennedy.
4) Modern digital electronics by R. P. Jain

PHY-EC-432C: c) NUCLEAR AND PARTICLE PHYSICS I

Course Objectives	• To familiarize about the essential properties of the nucleus such as its shape, size, radius, density, magnetic moment, electric quadrupole moment etc. • In order to probe these properties several models have been proposed such as liquid drop model, shell models, collective models • The most useful part of this knowledge is the nuclear energy which has immense applications. The concept behind this energy was first given by Hans Bethe in the form of semi-empirical mass formula which is in the course content
Course Outcomes	• Students will be enriched with the fundamental knowledge of the nucleus and its properties • The principles behind the modern medical instruments such as nuclear magnetic resonances will be clear to the students • Students will be enshrined in detail about the radiation hazards, peaceful use of nuclear energy and carbon dating for fossil's age determination • The students will be able to do higher studies in this field. They may get employment opportunities in radiology and medical field

DETAILED CONTENT

Module I Nuclear interactions and nuclear reactions
Nuclear Forces: two nuclear system, deuteron problem, binding energy, nuclear potential well, pp and pn scattering experiments at low energy, meson theory of nuclear forces, e.g. Bartlett, Heisenberg, Majorans forces and potentials, exchanges forces and tensor forces, effective range theory-spin dependence of nuclear forces-charge independence and charge symmetry of nuclear forces-isospin formalism- Yukawa interaction.
Nuclear Reactions: Direct and compound nuclear reaction mechanisms, cross sections in terms of partial wave amplitudes, compound nucleus, scattering matrix, reciprocity theorem, Breit Winger one level formula, resonance scattering.

Module II Elementary particles and their properties
Historical survey of elementary particles and their classification, determination of mass, life time, decay mode, spin and parity of muons, pions, kaons and hyperons. Experimental evidence for two types of neutrinos, production and detection of some important resonances and antiparticles.

Module III Symmetries and conservation laws
Conserved quantities and symmetries, the electric charge, baryon number, leptons and muon number, particles and antiparticles, hypercharge (strangeness), the nucleon isospin, isospin invariance, isospin of particles, parity operation, charge conservation, time reversal invariance, CP violation and CPT theorem, the KO – KO doublet unitary symmetry SU(2), SU (3) and the quark model.

Module IV Nuclear Model

Liquid drop model, Bohr-Wheeler theory of fission, experimental evidence for shell effects, shell Model, spin-orbit coupling, magic-applications of Shell model like angular momenta and parities of nuclear ground states, quantitative discussion and estimates of transition rates magnetic moments and Schmidt lines, collective model, nuclear vibrations spectra and rotational spectra, applications, Nilsson model.

Module V Nuclear Decay

Beta decay, Fermi theory of beta decay, shape of the beta spectrum, decay rate, angular momentum and parity selection rules, comparative half-lives, allowed and forbidden transitions, selection rules, parity violation, two component theory of neutrino decay, detection and properties of neutrino, Gamma decay, multipole transitions in nuclei, angular momentum and parity selection rules, internal conversion, nuclear isomerism.

Text Books:

1) A. Bohr & B.R. Mottelson: Nuclear Structure, Vol.1 (1969) and Vol.2 Benjamin, Reading, 1975.
2) Kenneth S. Krane: Introductory Nuclear Physics, Wiley, New York, 1988
3) G.N. Ghoshal: Atomic and Nuclear Physics Vol.2, S. Chand and Co., 1997

Reference Books:

1) P. H. Perkins: Introduction to High Energy Physics, Addison-Wiley, London, 1982.
2) D. Grifiths: Introduction to Elementary particle physics.

PHY-EC-433A: a) SOLID STATE PHYSICS I

DETAILED CONTENT

Course Objectives	• To Provide an introduction to some basic concepts in solid state Physics. • To understand crystal structure; lattice vibrations, electron interactions, Fermi surface and models of electron dynamics. • To understand electron transport in metals semiconductors and super conductors.
Course Outcomes	• Comprehend basic model of electron dynamics in metals • Analyze higher and advanced models of electron dynamics in metals • Learn basic concepts of crystal structure and lattice arrangements • Recall lattice dynamics electron and lattice interactions • Explain basic electron mobility in a crystal structure

Module I
Classification of Semiconductors; Crystal structure with examples of Si, Ge & GaAs semiconductors; Energy band structure of Si, Ge & GaAs; Extrinsic and compensated Semiconductors; Temperature dependence of Fermi- energy and carrier concentration. Drift, diffusion and injection of carriers; Carrier generation and recombination processes- Direct recombination, Indirect recombination, Surface recombination, Auger recombination; Applications of continuity equation- Steady state injection from one side, Minority carriers at surface,

Module II
Drude Model of Metals, DC & AC Electrical Conductivity, Hall Effect and Magneto resistance, Thermal Conductivity, Thermal Electric Effect

Module III
Summerfeld theory of metals, Fermi Statistics and Fermi Surface, Electronic Heat Capacity - The Linear T-dependence, Consequences to the Transport Properties of Metals, Inadequacy of the Free Electron Model.

Module IV
Description of the Semiclassical Model, Basis for the Equation of Motion, Holes, Semiclassical Motion in Uniform Electric and Magnetic Field, Effective Mass, Quantization of Electron Orbits in a Magnetic Field, De Haas-van Alphen Effect

Module V
Lattice vibrations and phonons, brillouin zone, wave motion of one dimensional atomic lattice ,momentum of phonon, Schottky barrier–Energy band relation, Capacitance- voltage

(C- V) characteristics, Current- voltage (I-V) characteristics; Ideality factor, Barrier height and carrier concentration measurements; Ohmic contacts. Static Characteristics; Frequency Response and Switching, Semiconductor hetero junctions, Hetero junction bipolar transistors.

Text Books:

1) S.M. Sze; Semiconductor Devices: Physics and Technology, 2nd edition, John Wiley, New York, 2002.
2) B.G. Streetman and S. Benerjee; Solid State Electronic Devices, 5th edition, Prentice Hall of India, NJ, 2000.
3) W.R. Runyan; Semiconductor Measurements and Instrumentation, McGraw Hill, Tokyo, 1975.

Reference Books:

1) Adir Bar- Lev: Semiconductors and Electronic devices, 2nd edition, Prentice Hall, 1984.
2) Donald A. Neamen; Semiconductor Physics and Devices: Basic Principles, 3rd edition, Tata McGraw- Hill, New Delhi, 2002.
3) M. Shur; Physics of Semiconductor Devices, Prentice Hall of India, New Delhi, 1995.

PHYS-EC-433B: b) PLASMA PHYSICS I

Course Objectives	• To impart the knowledge about the fundamental and basics of Plasma Physics • To learn about the charged particle motion in electric and magnetic field • To learn about the basic Plasma Diagnostic Methods • To learn how to use plasma for various application
Course Outcomes	• Will have an idea about the basis of Plasma • Able to visualize the motion of charged particles in electric and magnetic field • Will be able to measure the different plasma parameters

DETAILED CONTENT

Module I

Introduction and brief history of plasma physics, concept of temperature, Energy distribution function, plasma as the fourth state of matter, types of plasma, plasma parameter, collective behaviour, quasi-neutrality, plasma frequency, plasma sheath, Debye shielding, criteria for existence of plasma.

Module II

Single particle dynamics; charged particle motion in electric field, magnetic field and in combined electric and magnetic field, basics of ExB drift, drift of guiding center, gradient drift, curvature drift and magnetic mirror.

Module III

Plasma production: breakdown of gases, I-V characteristic of electrical discharge, Paschen curve, Plasma devices and machines; glow discharge, dc and rf sputtering, vacuum arcs, stabilized atmospheric arc plasma.

Module IV

Basic plasma diagnostics: electric probes (single and double), optical emission spectroscopy (basic idea) Plasma Applications: MHD energy generator, Controlled thermo-nuclear fusion, Tokamaks, Space & Astrophysical plasmas.

Module V

Basics of vacuum technology, gas flow at low pressures, conductance, throughput and pumping speed, vacuum pumps, vacuum gauges, vacuum accessories, components and vacuum systems.Industrial applications of plasma: plasma displays, plasma lighting, isotope separation, plasmas for sterilization, plasma in semiconductor industry, plasma welding, cutting, drilling, etching, spheroidization and waste disposal.

Text Books:

1) Introduction to Plasma Physics and Controlled Fusion, Francis F. Chen, Plenum Press, 1984
2) Fundamentals of plasma physics, J. A. Bittencourt, Springer-Verlag New York Inc., 2004

Reference Books:

1) The Fourth state of matter- Introduction to plasma science, S. Eliezer and Y. Eliezer, IoP Publishing Ltd., 2001
2) Elementary plasma physics, L.A. Arzimovich, Blaisdell Publishing Company, 1965
3) Plasmas – The fourth state of Matter, D. A. Fran k-Kamenetskii, Macmillan Press, 1972

PHY-EC-433C: c) NANO PHYSICS I

Course Objectives	• To make the students understand Nano science and nano technology. • To make the students understand various approaches.
Course Outcomes	• The students will be able to understand the nano science and nano technology. • The students will be understanding the various approaches.

DETAILED CONTENT

Module I Introduction to Nanoparticles

Introduction - Historical perspective of nanoparticle - Classification of nanomaterials - Nanorods - Nanoparticle - Nanomaterial preparation - Plasma arching - Chemical vapour deposition - Solgel electrodeposition - Ball milling technique.

Module II Nanocrystals

Synthesis of metal nanoparticles and structures - Background on quantum semiconductors - Background on reverse Miceller solution - Synthesis of semiconductors - Cadmium telluroid nano crystals - Cadmium sulfide nano crystals - Silver sulfide nano crystals - Nano manipulator - Nano tweezes - Nanodots.

Module III Characteristics of Nanomaterials

Magnetism in particle of reduced size dimension - Variation of magnetism with size - Magnetic behavior of small particle - Diluted magnetic semiconductor (DMS) - Fe DME and its applications, Nanoparticle as chemical reagents - Specific heat of nanoparticle crystals - Melting point of Nanoparticle material - Nanolithography - Estimation of nanoparticle size using AFM.

Module IV Nano Tubes

New form of carbon - Types of nanotubes - Formation of nanotubes, Various techniques - Preparation and properties of nanotubes, Uses of nanotubes and applications, Nano material processing for nanotube - Light and Nano technology - Nanoholes and photons - Quantum electronic devices - Quantum electronic devices - Quantum information and Quantum Computers.

Module V Applications

Micromechanical systems - Robots - Ageless materials – Nanomechanics, Nano electronics - Optoelectronic devices – LED, Applications - Colourants and pigments - Nano biotechnology - DNA chips - DNA array devices - Drag delivery systems.

Text Books

1) Solid State Physics, J.P. Srivastva- Prentice Hall.
2) Introduction to nanoscience and Nanotechnology, K.K. Chattopadhyay and A.N. Banerjee-PHI Learning Pvt. Ltd.

Reference Books:

1) Introduction to Nanotechnology – Charles P. Poole Jr. and Frank J. Owens, Wiley India Pvt. Ltd., 2007.
2) Nanomaterials – Guozhong Cao, Imperial College Press, 2004.

PHYS-OE-002: RADIATION PHYSICS

Course Objectives	• To familiarize about the crystal structure. • To understand Lattice dynamics and thermal properties
Course Outcomes	• Students will be enriched with the fundamental knowledge of the crystal structure and its properties • Able to understand the concept of superconductivity.

DETAILED CONTENT

Module I

Radiation and need for its measurement, Physical features of radiation, Conventional sources of radiation. Exposure to natural radiation: external to the body, Radiation from cosmic rays and solar radiation, Internal exposure to the body, Radioactivity arising from technological development: Possible health hazards from nuclear and laser radiations Maximum permissible level of radiation. Radiation quantities and units of energy flux, energy fluence, cross-section.

Module II

Biological effects of radiation: Dose - response characteristics, Direct and indirect action, Acute effects, Delayed effects, Cumulative effect, Accidental exposure, Radiation induced chemical changes in tissues, Radiation protection procedures (diagnostics and therapy). Basic radiation safety criteria, Protection from direct radiation, Energy deposition, Effect of distance and shielding, Protection from contamination, Preparation of a safe radiation area, Radioactive waste disposal and management: Type of radioactive waste, Airborne waste, Solid and liquid waste, Assessment of Hazard.

Text books:

1) Introduction to Radiobiology and Radiation Dosimetery - F.H. Aurix, John Wiley.

References Books:

1) Techniques of Radiation Dosimetery- Eds K. Mahesh and DR Vij Wiley Eastern Limited.
2) Nuclear Energy - Raymond L. Murray Pergamon Press, N.Y.

PHY-434 PHYSICS LABORATORY-III

Course Objectives	• To make the students to understand experimental physics • To apply the theoretical knowledge for developing new devices
Course Outcomes	• Comprehend the concepts through simple experiments. • Design and develop the instruments for advanced studies. • Evaluate theoretical calculations using experimental observations.

DETAILED CONTENT

1. To study the relationship between temperature of given samples (1&2) and its time of cooling by plotting a cooling curve and identify the samples.
2. To study Hall Effect in semiconductor and determine Hall coefficient (Rh) &charge career density.
3. Characterization of Nano-fluids like Ag/Au & ferrofluids.
4. To evaluate modest nano-particles concentrations in the fluid for significant enhancement of its property.
5. Study of phase transition and to detect/assess weak and strong molecular interactions in nano-fluids.
6. To determine the Stefan's constant by using an incandescent lamp and Photovoltaic cell.
7. To demonstrate Hysteresis curve of hard magnet.
8. To determine Dielectric constant of specimen at high frequency by Lecher wires.
9. To study the dispersion relation for mono-atomic lattice and determine the cut of frequency.
10. To determine heat capacity of solids
11. Measurement of Planck's constant using LED.
12. Measurement of Planck's constant using photo voltaic cell.

***Text Books**:*
1) A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal

***Reference Books**:*
1) Advanced Practical Physics for Students, B.L. Worsnop, H.T. Flint
2) BSc Practical Physics, Geeta Sanon, R. Chand & Co.

PHY-501: SEMINAR

The seminar will aim to introduce student to the basics and methodology of research in physics, which is done via theory, seminar and power point presentation either all together or separately by one of these approaches. It is intended to give research exposure to students at M.Sc. level itself.

SEMESTER-IV

PHY-CC-441: STATISTICAL MECHANICS

Course Objectives	• To understand micro-canonical, canonical and grand canonical ensembles • To understand Bose Einstein condensation, Pauli paramagnetism statistical equilibrium of white dwarf stars • Familiar with the application of above concept to solve problems
Course Outcomes	• Analyze the concepts of microstate and macrostate of a model system • Recall the concept of ensambles and their comparison • Explain Boltzamann formula, thermodynamical behaviour of an ideal gas

DETAILED CONTENT

Module 1 Classical stat. mech. I
Foundation of statistical mechanics; specification of states in a system, contact between statistics and thermodynamics, the classical ideal state, the entropy of mixing and Gibbs paradox, the phase space of classical systems, Liouville's theorem and its consequences.

Module II Classical Stat. mech. II
The microcanonical ensemble with examples. The canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations in the canonical ensemble, A system of harmonic oscillators, The statistics of paramagnetism, The grand canononical ensemble, the physical significance of the statistical quantities, examples, fluctuation of energy and density. Cluster expansion of classical gas, the virial equation of state.

Module III Quantum stat. mech. I
Quantum states and phase space, the density matrix, statistics of various ensembles, Example of electrons in a magnetic field, a free particle in a box and a linear harmonic oscillator, Significance of Boltzamann formula in classical and quantum statistical mechanics.

Module IV Quantum stat. Mech. II
An ideal gas in quantum mechanical microcanonical ensemble,
Statistics of occupation numbers, concepts and thermodynamical behaviour of an ideal gas, Bose Einstein condensation, Discussion of a gas of photons and phonons, Thermodynamical behaviour of an ideal fermi gas, electron gas in metals, Pauli paramagnetism, statistical equilibrium of white dwarf stars.

Module V Non-Ideal Systems

Cluster expansion method for a classical gas, Simple cluster integrals, Mayer-Ursell relations, Virial expansion of the equation of state, Van der Waal's equation, Validity of cluster expansion method; Phase transitions: Construction of Ising model, Solution of Ising model in the Bragg-William approximation, Exact solution of the one-dimensional Ising model; Critical exponents, Landau theory of phase transition, Scaling hypothesis

Text Books:

1) Statistical Mechanics: R.K. Patharia- Butten Worth Heinemann, 1996

Reference Books:

1) Statistical and Termal Physics: F. Reif-Mc-Graw Hill, 1965
2) Statistical Mechanics: Kerson Huang-Wiley, 1963.

PHY-CC-442: ADVANCED QUANTUM MECHANICS

Course Objectives	• Familiar with the fundamentals of quantum mechanics • To understand the relativistic quantum mechanics
Course Outcomes	• Able to solve and analyse various quantum mechanical problem related to field quantization • Able to treat molecules quantum mechanically

DETAILED CONTENT

Module I Relativistic Quantum Mechanics

Introduction, Klein-Gordan (KG) equation: Plane wave solution, Probability and current densities, KG equation with electromagnetic potentials; Energy levels in a Coulomb field (Hydrogen atom problem). Difficulties of KG equation, Dirac's relativistic equation: Free particle solutions, Dirac matrices and spinors, Probability and current densities, Dirac equation with electromagnetic potentials, Dirac equation for a central field, Existence of spin angular momentum, spin - orbit energy. Energy levels of Hydrogen atom and their classification (Lamb shift).

Module II Field Quantization

Introduction, Classical and Quantum field equations: Coordinates of the field, Time derivatives, Classical Lagrangian equation, Classical Hamiltonian equations; Quantum equation of the field, Field with more than one component, Complex field, Quantization of the non relativistic Schrödinger equation (Second quantization): Classical Lagrangian and Hamiltonian equations, Quantum field equations, The N representation, Creation, Destruction and Number operators for Bosons and Fermions, Connection with the many particles Schrödinger equation.

Module III Quantization of Relativistic Fields and

Natural system of units, Quantization of K-G field, Dirac field and Electromagnetic fields (in vacuum); Lagrangian equations, quantum equations, quantized field energy. Interacting fields.

Module IV Feynman Diagrams

Feynman Diagrams: Introduction, Normal product, Dyson and Wick's chronological products, Contraction, Wick's theorem, Electromagnetic Coupling, The Scattering Matrix, Power series expansion of S-matrix, Scattering processes up to second order.

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Module V Quantum theory of radiation

Classical radiation field, Transversality condition, Fourier decomposition and radiation oscillators, Quantization of radiation oscillators, Creation, Annihilation and Number operators, Photon states, Photon as a quantum mechanical excitations of the radiation field, Fluctuations and the uncertainty relation, Validity of the classical description, Matrix element for emission and absorption, Spontaneous emission in the dipole approximation, Rayleigh scattering, Thomson scattering and Raman effect, Radiation damping and Resonance fluorescence.

Text Books:

1) Quantum Mechanics by L. I. Schiff (3rd edition)
2) Quantum Mechanics by V. K. Thankappan
3) Advanced Quantum Mechanics by J. J. Sakurai
4) Quantum Mechanics by A. P. Messiah

Reference Books:

1) Advanced Quantum Mechanics by B. S. Rajput
2) The principles of Quantum Mechanics by P. A. M. Dirac
3) Relativistic Quantum Mechanics by Schweber

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PHY-EC-443A: a) MATERIAL SCIENCE- II

Course Objectives	• To make the students familiar with the material testing. • To understand mechanical properties and characterisation techniques.
Course Outcomes	• Will have knowledge about material science basic concepts and properties.

DETAILED CONTENT

Module I Material Testing

The Tension Test: engineering stress-strain curve, true stress-strain curve, instability in tension, Considere's construction, ductility measurement, effect of strain rate on flow properties, strain rate sensitivity; notch tensile test; The Hardness Test: Brinell hardness, Meyer hardness, Vicker's hardness number and test, Rockwell hardness test, Knoop hardness number and test; The Impact Test: brittle fracture problem, notched bar impact tests-Carpy and Izod Impact tests; The Fatigue Test: fatigue failures, stress cycles, the S-N curve, fatigue limit; The Creep Test: creep curve, primary, secondary and tertiary creep, effect of temperature and stress on the creep curve.

Module II Magnetic Materials

Magnetic Processes: Larmor frequency; Diamagnetism, magnetic susceptibility, Langevin's diamagnetism equation; Paramagnetism, Curie constant, density of states curves for a metal; Ferromagnetism, Curie temperature, Curie-Weiss law, exchange interactions, domain structure; Antiferromagnetism and magnetic susceptibility of an antiferromagnetic material; Ferrimagnetism and Ferrites; Paramagnetic, ferromagnetic and cyclotron-resonance.

Module III Dielectice, Optical

Introduction, Energy bands, dielectric constant, complex permittivity, dielectric loss factor, polarization, mechanism of polarization, classification of dielectrics-frequancy dependence of dielectric constant; Optical absorption, transmission and reflection, refractive index, color.

Module IV Ferroelectric Materials

Ferro, para and pyro-electric states, transition temperature, classification of ferro electric crystals, polarization catastrophe, Landau theory of first and second-order phase transitions, antiferroelectricity, ferro electric domains.

Module V Solid Surfaces and Analysis

Surface and its importance, selvedge depths of surface; Methods of Surface Analysis: Auger Electron spectroscopy (AES)- basic principle, methodology, composition analysis and depth profiling; X-ray photoelectron spectroscopy (XPS) or ESCA: principle, methodology and quantitative analysis; Glancing angle X-ray Diffraction (GXRD), basic concept, methodology and structural analysis; Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM): Principle, methodology and Applications in surface analysis; Atomic Force Microscopy (AFM): Basic principle, Methodology, applications in structural analysis.

Text Books:

1) Material Science, J.C. Anderson, K.D. Leaver, J. M. Alexander and R. D. Rawlings
2) Mechanical Metallurgy, G.E. Dieter.
3) Electronic Processes in Materials, L. V. Azaroff and J. J. Brophy

Reference Books:

1) Fundamentals of Surface and Thin Film Analysis, L.C. Feldman and J. W. Mayer
2) Surface Analysis Methods in Material Science, D. J. O'Connor, B. A. Sexton and R. St. C. Smart (Eds), Springer Series in Surface Sciences 23

PHY-EC-443B: b) ELECTRONICS-II

Course Objectives	• To make the students familiar about the concepts of components used in various electronic devices • To make the students learn the basics of digital electronics which will be useful to them in understanding the concept behind Digital India
Course Outcomes	Able to understand the fundamentals and to analyze various electronic circuits

DETAILED CONTENT

Module I IC Fabrication-I

Silicon planar process, crystal growth, wafer production, thermal oxidation, high pressure oxidation, concentration enhanced oxidation, chlorine oxidation, lithography & pattern transfer, etching process, factors affecting the etching process, HF-$HN0_3$ system, dopant addition, ion implantation, diffusion, diffusion in concentration gradient, Fick's Laws, diffusivity variation, Segregation, CVD, epitaxial and non-epitaxial films.

Module II IC Fabrication-II

Monolithic IC technology, BJT Fabrication, PNP transistor, multi-emitter Schottky transistor, superbeta transistor fabrication, Fabrication of FET/NMOS enhancement as well as depletion transistor, Fabrication of CMOS devices, Monolithic diodes, Clean rooms & their classifications.

Module III MOS systems & SPICE

Metal semiconductor contacts, ideal MS contacts, Schottky barriers and ohmic contacts, oxide and interface charges, origin of oxide charges, the MOS structure, Effect of bias voltage, capacitance of MOS system, Introduction to electrical computer simulation, SPICE and its evaluations, Electrical circuit specifications, The SPICE DC analysis.

Module IV Combinational logic design using IC

Adders and their use as Substractors, Ripple counters, Sequential logic design, Shift registers, Application of shift registers as delay line, serial to parallel converter, parallel to serial converter, ring counter, twisted ring counter, sequence generator.

Module V Synchoronous

synchoronous counter design, up-down counter, Asynchronous versus synchronous sequential circuits, Applications of Asynchronous sequential circuits, Asynchronous sequential machine modes, Asynchronous sequential circuit design.

Text Books:

1) Integrated electronics - MuIlman & Halkias.
2) Microprocessor and Interfacing - D. V Hall.
3) Theory and Application of Micro Electronics - S.K. Gandhi.
4) Micro Electronics - Millman & Grabel.

Reference Books:

1) Digital Computer Electronics - AP. Malvino.
2) Device Electronics for Integrated Circuits - Muller & Kamins.

PHY-EC-443C: c) NUCLEAR AND PARTICLE PHYSICS- II

Course Objectives	• To make the students familiar with Nucleon Problem. • To make the students learn about the Passage of Charged Particles through matter and nuclear models.
Course Outcomes	Able to understand the Nucleon Problem, Nuclear Models and Particle Detectors and Accelerators

DETAILED CONTENT

Module I The Two Nucleon Problem

Qualitative features and phenomenological potentials, Exchange forces, generalized Pauli principle. The ground state of deuteron, Range-depth relationship for square well potential. Neutron-Proton scattering at low energies (below 10 Mev), Concept of scattering length and its interpretation, Spin dependence of neutron-proton scattering, Effective range theory of n-p scattering, Coherent scattering of neutrons on ortho and para hydrogen, Magnetic moment and its importance in the determination of exact ground state of deuteron.

Module II Nuclear Models-I

Liquid drop model, Outlines of Bohr and Wheeler theory of nuclear fission, Concept of magic numbers, The properties of magic nucleus, Nuclear Shell Model, Predictions of shell closure on the basis of harmonic oscillator potential, Need of introducing spin-orbit coupling to reproduce magic numbers. Extreme single particle model and its predictions regarding ground state spin parity, magnetic moment and electric quadrupole moments.

Module III Nuclear Models-II

Nuclear surface deformations, General parameterization, Types of multipole deformations, Quadrupole deformations, Symmetries in collective space, Surface vibrations, Vibrations of a classical liquid drop, The Harmonic quadrupole oscillator, The collective angular momentum operator, The collective quadrupole operator, Quadrupole vibrational spectrum, Rotating nuclei, The rigid rotor, The symmetric rotor, The asymmetric rotor.

Module IV Passage of Charged Particles Through Matter

Ionization loss of charged particles, derivation of stopping power equation for electronic loss based on impact parameter approach, Bethe-Bloch formula (no derivation), concept of effective charge, Shell and Density effect corrections, scaling law and its importance, nuclear energy Loss, radiation loss of electrons- Bremsstrahlung process, emission of Cerenkov radiations at relativistic velocities, stopping power in compounds- Bragg's additivity rule, concept of energy loss straggling- collisional and charge exchange straggling.

Module V Particle Detectors and Accelerators

Nuclear emulsion detector- principle and mechanism for charged particle detection, nuclear emulsion as a 4π detector, advantage of nuclear emulsion in relativistic hadron-nucleus interactions (multiplicity, momentum, energy distributions of produced particles); Solid state nuclear track detectors- principle and mechanism of detection of nuclear charged particles, Ion-explosion spike model and its predictions, restricted energy loss model for organic detectors; Basic principle of working of cloud chamber, bubble chamber, cerenkov counter; Calorimeters- formation of electromagnetic and hadron showers; Principle of neutrino detection Accelerators: Principle and important features of Linear accelerator (LINACs), cyclic accelerator (synchrotrons): electron synchrotron, colliding beam machine, Introduction to Large Hadron collider, Introduction to Higg's boson and status of experimental discovery.

Text Books:

1) Introduction to High Energy Physics (2^{nd} and 4^{th} edition): D. H. Perkins.
2) Solid State Nuclear Tracks Detection, 'Principle Methods and Applications: S. A. Durrani and R. K. Bull
3) Nuclear Tracks in Solids: Principles and Applications (1975): R. L. Fleischer, P. B. Price and M. Walker

Reference Books:

1) R. R. Roy and B. P. Nigam, "Nuclear Physics: Theory and Experiment", Wiley Eastern Limited, 1993.
2) M. K. Pal, "Theory of Nuclear Structure", Affiliated East-West Press, New Delhi.
3) Greiner and Maruhn, "Nuclear Models", Springer, 1996

PHY-EC-444A: a) SOLID STATE- II

Course Objectives	• To familiarize about the crystal structure. • To understand Lattice dynamics and thermal properties
Course Outcomes	• Students will be enriched with the fundamental knowledge of the crystal structure and its properties • Able to understand the concept of superconductivity.

DETAILED CONTENT

Module I Crystal structure

Recapitulation of basic concepts: Bravais lattice and Primitive vectors; Primitive, conventional and Wigner-Seitz unit cells; Crystal structures and lattices with basis, Lattice planes and Miller indices; Determination of crystal structure by diffraction: Reciprocal lattice and Brillouin zones (examples of sc, bcc and fcc lattices), Bragg and Laue formulations of X-ray diffraction by a crystal and their equivalence, Laue equations, Ewald construction, Brillouin interpretation, Crystal and atomic structure factors, Structure factor of the bcc and fcc lattices; Non-crystalline solids: Diffraction pattern, Monatomic amorphous materials, Pair-distribution function; Experimental methods of structure analysis: Types of probe beam, the Laue, rotating crystal and powder methods.

Module II Lattice dynamics and thermal properties

Classical theory of lattice vibration (harmonic approximation): Vibrations of crystals with monatomic basis- Dispersion relation, First Brillouin zone, Group velocity, Two atoms per primitive basis- acoustical and optical modes; Quantization of lattice vibration: Phonons, Phonon momentum, Inelastic scattering of neutrons by phonons; Thermal properties: Lattice (phonon) heat capacity, Normal modes, Density of states in one and three dimensions, Models of Debye and Einstein; Effects due to anharmonic crystal interactions, Thermal expansion, Thermal conductivity.

Module III Electronic properties of solids

Free electron gas model in three dimensions: Density of states, Fermi energy, Effect of temperature, Heat capacity of the electron gas, Experimental heat capacity of metals, Thermal effective mass, Electrical conductivity and Ohm's law, Motion in magnetic fields and Hall effect; Failure of the free electron gas model and Band theory of solids: Periodic potential and Bloch's theorem.

Module IV Wave equation

Kronig-Penney model, Wave equation of electron in a periodic potential, Solution of the central equation, Approximate solution near a zone boundary, Periodic, extended and reduced zone schemes of energy band representation, Number of orbitals in a band, Classification into metals, semiconductors and insulators; Tight binding method and its application to sc and bcc structures.

Module V Superconductivity

Experimental survey: Superconductivity and its occurrence, Destruction of superconductivity by magnetic fields, Meissner effect, Type I and type II superconductors, Entropy, Free energy, Heat capacity, Energy gap, Microwave and infrared properties, Isotope effect; Theoretical survey: Thermodynamics of the superconducting transition, London equation, Coherence length, Microscopic theory: Qualitative features of the BCS theory, BCS ground state wave function, Quantitative predictions of the BCS theory (critical temperature, energy gap, critical field specific heat); Flux quantization in a superconducting ring; Dc and Ac Josephson effects; Macroscopic long-range quantum interference; High T_c superconductors (introduction only).

Text books:

1) Solid State Physics: An Introduction to Theory and Experiment by H. Ibach and H. Luth
2) Principles of the Theory of Solids (2^{nd} edition) by J. M. Ziman

Reference Books:

1) Introduction to Solid State Physics (7^{th} edition) by Charles Kittel
2) Solid State Physics by Neil W. Ashcroft and N. David Mermin
3) Applied Solid State Physics by Rajnikant

PHY-EC-444B: b) PLASMA PHYSICS-II

Course Objectives	• To provide the knowledge about the fluid models and kinetic theory • To learn about the plasma instabilities • To learn how to use Boltzmann and Vlasov Equations
Course Outcomes	• Will have an idea about fluid models • Will have knowledge about Non-linear plasma theories and Kinetic theory • Will be able to understand Plasma instabilities and Boltzmann and Vlasov Equations

DETAILED CONTENT

Module I Fluid Models

Fluid theory in Plasma, Fluid equations of motion, Single fluid mangneto-hydrodynamics, magnetic Reynolds number, magnetic equilibrium-the concept of beta, diffusion, resistivity and collision in Plasma, Fokker plank equation

Waves in fluid plasma: Representation of waves- group velocity- plasma oscillations- waves in unmagnetized plasmas- electron plasma waves-Langmuir waves and oscillations-ion sound waves, high frequency electromagnetic waves in unmagnetized plasma.

Module II Boltzmann and Vlasov Equations

The fokker plank equation, integral expression for collision lern zeroth and first order moments, the single equation relaxation model for collision lern, application kinetic theory to electron plasma waves, the physics of landau damping, elementary magnetic and inertial fusion concepts.

Module III Kinetic theory

Kinetic theory: need for kinetic theory, f (υ) equations by kinetic theory, Vlaslov equations, Kinetic effects on plasma waves and in a magnetic field, Landaus treatment, BGK and Van Kampen modes- experimental verification

Module IV Non-linear plasma theories

Non-linear electrostatic waves, K dV Equations, non-linear Schrodinger Equation, parametric instabilities, ion acoustics shock waves, plasma echoes, sheaths, the ponder motive force, solitons, shocks, non-linear Landou Damping.

Module V Plasma instabilities

Plasma instabilities: instability in plasma, streaming instability, ion drag force induced, drift wave instability and parametric instability, Chaos and time series analysis, Fourier theory, Liapunov exponent, Attraction, self–similarity, Hurst exponent and Fractal dimension

Text books:

1) Introduction to Plasma Physics and Controlled Fusion: F. F. Chen-Springer, 1984
2) Plasma Physics: R. O. Dendy-Cambridge University Press, 1995

Reference books

1) Robert J Goldston and Paul H Rutherford: Introduction to Plasma Physics, Institute of Physics, London, 1995.
2) U. S. Unan and U Golkowsky: Principles of Plasma Physics for Engineers and Scientist, Cambridge University Press, 2011.

PHY-EC-444C: c) NANO PHYSICS- II

Course Objectives	• To understand the concepts of nanomaterials and improve their knowledge in synthesis methods and characterization for further advanced research studies. • To describe the basic science behind the properties of materials at the nanometer scale and the principles behind advanced experimental and computational techniques for studying nanomaterials
Course Outcomes	• Able to explain different types of nanomaterials including carbon and metal based materials • Able to synthesize nanomaterials both from top-down and bottom-up routes and how to develop an engineering related devices • Able to identify and compare state-of-the-art nanofabrication methods and perform a critical analysis of the research literature • Able to evaluate state-of-the-art characterization methods for nanomaterials • Able to apply interdisciplinary systems of engineering approaches to the field of bio and nanotechnology

DETAILED CONTENT

Module I Introduction and synthesis of nanomaterials
Introduction, Basic idea of nanotechnology, nanoparticles, metal nanoclusters, semiconductor nanoparticles, physical techniques of fabrication, inert gas condensation, Arc discharge, RF plasma, Ball milling, molecular beam epitaxy, Chemical vapour deposition, Electro deposition, Chemical methods-metal nanocrystals by reduction, photochemical synthesis, electrochemical synthesis, Sol-gel, micelles and micro emulsions, cluster compounds, lithographic techniques-AFM based nanolithography and nano manipulation, E-beam lithography and SEM based nanolithography, X ray based lithography.

Module II Characterization techniques
X-ray diffraction, data manipulation of diffracted X-rays for structure determination, Scanning Probe microscopy, Scanning Electron microscopy, Transmission Electron Microscopy, Scanning Tunneling Microscopy, Optical microscopy, FTIR Spectroscopy, Raman Spectroscopy, DTA, TGA and DSC measurements, PL, band Gap; optical transmission and absorption, transport properties measurements; two probe and four probe methods and Vander Pauw techniques.

Module III Carbon nanotubes and other carbon based materials
Preparation of Carbon nano tubes, CVD and other methods of preparation of CNT, Properties of CNT; electrical, optical, mechanical, vibrational properties etc., application of CNT; Field emission, fuel cells, Display devices, other important carbon based materials; preparation and characterization of fullerenes and other associated carbon clusters/molecules, graphene preparation, characterization and properties, DLC and nano diamonds.

Module IV Nanosemiconductors

Semiconductor nanoparticles-applications; optical luminescence and fluorescence from direct band gap semiconductor nanoparticles, carrier injection, polymers- nanoparticles, LED and solarcells, electroluminescence.

Module V Nano sensors

Micro and nanosensors; fundamentals of sensors, biosensor, microfluids, MEMS and NEMS, packaging and characterization of sensors, quantum dots; their special properties, synthesis and applications.

Text Books:

1) Solid State Physics: J.P. Srivastva-Prentice Hall, 2007.
2) Nanomaterials: B. Viswanathan- Narosa, 2009.
3) Encyclopedia of Nanotechnology: H.S. Nalwa-American Scientific Publishers, 2004.
4) Introduction to nanoscience and Nanotechnology: K.K. Chattopadhyay and A.N. Banerjee-PHI Learning Pvt. Ltd. 2009
5) Nanotechnology Fundamentals and Applications: Manasi Karkare, I.K. - International Publishing House, 2008

Reference Books:

1) Springer Handbook of Nanotechnology: Bharat Bhushan-Springer, 2004.
2) Introduction to Nanotechnology: Charles P. Poole Jr. and Franks J. Qwens,-John Wiley & Sons, 2003
3) Nanostructures and Nanomaterials, Synthesis, Properties and Applications: Guoahong Cao- Imperial College Press, 2004
4) Science of Engineering Materials: C.M. Srivastva and C. Srinivasan-New Age International, 2005
5) The Principles and Practice of electron Microcopy: Ian. M., Watt-Cambridge University Press, 1997

PHYS-502 DISSERTATION

Course Objectives	• The aim of the project is to provide glimpses of latest research going on in various areas of Physical sciences. • To provide sufficient hands-on learning experience related to the area of specialization with a focus on research orientation
Course Outcomes	• The completion of the successful project will prepare the students for higher level research • Formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints • Synthesise the results and arrive at scientific conclusions/ products/solution • Document the results in the form of technical report/ presentation

All the M.Sc. Physics Students will do a supervised Physics Project in IV Semester. Department considers it an important culmination of training in Physics learning and research. This project shall be a supervised collaborative work in Condensed Matter Physics, Electronics, Atmospheric Physics and Space sciences, Microwaves, Material Science, Nano Science or any interdisciplinary project based on physics principles. Physics The project will aim to introduce student to the basics and methodology of research in physics, which is done via theory, computation and experiments either all together or separately by one of these approaches. It is intended to give research exposure to students at M.Sc. level itself.

Format of Dissertation:

Title Page

M.SC. PROJECT REPORT ON TITLE OF THE PROJECT

Supervised by:
Submitted by:
Name of the Group Name 1
Name 2
Name 3
Department of Applied Science
Sri Sai University, Palampur
Session
Month Year

Page 2

(Preferably on (Guide's) letter head)

CERTIFICATE

This is to certify that the project entitled "**Title of Project**" aimed at "Project purpose" was worked upon by the following students under my supervision at Physics Laboratory in Department of Applied Science, Sri Sai University, Palampur.
Name 1 with signatures

Name 2 with signatures
Name 3 with signatures
It is certified that this is a live project done by the team and has not been submitted for any degree.
Chairman Name of Guide

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ACKNOWLEDGEMENTS

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PREFACE

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M.Sc. Physics

ABBREVIATIONS USED

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LIST OF GRAPH AND FIGURES

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INTRODUCTION

Chapter 1
Chapter 2
Chapter 3
…………..
Concluding remarks

END OF REPORT

Appendices
Source code and other relevant appendices
Bibliography /References.

INSTRUCTIONS FOR THE FORMATTING AND PRESENTATION OF PROJECT REPORT

The following instructions be strictly adhered to while formatting the Project Report.
Top margin = 2.54 cm
Bottom margin = 2.54 cm
Left margin = 3.17 cm
Header and Footer = 3.17 cm
Page Size = 1.25 cm (from edge)
Font = Times new Roman
- Body test size…………. 12pt
- Chapter headings ……… 18 pt Bold
- Section heading …………16 pt Bold
- Sub Section heading …….14 pt Bold

Header and footers
- Header ……………… Chapter Name
- Footer……………….. Page number

Spacing before and after body text paragraph 6 pt uniform
Spacing before section headings Zero
Spacing after section headings 12

Line spacing 1.5 lines
Tables……………………………….Centered, captions must.
Diagrams……………Centered, captions must, No text around Diagrams
Page Numbering scheme for entailing chapters…. Roman Numbers
Page Numbering scheme for entailing pages of chapters ….. Arabic
The pages starting from Certificate to list of graph and figures must be enlisted in chronological sequence using Roman Numbers.
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- Rexene Covered
- Golden text to be used on cover
- Print details on side strip also in text book format.
- Paper to be used Bond paper

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LAST DATE FOR SUBMISSION OF PROJECT REPORT

Last date for submission of project report shall be one month after the last theory paper examination of IV Semester for regular students.