Maharashtra Education Society's

Abasaheb Garware College

(Autonomous)

(Affiliated to Savitribai Phule Pune University)

Two Year M.Sc. Degree Program in Physics

(Faculty of Science and Technology)

Syllabi under Autonomy

M.Sc. II (Physics)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2023-2024

Eligibility for **M.Sc. II Physics:** 50% credits from M.Sc. I Physics

Structure of the Course: M.Sc. II Physics

Year	Semester	Course Type	Course Code	Course Name	Credit	No. of lectures/ Practical to be conducted
2	III	Core Compulsory Theory	PSPH-231	Statistical Mechanics	4	60
			PSPH-232	Solid State Physics	4	60
			PSPH-233	Experimental Techniques in Physics – I	4	60
		Special Theory - I	PSPHSPL-234	Materials Science - I	4	60
		Core Compulsory Practical	PSPHP-235	Physics Laboratory - III	4	12
	IV	Core Compulsory Theory	PSPH-241	Nuclear Physics	4	60
			PSPH-242	Experimental Techniques in Physics – II	4	60
		Elective – III	PSPHELE-243	Choose any one from **Group I**	4	60
		Special Theory – II	PSPHSPL-244	Materials Science - II	4	60
		Core Compulsory Practical	PSPHP-245	Project	4	

Courses in Group I (Elective): The course in this group shall be conducted only once during the program

Sr. No.	Course Name
1	Laser Fundamentals and Applications
2	Physics of Thin Films
3	Physics of Nanomaterials
4	Electronics Instrumentation

Additional Credits Courses are as follows:

Year	Semester	Course Code	Mandatory Add-On Credit Course	Credits
II	III	PSCYS3-23	Cyber Security -III	1
		PSSD1-23	Skill Development - I	1
		PSIC-23	Introduction to Indian Constitution	2
	IV	PSCYS4-24	Cyber Security -IV	1
		PSSD2-24	Skill Development - II	1
			Total Credits	**06**

Note: Only Grade will be given for add-on courses and this will not be counted for SGPA or CGPA calculations. Student must pass in all add-on courses to get the **M.Sc. Physics** degree.

SEMESTER - III

Course Code and Title: PSPH-231 Statistical Mechanics

Lectures: 60 (Credits-04)

Course Outcomes: After completion of the course, students would be able to:

1. Describe macroscopic and microscopic systems, thermodynamic potentials.
2. Find the connection between statistics and thermodynamics.
3. Differentiate between different ensemble theories used to explain the behavior of the systems.
4. Differentiate between classical statistics and quantum statistics.
5. Explain the statistical behavior of ideal Bose and Fermi systems.
6. Show an analytic ability to solve problems relevant to statistical mechanics.

Module 1: Probability theory, Statistical Description of thermodynamic system 1 Credit

Brief discussion on probability distributions, Laws of Thermodynamics and basic thermodynamic relations including Maxwell's equations; Specification of the state of the system, Macroscopic and Microscopic states, Phase space, Statistical ensemble, Postulate of equal a priori probability, Probability calculations, Behaviour of density of states, Liouville's theorem (Classical); Sharpness of the probability distribution, Equilibrium between interacting systems.

Module 2: Classical Statistical Mechanics 1 Credit

Micro-canonical ensemble, Canonical ensemble, Partition function, Applications of canonical ensembles to Paramagnetism, Molecule in an ideal gas, Law of atmosphere; System with specified mean energy, Calculation of mean values and fluctuations in a canonical ensemble in terms of energy, enthalpy and pressure; Connection with thermodynamics and Calculations of thermodynamic quantities; Grand-canonical ensemble, Physical interpretation of Chemical potential (?) in the equilibrium state; Mean values and fluctuations in grand canonical ensemble; Thermodynamic functions in terms of the Grand partition function.

Module 3: Applications of Statistical Mechanics and Quantum Distribution Functions

1 Credit

Classical partition functions and their properties, Calculations of thermodynamic quantities, Ideal monoatomic gas, Gibbs paradox, Equipartition theorem and its some applications. i) Mean kinetic energy of a molecule in a gas ii) Brownian motion iii) Harmonic Oscillator iv) Specific heat of solid (Einstein Specific heat) v) Maxwell velocity distribution, related distributions and mean values.

Symmetry of wave functions, Quantum distribution functions, Boltzmann limit of Boson and Fermion gases, Evaluation of the partition function, Partition function for diatomic molecules, Equation of state for an ideal gas, quantum mechanical paramagnetic susceptibility

Module 4: Ideal Bose and Fermi Systems 1 Credit

Bose-Einstein statistics: Partition function, thermodynamic behaviour, Ideal Bose gas: Photon gas -i) Radiation pressure ii) Radiation density iii) Emissivity iv) Equilibrium number of photons in the cavity; Einstein derivation of Planck’s law, Bose Einstein Condensation, Specific heat of gas (Debye model).

Fermi-Dirac distribution function: Ideal Fermi system, Fermi energy, Mean energy of fermions at absolute zero, Fermi energy as a function of temperature, Electronic specific heat, White – Dwarfs (without derivation)

Reference Books

1. Fundamentals of Statistical and Thermal Physics: F. Reif, McGraw Hill International Edition
2. Fundamentals of Statistical Mechanics: B.B. Laud, New Age International Publication
3. Statistical Mechanics: R.K. Pathria, Butterworth Heinemann
4. Statistical Mechanics: K. Huang, John Willey and Sons
5. Statistical Mechanics: Satya Prakash, Kedar Nath Ram Nath Publication
6. Statistical Mechanics – An Introduction: S. Loknathan and R.S. Gambhir, PHI Publication

Course Code and Title: PSPH-232 Solid State Physics

Lectures: 60 (Credits-04)

Course Outcomes: After completion of the course, students would be able to:

1. Describe the band theory of solids.
2. Explain the origin of magnetism and magnetic interactions leading to different types of magnetic materials
3. Calculate quantities related to conduction mechanism in materials, magnetic properties and superconductivity.
4. Review types of materials based on their electrical and magnetic properties.
5. Comparison of classical and quantum mechanical theories for different magnetic properties.
6. Study of superconductivity.
7. Analyze solid-state problems using mathematical and numerical methods.

Module 1: Crystal Structure and Band Theory of Solids 1 Credit

Revision of crystal structures, structure of atomic form factor, Geometrical structure factor, Atomic scattering factor, calculations for SC, BCC, FCC, HCP and diamond structure

Revision of nearly free electron model, DC and AC electrical conductivity of metals, Bloch theorem (with proof), Kronig-Penney model, Motion of electron in 1-D according to band theory, Tight binding approximation, Band structure (in R space) of semiconductor crystal, Cyclotron resonance, Quantization of electronic orbit in a magnetic field

Module 2: Diamagnetism and Paramagnetism 1 Credit

Classical theory of diamagnetism, Langevin theory of Paramagnetism, Quantum theory of Paramagnetism, Paramagnetic susceptibility of conduction electron, Magnetic properties of rare earth ions and iron group ions with graphical representation, Crystal field splitting, quenching of orbital angular momentum

Module 3: Ferromagnetism and Antiferromagnetism 1 Credit

Wiess theory, Curie point, Exchange integral, saturation magnetization and its temperature dependence, Saturation magnetization at absolute zero, ferromagnetic domains, Anisotropy energy, Bloch wall. Antiferromagnetism- Neel temperature and Ferrimagnetism (Explanation only for both)

Module 4: Superconductivity Dielectric Properties of Solids 1 Credit

Properties of Superconductors: Meissner effect, Heat capacity, Energy gap, Isotope effect; Type I and II superconductors; Thermodynamics of superconductivity; London equation and London penetration depth; BCS theory; Quantization in a superconductivity ring and Qualitative discussion of Josephson superconductor tunneling

Macroscopic and local electric field, Polarizability, Dielectric constant, Clausius– Mossotti relation,Piezoelectricity, Dielectric behavior in $BaTiO_3$

Reference Books

1. Solid State Physics: N. W. Ashcroft and N. D. Mermin, CBS Publishing Asia Ltd.
2. Introduction to Solid State Physics: C. Kittel, John Wiley and Sons.
3. Introductory Solid State Physics: H. P. Myers, Viva Books Pvt. Ltd.
4. Solid State Physics: H. Ibach and H. Luth, Springer-Verlag.
5. Fundamentals of Solid State Physics: J. R. Christman, John Wiley and Sons.
6. Solid State Physics: A. J. Dekkar, Prentice Hall.
7. Solid State Physics – Principles and Modern Applications: J.J. Quinn and K. Soo Yi, Springer.

Course Code and Title: PSPH-233 Experimental Techniques in Physics I

Lectures: 60 (Credits-04)

Course Outcomes: After completion of the course, students would be able to:

1. Classify of discrete time signals and systems.
2. Study of errors.
3. Understand the operational principles of sensors.
4. Understand the principles and working of various pumps.
5. Understand the principles and working of vacuum gauges.

Module 1: Signal, Signal Analysis and Sensors 1 Credit

Signals, Signal analysis (Time and Frequency Domain), Signal to noise ratio; Measurement, result of a measurement, sources of uncertainty and experimental error, Systematic error, random error; Reliability-Chi square test, Analysis of repeated measurement, Precision and accuracy, Elementary data fitting.

Sensors: Characteristics, Classification, Operational principles of sensors such as electric, thermal, mechanical, pressure, gas and humidity with examples.

Module 2: Vacuum Physics 1 Credit

Importance and fields applications of vacuum, kinetic theory of gases, impingement rate of molecules on a surface, average velocity of gas and mean free path, gas transport properties (thermal conductivity, viscosity and diffusion), various ranges of vacuum, gas conductance of a vacuum line, gas impedance of a vacuum line, pumping speed, flow of gases through apertures, elbows, tubes etc. for viscous and molecular flow regimes, pump down time

Module 3: Vacuum Techniques 1 Credit

Principles of Pumping concept, Types of Vacuum pumps: Rotary, Molecular drag, Oil diffusion, Cryogenic getter ion, Titanium sublimation, Sputter ion, Orbitron

Module 4: Vacuum Measurement and Low Temperature Techniques 1 Credit

Vacuum gauges: McLeod, Thermocouple (Pirani), Penning, Hot cathode ionization (triod type), Bayard-Alpart; Leak detection in vacuum pump; Low Temperature Techniques: Refrigeration principle (including thermodynamical aspects) and low temperature production techniques (Throttling process).

Reference Books

1. Instrumentation: Devices and Systems: C.S. Rangan, G.R. Sarma and V.S.V. Mani, Tata Mc Graw Hill Publishing Co. Ltd.
2. Vacuum Physics and Techniques: T. A. Delchar, Chapman and Hall
3. Vacuum Technology: A. Roth, North Holland, Elsevier Science B.V.
4. High Vacuum Techniques: J. Yarwood, Chapman and Hall, London
5. Experimental Principles and Methods below 1 K: O. U. Lounasmaa, Academic Press, London and, New York

Course Code and Title: PSPHSPL-234 Materials Science-I

Lectures: 60 (Credits-04)

Course Outcomes: After completion of the course, students would be able to:

1. Acquire knowledge of different properties of solids and defects occurring in them.
2. Gain knowledge of solid solutions.
3. Analyze different phase diagrams.
4. Understand thermodynamics of phase diagrams.

Module 1: Properties of Materials and Defects in Solids 1 Credit

Mechanical, magnetic, electrical and thermal properties

Point defects - Vacancies, interstitials, non-stoichiometry, substitution, Schottky and Frenkel defectswith proofs

Line defects - Edge and screw dislocations, properties of dislocations – force on dislocation, energy of dislocation, pinned dislocation (These properties with derivation), dislocation density, interaction between dislocations, motion of a dislocation (cross-slip and climb), dislocation generator (Frank Read source)

Surface defects – grain boundaries with explanation of high angle, low angle, tilt and twist boundaries, stacking fault

Volume defect- twin boundary

Module 2: Solid Solutions and Diffusion in Solids 1 Credit

Solid solubility with few examples, Types of solid solutions – Substitutional and

Interstitial, Factors governing solid solubility (Hume - Rothery rule), Atomic size and size factor in solid solutions, Vegard's law, Explanation of strain in solid solutions

Mechanism of Diffusion, Fick's first and second laws of diffusion, solution to Fick's second law (without proof, introduction of error function), Factors governing diffusion, Experimental determination of D, Applications of diffusion: Corrosion resistance of duralumin, Carburization of steel, Decarburization of steel, Doping of semiconductors

Module 3: Metallurgical Thermodynamics 1 Credit

Revision of laws of thermodynamics, Auxiliary thermodynamic functions, measurement of changes in enthalpy and entropy, Richard's rule, Trouton's rule, Phase equilibrium in a one-component system, Chemical reaction equilibrium, Thermodynamic properties of solutions (mixing processes – Rault's law, activity coefficient; regular solution behaviour – Henry's law), Gibb's phase rule: proof, explanation and application to single component (H_2O) and binary phase diagram

Module 4: Phase diagrams 1 Credit

Thermodynamic origin of phase diagrams, Lever rule, Type I (Cu-Ni) phase diagram, Type II (explanation only) phase diagram, Type III (Pb-Sn) phase diagram, Maxima and minima in two-phase regions, Miscibility gaps, Limited mutual solid solubility, Topology of binary phase diagrams (Explanation in short of eutectic, peritectic, Monotectic, eutectoid, peritectoid, syntactic reaction,extension rule), Experimental determination of phase diagrams

Reference Books

1. Elements of Materials Science and Engineering: Lawrence H. Van Vlack, Addison - Wesley Publishing Co.
2. Materials Science and Engineering: V. Raghvan, PHI Learning
3. Physical Metallurgy (Part I): Edited by R.W. Cahn and P. Hassen, North Holland Physics Publisher, New York
4. Introduction to Materials Science for Engineers: J.F. Shaekelford and M.K. Murlidhara, Pearson Education
5. Materials Science and Metallurgy for Engineers: V.D. Kodgire and S.V. Kodgire, Everest Publishing House

Course Code and Title: PSPHP-235 Physics Laboratory-III

(Credits-04)

Course Outcomes: After completion of the course, students would be able to:

1. Learn computational methods to solve problems within different fields of physics.
2. Articulate an approach to solve a given problem using one or more computational methods through programming and running the program and then Analyze the obtained result.
3. Understand basic concept of Materials Science.
4. record the appropriate experimental data accurately and analyze it.
5. Interpret the data by graphically and computationally.
6. Determine possible causes of discrepancy in experimental observations in comparison to theoretical results.
7. Inculcate the research attitude.

Student has to perform any **12** experiments

Section 1 (any 6)

1. Study of creep behaviour for binary Sn-Pb alloy
2. Density of ceramic material using XRD
3. Temperature dependent resistivity measurement of a material
4. Phase equilibrium diagram for binary Sn-Pb alloy
5. Measurement of stress in a transparent conducting oxide
6. Study of Beer and Lamberts law in absorption spectroscopy using calorimetry
7. Determination of resonance frequency of ferroelectric material
8. Study of Thermogravimatric method.
9. Study of the particles (e.g. CdS, ZnS, Au, Ag etc.) using UV/VIS spectroscopy for theparticle size and gap energy.
10. Study of oxidation laws

Section 2 (any 6)

1. Find out Legendre polynomials using the standard recurrence relation. Confirm that the method works well for Legendre functions by comparing with standard tables for special functions. (Use forward recursion.)
2. Differential Equation: Find out the motion of a charged particle in a uniform magnetic field. The equation of motion of particle with charge 'q' and mass 'm' in auniform magnetic field B is given by
$$\frac{d\bar{r}}{dt} = \frac{q}{m}(\bar{v}\, x\, \bar{B})$$
where r denotes the position vector.
3. Use modified Euler method to solve the differential equation
$$m\frac{d^2z}{dt^2} = mg$$
For the displacement z of a freely falling body as a function of time t, from a given

height z = z_0 at t = 0. Compare with known analytical results. Add a term due to buoyancy of air on the motion of a spherical body (say a rain drop) of radius r (No damping due to viscosity anddrag is considered). Thus,

$$m\frac{d^2z}{dt^2} = (\frac{4}{3}\pi r^3\rho)g$$

where r is the density of air.

4. Find out the value of ‘π’ using Monte-Carlo method. Obtain the result correct up to five decimal positions.
5. Interpolation: Interpolate the value of a function at a point using Lagrange interpolation method.
6. Trapezoidal/Simpson rule: Evaluate a given function f(x) using Trapezoidal/Simpson rule.
7. Rotation of matrix: Rotate the elements of a (n x n) matrix in clockwise/ anticlockwise direction and display the matrices (n ≥ 5).
8. Inverse of a matrix: Find the inverse of a (n x n) matrix and display both matrices.
9. Graphics: Write a program and display the Miller planes in the cubic lattice. Display the FCC, BCC and simple cubic lattice on the computer screen
10. Write a program to graphically display eigen functions and probability density curves for particle in one dimensional rigid box.
11. Differential Equation: Write the one–dimensional time independent Schrodinger’s equation. Solve it using Runge – Kutta method for three different harmonic Oscillator potential.
12. Fourier Analysis: Perform the Fourier analysis for (1) Full wave rectifier and (2) Square wave.

Reference Books

1. Handbook of Experiments in Materials Science: V. Raghvan
2. The C Programming Language: B.W. Kernighan and D.M. Ritchie, Prentice Hall of India Pvt. Ltd.
3. Schuam’s Series “Programming in C”.
4. Introductory Methods of Numerical Analysis: S.S. Sastry, Prentice Hall of India Pvt. Ltd.
5. Computational Physics: R.C. Verma, P.K. Ahluwalia and K.C. Sharma, New Age International Publishers
6. Computational Physics: S.E. Koonin, Benjamin/Cumming Publishing Co.
7. Computer Method for Engineering: Y. JalurIa, Allyn and Bacon Inc.

SEMESTER - IV

Course Code and Title: PSPH-241 Nuclear Physics

Lectures: 60 (Credits-04)

Course Outcomes: After completion of the course, students would be able to:

1. Review of general properties and concepts of nuclei.
2. Explain types of nuclear interactions, working of different types of nuclear detectors.
3. Demonstrate different type of nuclear reactions and know the working of nuclear reactors
4. Distinguish various models of nucleus and review the reaction dynamics.
5. Study the processes of different scattering mechanisms.
6. Classify mass spectra, elementary particles and their decay mechanisms.

Module 1: General Properties and Concepts of Nuclei 1 Credit

Nuclear Mass and Binding Energy, Systematic of Nuclear Binding Energy, Measurement of Charge Radius- Electron Scattering Experiment, Concept of Mass Spectrograph, Nuclear spin, Abundance of Elements, Magnetic Dipole Moments & Electric Quadrupole Moments of Nuclei , Basic theory of deuteron nucleus and problems, Radioactivity, Unit of Radioactivity, Alpha Decay: Velocity of Alpha Particles, Disintegration Energy, Range-Energy Relationship, Geiger-Nuttal Law, Beta Decay: Conditions for Spontaneous Emission of β^- and β^+ Particles, Selection Rules, Origin of Beta Spectrum-Neutrino Hypothesis, Gamma Decay: Decay Scheme of ^{137}Cs &^{60}Co Nuclei, Internal Conversion, Internal Pair Creation

Module 2: Radiation Detectors and Nuclear Models 1 Credit

Detectors: NaI (Tl) Scintillation Detector, Si (Li) and Ge (Li) Detectors, High Purity Germanium Detector, Bubble Chamber, Cloud Chamber, Spark Chamber, Nuclear Models: Shell Model-Square Well Potential, Harmonic Oscillator Potential, Spin-Orbit Coupling, Predictions of the Shell Model, Achievements and failures of shell Model, Fermi Gas Model, Collective Model

Module 3: Reaction Dynamics, Nuclear Reactors and Accelerators 1 Credit

Reaction Dynamics: Types of Nuclear Reactions, Conservation Laws in Nuclear Reactions, Q of Nuclear Reaction, Compound Nucleus Hypothesis, Fission and Fusion Reactions, Reactors: Fission Chain Reaction, Four Factor Formula, Multiplication Factor, General Properties and Concepts of Nuclear Reactors, Reactor Materials, Types of Reactors, List of Different Types of Reactors Developed in India, Accelerators: Van de Graff, Microtron, Electron & Proton Synchrotron, Pelletron, Cyclotron, Special Accelerators in world: Light Hydron Collidor (LHC)

Module 4: Nuclear Interactions and Particle Physics 1 Credit

Nuclear Interactions: Low Energy Neutron-Proton Scattering, Scattering Length, Spin Dependence of n-p Interaction, Proton-Proton and Neutron-Neutron Scattering at Low Energies, Particle Physics: Classification of Elementary Particles, Mass Spectra and Decays of Elementary Particles- Leptons and Hadrons, Quantum Numbers, Conservation Laws, Quarks, Higgs Boson concept

Reference Books

1. Introductory Nuclear Physics: K.S. Krane, Wiley India Pvt. Ltd.
2. Concepts of Nuclear Physics: B.L. Cohen, Tata McGraw Hill, New Delhi
3. Nuclear Physics: I. Kaplan, Narosa Publishing House, New Delhi
4. Atomic and Nuclear Physics: S.N. Ghoshal, S. Chand Publishing Co.
5. Nuclear Physics: An Introduction: S.B. Patel, New Age International Publishers
6. Nuclear Physics: D.C. Tayal, Himalaya Publishing House
7. The Atomic Nucleus: R.D. Evans, Tata McGraw Hill Publishing Co. Ltd.
8. Radiation Detection and Measurement: G.F. Knoll, Wiley India Pvt. Ltd.
9. Nuclear Radiation Detectors: S.S. Kapoor and V.S. Ramamurthy, New Age International Publishers
10. Nuclear Physics - Theory and Experiment: R.R. Roy and B.P. Nigam, New Age International Publishers
11. Theoretical Nuclear Physics: J.M. Blatt and V. F. Weisskopf, John Wiley and Sons
12. Atomic and Nuclear Physics: S. Sharma, Pearson Education, India

Course Code and Title: PSPH-242 Experimental Techniques in Physics-II

Lectures: 60 (Credits-04)

Course Outcomes: After completion of the course, students would be able to:

1. Study of the working principles of the different characterization techniques
2. Know the merits and de-merits of each characterization technique.
3. Analyze the data obtained by the different characterization techniques.
4. Select an appropriate technique for characterizing the sample.

Module 1: Radiation Sources and Detectors 1 credit

Electromagnetic spectrum, Sources of Electromagnetic Radiations: Different types of radiations (γ -rays, X-rays, UV-VIS, IR, microwaves) and their sources, Detectors: γ-rays, X-rays, UV-VIS, IR, microwaves

Module 2: Structural Characterization and Thermal Analysis 1 credit

X-ray Diffraction – Production of X-rays, Types (continuous and characteristics), Bragg's diffraction condition, principle, instrumentation (with filters) and working, Techniques used for XRD – Powder method, Derivation of Scherrer formula for size determination, Neutron Diffraction: Principle, Instrumentation and Working

Thermal analysis: Principle, Instrumentation and Working: Thermo-gravimetric (TGA), Differential Thermal Analysis (DTA)

Module 3: Morphological and Magnetic Characterization 1 credit

Optical Microscopy: Principle, Instrumentation and Working of optical microscope

Electron Microscopy: Principle, Instrumentation and Working of Scanning Electron Microscope (SEM), Field Emission Scanning Electron Microscope (FESEM) – Advantages over SEM, Transmission Electron Microscope (TEM), Selected Area Electron Diffraction (SAED)

Probe Microscopy: Principle, Instrumentation and Working of Scanning Tunneling Microscope (STM) and Atomic Force Microscope (AFM)

Magnetic Characterization: Principle, Instrumentation and Working of Vibrating Sample Magnetometer (VSM), Analysis of Hysteresis loop, SQUID Technique: Principle only

Module 4: Spectroscopic Analysis 1 credit

Spectroscopic characterization (principle, instrumentation and working): Infra-Red (IR), Fourier Transform Infra-Red (FTIR), Ultraviolet-Visible (UV-VIS), Diffused Reflectance Spectroscopy (DRS), X-ray Absorption (XPS), Electron Spin Resonance(ESR), Nuclear Magnetic Resonance(NMR), Raman Spectroscopy

Reference Books

1. Nuclear Radiation Detectors: S.S. Kapoor, V. S. Ramamurthy, Wiley-Eastern Limited, Mumbai
2. Instrumentation: Devices and Systems: C.S. Rangan, G.R. Sarma and V.S.V. Mani, Tata McGraw Hill

3. Characterization of Materials: John B. Wachtman, with chapters on X-ray methods by Zwi. H. Kalman, Butterworth - Heinemann
4. Instrumental Methods of Chemical Analysis: G.R. Chatwal and S. Anand, Himalaya Publishing House
5. Elements of X-ray Diffraction: B. D. Cullity and S. R. Stock, Prentice Hall
6. Instrumental Methods of Analysis: H. H. Willard, L. L. Merritt, J. A. Dean and F.A. Settle Jr., CBS Publishers and Distributors

Course Code and Title: PSPH-244 Materials Science-II

Lectures: 60 (Credits-04)

Course Outcomes: After completion of the course, students would be able to:

1. Know magnetic, ceramic and semiconducting materials and their applications.
2. Study of various interactions and types of magnetic materials.
3. Understand new materials and their applications.
4. Learn processing of ceramic materials.

Module 1: Ceramic Materials **1 Credit**

Ceramics phases ceramic crystals (AX) Ceramic crystals (AmXp), multiple compounds, silicates, mechanical behaviour of ceramics, processing of ceramic materials (review and study)

Module 2: Magnetic Properties of Materials **1 Credit**

Ferromagnetic (briefly) and ferrimagnetic materials, magnetic domains, hysteresis, Hard magnets and soft magnets, Origin of interaction in Ferromagnetic material, rare earth garnets orthoferrites and Hematite, Hexagonal ferrites, magnetic bubbles

Module 3: Semiconductors **1 Credit**

Intrinsic semiconductors, Band structure impurities, semiconductors III-V and II-VI compounds, p-n diodes (details), transistor FET, tunnel diode, Gunn effect, Contact diode, microelectronic circuits (elementary level)

Module 4: New Materials **1 Credit**

High Tc materials, Giant magneto-resistance (GMR) materials (with brief discussion on magneto-resistance), Quasi crystals, optical materials, piezoelectric and ferroelectric material, nanoparticles

Reference Books

1. Elements of Materials Science and Engineering: Lawrence H. Van Vlack, Addison-Wesley Publishing Co.
2. Materials Science and Engineering: V. Raghvan, PHI Learning
3. Introduction to Materials Science for Engineers: J.F. Shaekelford and M.K. Murlidhara, Pearson Education
4. Introduction to Ceramics: W.D. Kingery, H.K. Bowen and D.R. Uhlmann, Wiley

Course Code and Title: PSPHP-245 Project

(Credits-04)

Course Outcomes: After completion of the course, students would be able to:

1. Explain the necessity, relevance and importance of the project
2. Describe aims and objectives of the project.
3. Search the relevant references.
4. Perform the experiments as per the procedure to achieve the aim of the project.
5. Analyze the data with the help of theory and formulae.
6. Regulate the procedure to check the repeatability of the results with earlier observed results.
7. Inculcate the research attitude.

Skill Development Course – I and II

(Credit – 01 / per semester)

SEM III - Module 1 and 2 **SEM IV – Module 3 and 4**

Course Outcomes: After completion of the course, students would be able to:

1. Impart the knowledge of generalized measurement systems.
2. Learn the characteristics of various types of measurement systems and errors in measuring instruments.
3. Analyze the circuits for the measurement of Resistance, Capacitance, Inductance and Frequency.
4. Impart with the basic concepts of CRO and its usage for the measurement of various parameters.
5. Understand the concepts of Ammeters, Voltmeter and Multimeters.
6. Understand the importance of Display Devices and Recorders in practical fields.

Module -1 Measurements and Errors

Measurements: introduction, Significance of measurements, methods of measurements, instruments and measurement systems, Functions of instruments and measurement systems, Applications of measurement systems

Measurement Errors: Introduction – Types of Measurement errors - Gross errors and systematic errors, Absolute and relative errors, basic concepts of accuracy, Precision, Resolution and Significant figures, Combination of errors (relevant problems)

Module -2 Measuring Instruments

Ammeters, Voltmeter and Multimeters: Introduction, DC ammeter - principle only, DC voltmeter, Multi-range voltmeter, Extending voltmeter ranges, Loading, Peak responding and True RMS voltmeters (relevant problems)

Digital Voltmeters: Introduction, Ramp type, Dual slope integrating type (V–T), integrating type (V–F) and Successive approximation type (relevant problems)

Digital Instruments: Introduction, Block diagram of a Basic Digital Multimeter, Digital frequency meters: Basic circuit of a Digital frequency meter, Basic circuit for frequency measurements

Module -3 Oscilloscopes

Oscilloscopes: Introduction, Basic principles, CRT features, Block diagram and working of each block, Typical CRT connections, Dual beam and dual trace CROs, Electronic switch

Special Oscilloscopes: Delayed time-base oscilloscopes: Need for a time delay and delayed-time-base system; Analog storage oscilloscopes: Need for trace storage, bi-stable storage CRT, Variable persistence storage CRT

Module - 4 Generators and Bridges

Signal Generators: Introduction, Fixed and variable AF oscillator, Standard signal generator, Modern laboratory signal generator, AF sine and Square wave generator, Function generator, Square and Pulse generator

Bridge Circuits for Measurement of R, L and C: DC bridges: Introduction, Wheatstone's bridge, Kelvin Bridge; AC bridges: Capacitance Comparison Bridge, inductance Comparison Bridge, Maxwell's bridge, Schering Bridge (relevant problems)

Reference Books

1. Electronic Instrumentation: H.S. Kalsi, Tata McGraw Hill
2. Electronic Instrumentation and Measurements: D.A. Bell, Oxford University Press
3. Electrical and Electronic Measurements and Instrumentation: A.K. Sawhney, Dhanpat Rai and Sons
4. Principles of Measurement Systems: J.P. Bentley, Pearson
5. Modern Electronic Instrumentation and Measuring Techniques: A.D. Helfrick and W.D. Cooper, PHI Publication