DEPARTMENT OF PHYSICS
Ph.D. PROGRAMME (2019-2020)

PAPER I: RESEARCH METHODOLOGY

Objectives:

- To give proper perception on research, its function, identification and design of research problems.
- To provide the scientific methods of analyzing the data and its presentation technique.
- To nurture about scientific writing, presentation and thesis writing.

Unit-I: Meaning and Function of Research

Meaning of Research - Function of Research-Characteristics of Research-Steps involved in Research-Research in Pure and Applied Sciences-Inter Disciplinary Research. Factors which hinder Research-Significance of Research-Research and scientific methods-Research Process-Criteria of good Research-Problems encountered by Researchers-Literature review.

Unit-II: Identification of Research Problem and research design

Selecting the Research problem-Necessity of defining the problem-Goals and Criteria for identifying problems for research. Perception of Research problem- Techniques involved in defining the problem-Source of problems-Personal consideration.

Formulation of Research design-Need for Research design-Features of a good design – Important concepts related to Research design. Different research designs- Basic principles of experimental designs-Computer and internet in designs.

Unit-III: Scientific Data analysis

Basic concepts and definitions on data and error - various types of data and their error - propagation of errors - four steps to a meaningful experimental results. Basic statistical concepts - best estimate of true value of data - measure of dispersion - confidence level - central limit– significance test - chi square test for goodness of fit - criteria for goodness of fit. Graphical Representation - equations - functional relationships - sequential differences method of extended differences - method of least squares. Analysis and Interpretation using MS-XL and Origin.

Unit-IV: Scientific writing Techniques

Scientific Writing - definition - organizing a scientific paper - Title - listing of authors and address - abstract-Introduction - materials and methods section - results section - discussion section

- acknowledgement - references - design of effective tables- effective illustrations - manuscript - submission - review process - publishing process - reprints - review paper - conference report - oral and poster presentation – thesis writing- plagiarism - usage of English.

Unit-V: Applied Mathematical Functions and Transforms

Hypergeometric equation-various cases-integral representations - applications of Fourier series to periodic functions and forced vibrations. Fourier Transform theory: Fourier Transform of a Time Dependent Function Some Important Theorems - The Convolution theorem - The Gaussian Wave Packet in Quantum Mechanics - Three dimensional Fourier transform - The Use of Fourier Transforms in Solving Differential Equations.

Text Books:

1. Research Methodology Methods & Techniques, C.R. Kothari, New Age international Publishers, 2008.
2. Statistical Methods, G.W. Snedecor and W.G. Cochrans, Lowa state University Press, 1967.
3. Research in Education, John W.Best, McGraw Hill, in 1986.
4. A First course in Numerical Analysis, Anthony Rabston, McGraw Mill Co., New York, 1965
5. Introduction methods of Numerical analysis, S.S. Sastry, Prentice Hall of India Pvt. Ltd., 1977.
6. Mathematical Physics, AK Ghatak, IC Goyal & SJ Chua Macmillan, New Delhi,2002

Reference Books:

1. A Hand Book of Methodology of Research, Rajammal, P.Devadas and K.Kulandaivel, RMM Vidyalaya press, 1976.
2. Thesis and Assignment Writing, J. Anderson, Wiley Eastern Ltd., 1997.
3. Research Methodology, Mukul Gupta, Deepa Gupta – PHI Learning Private Ltd., New Delhi,2011.
4. Fundamentals of Mathematical statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons, New Delhi, 1999.
5. How to write and publish a scientific paper - (4^{th} Edn.), Robert A. Day.
6. Numerical Analysis and algorithm, E.V. Krishnamurthy, Wiley Eastern, 1982.

PAPER II: ADVANCED PHYSICS

Objectives

- To understand the current advancement in the research field.
- To familiarize in the mathematical and computational tools in solving research problems.
- To enhance the experimental and analytical skills.

Unit-I: Applied Mathematics in Physics

Representation of Physical quantities by scalars, vectors and tensors - Solution of second order equations with constant co-efficients-Bessel's function of third kind – Hankel functions-Jacobi series. Bessel's Integrals-Orthonormality of Bessel's functions – Expansion of an arbitrary function in a series of Bessel's function.

Dirac Delta Functions-Derivative of delta function-Three dimensional delta function-Cylindrical coordinate system-Spherical coordinate system.

Unit-II: Quantum Mechanics

Second quantization of Schrodinger field-System of Bosons and Fermions – Second quantization of KG fields-Covariant commutation relations for KG field - Second quantization of Dirac field-Covariant anti-commutation relation for Dirac field - Quantization of electromagnetic fields-Canonical-Covariant formalism.

Unit-III: Nonlinear Dynamics and Systems

Linear and nonlinear systems-Mathematical model examples-Mathematical implications of nonlinearity: Superposition principle-Linear oscillators & Predictability -Nonlinear oscillators-Resonance Hysteresis.

Autonomous and Nonautonomous systems-Phase plane trajectories-Stability, attractors and repellers-Equilibrium points and stability-Limit cycle-Bifurcation – Period doubling phenomenon .

Unit-IV : Production and measurement of low temperatures and high pressure

Range of low temperature-Need of vacuum: Different pumps to produce vacuum of required order (Rotary pump and Diffusion pump)-Construction of thermostat and cryostat-Measurement of low temperature using different techniques.

Definition of pressure-Hydrostaticity-Generation of static pressure, pressure units-Piston cylinder-measurement by Primary gauge-Secondary gauge-Merits and demerits-Thermocouple pressure gauge.

Unit-V: Physics in biological systems

Human system-Physics of fever and cold-Physical aspects of cancer diagnosis and therapy-use of magnetic field in therapeutics-Guided drug delivery systems Radio isotopes as tracer elements.

Text Books

1. Mathematical Physics, B.D.Gupta, Vikas Publishing House Pvt. Ltd., 2015.
2. Advanced Quantum Mechanics, B.S.Rajput, Pragathi Prakashan, Meerut Publication,2014.
3. Nonlinear Dynamics, Integrability, Chaos and Patterns, M.Lakshmanan and S. Rajasekar, Springer, 2003.
4. The Physics of High Pressure, P.W.Bridgmann, G.Bell and Sons Ltd, London,1931.
5. The Physics of Radiation therapy, Faiz.M.Khan, Meri Pustak Publishers – New Delhi - 28

Reference Books

1. Mathematical Physics, B.S.Rajput, Pragati Prakashan, Meerut 20th edition, 2008.
2. Solitons, Nonlinear Evolution Equations and Inverse Scattering, M.J.Ablowitz and PA Clarkson, Cambridge University Press, 1991.
3. High Pressure Science and Technology, B.Vodar and Ph.Marteam,Vol.I and II, Pergamon Press, Oxford, 1980.
4. High Pressure Experimental Methods, M.I.Eremets, Oxford University Press, New York, 1996.
5. The Physics Book, Clifford.A.Pickover, Sterling Publishing, Newyork

PAPER III: INSTRUMENTATION

Objectives:

- To highlight the concept of instrumentation
- To familiarize the functioning and applications of various analytical instruments

Unit-I: Introduction to Instrumentation methods

Instrumental technique – Classifications - Important Considerations - functional elements of a measuring system - Major steps in solving analytical problems.

Sources of noise - Software and Hardware techniques-Statistical methods and their applications - Instrument calibration.

Unit-II: Analytical Instruments

Principle, block diagram, operation and applications: AAS, ICP-AES, ICP-MS, FTIR and FT-Raman spectral techniques.

Unit-III: Thermal and Microscopic Instrumentation

Thermogravimetry: TG - DTA and DSC, Microscopy: Electron microscopy (EM), SEM cryo EM, TEM and AFM.

Unit-IV: Chromatographic Instrumentation

Classification of separation methods-Principle-Basic components-operation and applications-Liquid Chromatography, High Performance Liquid Chromatography (HPLC) and Gas Chromatography. Electro chemical studies

Unit-V: Sophisticated Analytical Instruments

Principle, block diagram, working and applications: XRD, SAXS, NMR ESR and Laser Interferometry.

Text Books

1. Instrumental methods of analysis, H. Willard, D. Merrit, A. Dean and A. Settle, CBS Publishers, 2004
2. Chromatography, B.K. Sharma, Goel Publishing House, 2000.
3. Bio-Medical Instrumentation, M. Arumugam, Anuradha Agencies, 2003.

Reference Books:

1. Handbook of Analytical Instruments, R.S. Khandpur, Tata McGraw - Hill Publishers Company Ltd, 2007.
2. Instrumental methods of analysis, Gurdeep Chatwal and Sham Anand, Himalaya Publishers,2003.

PAPER-IV (i): APPLIED SPECTROSCOPY

Objectives:

- To impart knowledge in the field of spectroscopy.
- To educate the students about the fundamental aspects of Rotational and Vibrational Spectroscopy.
- To impart knowledge regarding the fundamental aspects of Resonance Spectroscopy.
- To expose the Students to the effective applications of various Molecular Spectroscopic techniques to study the Chemical and Structural properties of materials.
- To gain the basic knowledge in theoretical spectroscopy.

Unit-I: Data analysis

Line shapes in Spectroscopy: Lorentzian and Gaussian - Fitting of the spectra (curve fitting) - Deconvolution of spectrum - Derivative Peak shapes - software techniques.

Resolution of spectrometer - Resolving Power and factors influencing it -Sensitivity - Accuracy - static and dynamic errors.

Unit-II: UV/Visible and Fluorescence Spectroscopy

UV-Visible: Principle, theory and experimental techniques - study of molecular structure. Fluorescence: Principle - Instrumentation –Microprocessor based Spectrofluorimeter- sample preparation - applications.

Unit-III: Vibrational and Rotational Spectroscopy

Infrared spectroscopy: principle and theory- mode of vibrations of atom in polyatomic molecules, Instrumentation: FTIR spectrophotometer-Attenuated Total Reflectance (ATR) - Applications. Raman spectroscopy: Raman effect-observation of Raman spectra - classical and Quantum theory of Raman effect- vibration Raman spectra - pure rotational Raman spectra - Vibrational rotational Raman spectra- CARS- SERS- Applications.

Unit-IV: Resonance Spectroscopy

Electron Spin Resonance: Theory - Hyperfine structure- Fine structure-Instrumentation of ESR Spectrometer- applications.

Nuclear Magnetic Resonance: Theory- Chemical shift - Relaxation mechanisms - Instrumentation - FT-NMR and applications

NQR Spectroscopy: principle, Instrumentation and applications.

Mossbauer spectroscopy: Theory- Chemical Isomer shift - Quadrupole splitting - Instrumentation and applications.

Unit-V: Theoretical Spectral Studies

Hartree's Theory -Orbital energy and Total energy – Hartree - Fock Self Consistent Field Theory (HFSCF) - Slater Type Orbital (STO) - Roothan's method - Electron correlation and configuration interaction - Koopman's theorem - Density functional theory (DFT).

Software – Gaussian – AutoDock - Applications

Text books

1. Quantitative Analysis, Day R.A and Underwood A. L. Pearson education India, 6th Edition, 2015.
2. Handbook of Analytical Instruments, R. S. Khandpur, McGraw Hill Education (India) private Limited, 2015.
3. Molecular Spectra and Structure (Vol. I-III), G. Herzberg - D.Van Nostard Company, 3rd edition, 1996.
4. Introduction to IR and Raman Spectroscopy, B. Norman Colthup, H. Lawrence Daly and E. Stephen Wiberly, Academic press, 1990.
5. Nuclear Magnetic Resonance, E. R. Andrew, Cambridge University Press, 2009.

Reference Books

1. Characterization of Materials, John B. Watchman, Butterworth publisher, Heinemann Greenwich, Manning, 1993.
2. Fundamentals of Analytical Chemistry Skoog and West Holler, Cengage Learning EMEA, 2013
3. Instrumental Methods of Chemical Analysis (Analytical Chemistry), Gurdeep R Chatwal and Sham K. Anand, Himalaya Publishing House, New Delhi, 2018.
4. Instrumental Methods of Analysis, Hobart H. Willard, Lynne L. Merritt, John A. Dean and Frank A. Settle, CBS Publishers & Distributors, New Delhi,7th Edition,2004.
5. Spectroscopy (Vol. 1-3), B.P Straughan and S. Walker, Chapman and Hall, 1976.

PAPER - IV (ii) : MATERIALS SCIENCE

Objectives:

- To explore the knowledge on preparation of crystals and thin films fabrication.
- To gives a brief knowledge about the magnetic and dielectric materials.
- To analyze the technologies available for preparation of nano materials.
- To develop skill in Renewable Energy Resources.
- To achieve extensive knowledge about energy storage materials used for various applications in terms of its technical competence and economic implications**.**

Unit-I: Crystal Growth

Concept of crystal growth - Nucleation and growth – Crystal growth theory – classical theory – Classification of Crystal growth techniques – Growth by Slow evaporation – Melt growth – Bridgman method and Czochralski pulling technique – Vapour deposition techniques – measurement of micro hardness – Knoop & Vicker's hardness test.

Unit-II: Thin Films

Preparation of thin films: Substrate materials selection and their cleaning method - condensation nucleation and growth - Methods: Solution growth – Vacuum evaporation – Sputtering - Spray pyrolysis and Spin coating – Thickness measurement: weight method and interference technique - Optical properties: band gap - refractive index - electrical properties of thin films using Hall effect and Four Probe method.

Unit-III: Magnetic and Dielectric Materials

Classification of magnetic materials – Influence of temperature on magnetic behaviour – Origin of domain and Hysteresis - VSM technique. Ordinary and anisotropic magneto-resistance, Giant magneto-resistance (GMR): basic properties, mechanism, and applications

Dielectric behaviour, Field vectors and polarization – Types of polarization: electronic, ionic and orientational polarization. Measurement of Dielectric constant - Scherring Bridge method – Determination of dielectric permittivity and loss.

Unit-IV: Nanomaterials

Introduction to nanomaterials - Solids in reduced dimension – Quantum confinement – Surface to volume ratio – Quantum well, Quantum rod, Quantum dots – Carbon Nanotubes - Nanomaterial preparation - Top down and bottom up approaches for synthesis of nanostructured materials – Physical and Chemical vapour deposition – Sol-gel — Ball milling technique – Ultrasonic precipitate method - Nanocomposites : Metal-Metal, Polymer-Metal - Core-Shell structured nanocomposites - Application of Nanomaterials.

Unit -V: Energy Storage Materials

Renewable Energy Resources – Solar Cells: Principle and Types of Solar Cells – The Photovoltaic Effect - Dye Sensitized Solar Cell, Efficiency Measurements - Applications of Solar Cells.

Fuel Cells: Principles of Fuel Cells, Types of Fuel Cells and its Components –- Difference Between Batteries and Fuel Cells – Fuel Cell Thermodynamics - Heat, Work Potentials, Prediction of Reversible Voltage, Reduction and Oxidation –Applications of Fuel Cells.

Text Books

1. Materials Science and Engineering, V.Raghavan, Prentice Hall of India Pvt. Ltd, Third edition, 2015.
2. Thin Film Deposition: Principles and Practice, Donald L. Smith, McGrawHill, 2015..
3. Modern Magnetism, L.Bates, Cambridge University Press, 2011.
4. Springer Handbook of Nanotechnology, Bharath Bhusan, 3rd edition, Springer-Verlag , 2009.
5. Solar Energy Fundamentals and Applications, H.P. Garg, J. Prakash (Tata McGraw-Hill), 2014.

Reference Books

1. Crystal Growth, Brain R. Pamplin, Pergamon Press, Oxford, 2nd Edn., 2010.
2. The Materials Science and Thin Films, Milton Ohring, Academic Press, 2012
3. Thin film Fundamentals, A.Goswami, New Age international Publishers, 2015.
4. Dielectric properties and molecular behavior, N.E.Hill, W.E.Vaughan, A.H.Price, Mansel Davies, Van Nostrand Reinhold Company, London, 2000.
5. Chemistry of Nanomaterials : Synthesis, Properties and Applications, CNR Rao and T. Cheetham, Wiley & Sons, 2015.
6. Fuel Cell Fundamentals, R.P. O'Hayre, S. Cha, W. Colella, F.B. Prinz, (Wiley) 2006.

PAPER-IV (iii) NANOSCIENCE AND APPLICATIONS

Objectives:

- To provide a deep knowledge on various synthesis techniques
- To develop skill in characterization of the materials
- To impart knowledge on Energy storage and Conversion, Sensor and Drug Delivery

Unit-I: Synthesis of Nanomaterials

Surface Energy, Chemical Potential as a Function of Surface Curvature, Electrostatic Stabilization, Steric Stabilization, homogeneous nucleation, Growth controlled by diffusion, Growth controlled by surface process, Synthesis of metallic and semiconductor nanoparticles, sol-gel processing, hydrothermal synthesis, Vapor phase synthesis, micellar synthesis, Aerosol synthesis, Spray pyrolysis, Template-based synthesis, Electrochemical synthesis, Precipitation, Mechanical Milling.

Unit-II: Structural and Morphological studies

X-ray diffraction-Introduction-basic principles-characterization by XRD-examples of XRD characterization-Scherer formula-FTIR-Introduction-basic principles -methodologies and accessories-interferences and artifacts.

Scanning electron microscopy-Introduction-basics and primary modes of operation-instrumentation-sample requirements-applications-Transmission electron microscopy-Introduction - basic principles-TEM operation-specimen preparation-Scanning tunneling microscopy-Introduction-basic principles and instrumentation- common modes of analysis - EDAX - introduction – basic principles-Analysis

Unit-III: Optical & Thermal Studies of Nanomaterials

UV-Vis spectrophotometer-Introduction-basic principles-common modes of analysis and examples - sample requirements - quantitative abilities;Photoluminescence -Introduction-basic principles-common modes of analysis and examples-sample requirements-quantitative abilities.

Differential scanning calorimeter (DSC)-basic principle-instrumentation-sample preparation-Thermogravimetric/Differential Thermal Analyzer (TG/DTA)-basic principle-instrumentation – sample preparation.

Unit-IV: Electrical and Magnetic Techniques

Impedance Spectroscopy-Electroanalytical Techniques: Potentiometry- Voltametry - Cyclic Voltammetry - Physical Property Measurement System (PPMS) Vibrating SampleMagnetometer - Nuclear Magnetic Resonance-introduction-basic principles-structural and chemical information from solid state NMR line shapes- instrumentation –practical aspects and limitations-quantitative analysis.

Unit-IV: Applications of Nanomaterials

Solar cells - Energy storage devices: Lithium ion batteries-Supercapacitors. Introduction to sensors - Fundamentals of sensor - Organic and inorganic nano sensor - Magnetic nanoparticles for imaging and therapy.

Biosensors - Clinical diagnostics, generation of biosensors - nanomaterials based biosensors - Nanoparticles in medicine - Size dependent effects of magnetic particles - Magnetic nanoparticles as contrast agents for medical diagnosis. Drug delivery - Nano particulate carriers for Lungs and brain systems.

Text books

1. Nanoparticulates Drug Carriers, Vladimir P Torchilin, 2006, Imperial College Press, 57 Shelton Street, Covent Garden, London WC2H 9HE, ISBN 1- 86094-630-5.
2. Encyclopedia of Materials C. Richard Brundle, Charles A. Evans Jr., Shaun Wilson Characterization, Butterworth-Heinemann Publishers. 1992
3. Nanoparticle Technology Handbook, Masuo Hosokawa, Kiyoshi Nogi, Makio Naito, Toyokazu Yokoyama Elsevier Publishers. 2007.

References Books

1. 1.Biomaterials, Sujata V. Bhat, Narosa Publishing House, New Delhi, Second edition, 2010.
2. 2.Crash Course in MATLAB. Tobin A. Driscoll, 2003.
3. Elements of X-ray diffraction, B. D. Cullity Addison- Wesley Publishers. 1977.

PAPER – IV (iv) CHEMICAL PHYSICS

Objectives:

- To provide detailed information about dielectric theories
- To understand bonding studies in liquids

Unit-I: Theories of static permittivity and dielectric dispersion

The molecular origin of permittivity and loss – Debye's theory of static permittivity – Onsager's theory of the internal field and permittivity – Kirkwood's and Frohlich's theory for non polarizable dipoles – The macroscopic theory of dielectric dispersion – dielectric loss factor – loss tangent – Representation of Permittivity in theComplex plane.

Unit-II: Frequency domain and Time domain Techniques

X – Band microwave bench – Principle – Experimental arrangement – Dielectric relaxation – Higasi's and Cole-Cole plot methods – Time domain Reflectometry :Principle – Experimental arrangement – procedure – dynamic permittivity – Havariliak –Negami model – Applications.

Unit-III: Dipole moment Studies

Dipole moment – Experimental determination – Debye's method and Onsager'smethod – Application to molecular structure – Dipole moment of molecular complexes –Few and Smith method – Huyskens method.

Unit-IV: Fundamentals of H-bonding studies and IR Spectra in H-bonding

Nature of H – bonding – models of hydrogen bonding (Electrostatic model,Quantum mechanical models) – Thermodynamics of H – bonding – Application of IR Spectra in the study of H – bonding – Determination of equilibrium constant – Nash method – Whetsal and Kagarise method – Thermodynamic properties – Dipole moment derivatives – Enhancement of intensity in H-bonding system.

Unit-V: H – Bonds in solids and Biological materials

Introduction to Proteins and poly peptides – H-bonding in Proteins – Hydrophobicinteractions – Amide systems – Nucleic acids – Proton transfer in DNA – Carbohydrates– Dimensions of H-bonds – Location of the proton in a H-bond – Proton transfer in H-bonded solids.

Text Books

1. Dielectric properties and Molecular behavior, Nora.E.Hill, Van Nostrant Company, London, 1969.
2. I.R.Spectra of complex molecules, L.J.Bellamy, 1980.
3. X – band Microwave Bench, Laboratory Manual, Sisodia, M.L, Raghuvansi, G.S.,Wiley Eastern Ltd., New Delhi, 1987.

4. Moleculer Interactions Vol.2, H. Rataczak and W.J. Orwille Thomas. John Wiley and Sons , Newyork, 1980.
5. Dielectric Materials and Applications, Von Hippel.A.T., John Wiley and Sons Inc., Newyork, 1974.
6. Hydrogen Bonding and Transfer in the Excited State Google e Book, Ke , I Han, Guang, Jiu Zhao, John Wiley & Sons, 2011.

References Books

1. Dielectric behaviour and Molecular structure, C.P.Smyth, McGraw Hill Publications, 1955.
2. Hydrogen Bonding, S.N.Vinogradov and Robert H.Linnell, Van Nostrand Reinhold Company,1970.
3. Electric Dipole Moment, J.W.Smith, Butter worth Publications, 1955.
4. Molecular Interaction Vol.I, H.Rataczak and W.J. Orwille Thomas. John Wiley and Sons, 1978.
5. The theory of Rate processes, S.Glasstone, K.J.Laider and H.Eyring, Mc Graw Hill, New Delhi,1941.

PAPER – IV (v) ULTRASONICS

Objectives:

- To provide knowledge on the fundamentals of production and propagation of ultrasonic waves in liquids and solids.
- To understand the physico-chemical properties
- To develop skill in the applications of ultrasonics in various fields.

Unit-I: Characteristics, Production and Detection of Ultrasonic Waves

Characteristics of ultrasonic waves- Propagation through matter-Wave equation, absorption, reflection, dispersion and transmission of ultrasonic waves.

Classification of ultrasonic waves-Longitudinal, transverse, Rayleigh and lamb waves.Production and Detection: Low and high frequency waves-Longitudinal and transverse modes-Piezoelectric and magnetostriction transducers-Detection of ultrasonic waves -Crystal receivers.

Unit-II: Propagation of Ultrasonic Waves and Molecular Interactions in Liquids

Propagation of low amplitude waves in liquid-Measurement of ultrasonic velocity and absorption : Progressive wave method-Optical method-Acoustic interferometer-Pulse technique-Impedance method. Relaxation: Thermal and structural relaxation in liquid mixtures.

Theory of physical and thermodynamic properties-Adiabatic compressibility-Molar sound volume-Intermolecular free length-Free volume-Internal pressure-Gibb's free energy – Relaxation time and their excess properties-Apparent molar volume-apparent molar compressibility-Solvation number and viscosity B-coefficient. Hydrogen bond :Nature- Complex formation-Physical and thermodynamic properties-Detection using ultrasonic method.

Unit-III: Propagation of Ultrasonic Waves in Solids

Velocity and attenuation measurement in solid-Stationary and continuous wave method – Pulse echo method-Stress, strain and displacement relations-Elastic constants-equations of motion and their solutions-Propagations of ultrasonic waves in ferromagnetic and ferroelectric materials-Absorption due to lattice imperfections-Pressure and temperature dependence on velocity and attenuation.

Unit-IV: Glass and Nanomaterials

Glasses-types of glasses-bioactive glasses-metallic glasses-principle, preparation, properties and applications-measurement of Debye temperature and microhardness-analysis of glasses using XRD, FTIR and SEM. Nanomaterials-Synthesis and characterization of micro and nanofilters-Organic/Inorganic hybrid materials-Macro and micro composites-Shape memory alloys.

Unit-V: Applications

Scientific-Echo sounding-Sound signaling-depth sounding-SONAR-Cleaning of dirt – Cavitations-Biological and medical applications-Ultrasonic flowmeter-Ultrasonic delay lines – UTT (Ultrasonic Trans Tomogram). NDT-Its importance in characterising of materials – Flaw detection and thickness gauging – Metallurgical applications with special reference to soldering and welding.

Text Books

1. Fundamentals of Ultrasonics, Jack Blitz, Butter Worths, London, 1967.
2. Introduction to Chemical Ultrasonics, M.J.Blandamer, Academic press,London,1973.
3. Ultrasonic methods in Solid State Physics, Rohntrunell, Charlleselabaum and Bruce B.Chick , Academic press, 2013.
4. Molecular interaction, H. Ratajczak and W.J.O. Thomas. John Wiley and Sons, Britan, 1980.
5. Instrumental methods of analysis, Williard et al., CBS Edition, 1988.

Reference Books:

1. Absorption and Dispersion of Ultrasonic waves, A. Litvoitz and K.F. Herzfeld,Academic Press, London, 2013.
2. Molecular interaction, H. Ratajczak and W.J.O. Thomas. John Wiley and Sons,Britan, 1980.

3. SEM : A user's manual for Material Science, Barbra, L. Gabriel American Society for metals, 1985.
4. Nanostructures and Nanomaterials : Synthesis, properties and applications,Guozhong Cao, Ying Wang,World Scientific Publishing Co. Pt. Ltd., 2011.
5. Ulrasonic methods and applications Biltz Jack, Newnes – Butter worth 1971

PAPER-IV (vi) - BIOPHYSICS

Objectives:

- To explore the fundamentals of cell organization
- To develop skill in applications of various microscopic tools in cell biology
- To characterize biomolecular interactions and its macromolecular structure.

Unit- I: Cell and Cell Organelles

Universal properties of cell- Origin and evolution of cells- Prokaryotic vs Eukaryotic cells-Structural and functional organization of eukaryotic cells – Cytoskeleton - Plasma membrane - Ribosome- Endoplasmic reticulum- Golgi complex- Lysosome-Mitochondria-Peroxisome- Nucleus.

Unit- II: Macromolecular structure

Nucleic acid structure: Chemical structure of the nucleic acid – Conformational possibilities of monomers and polymers- Double helix structure of DNA- Polymorphism of DNA-DNA nanostructures and the structure of transfer RNA.Proteins structure: Amino acids and the primary structures of proteins-Secondary-Tertiary - Quaternary structure and virus structure.

Unit-III: Separation techniques

Electrophoresis-Moving boundary electrophoresis-Zone electrophoresis-Gel electrophoresis- Poly acrylamide gel electrophoresis (PAGE) - Sodium dodecyl sulphate poly acrylamide gel electrophoresis (SDS-PAGE) - Iso electric focusing electrophoresis-Continuous flow electrophoresis.

Centrifugation- Basic principles of sedimentation - Relative centrifugal force (RCF)-Sedimentation Rate - Svedberg unit or Sedimentation Coefficient - Types of Centrifugation - Analytical Centrifugation - Ultra centrifugation - Preparative centrifugation Differential centrifugation-Density gradient centrifugation-Rate zonal centrifugation - Isopycnic centrifugation.

Unit-IV: Histopathology and biochemical parameters

Histopathological and Immunohistochemical techniques- Samples preparation for biological tissues- Light microscopy- Elementary geometrical optics- Limits of resolution.

Types of microscopy- Bright field microscopy- Phase contrast microscopy-Fluorescence microscopy- Polarising Microscopy- Scanning electron microscopy -Transmission electron microscope- Preparation of the specimen for electron microscope-Flow cytometer.

Biochemical parameters-SOD- Catalase- GPx- GSH- TBARS-Hematological parameters- Hepatic parameters and renal parameters.

Unit -V: Infrared, Raman and NMR Spectroscopy

Introduction - Basic concept of IR spectroscopy-IR spectrophotometer - IR Spectrophotometer - Principle and instrumentation - Sample handling techniques- FTIR :principle –Instrumentation – Biomedical Applications. Basic concept of Raman Spectroscopy-Raman Spectrometer- Instrumentation and working - Biomedical applications.

Introduction to NMR - Basic principles of NMR - NMR theory and experiment -NMR applications in biochemistry and biophysics - Conformation of biomolecules -Two-dimensional NMR - Determination of macromolecular structure - NMR in medicine.

Text Books

1. Biophysics, Vasantha Pattabhi, N. Gautham, Narosa Publishing, 2009.
2. Biophysics P.S. Mishra, VK Enterprises, 2010.
3. Fundamentals of Biochemistry, A.C. Deb, New central book agency, 2011.

Reference Books

1 The Cell: A Molecular Approach, Geoffrey M.Cooper, ASM Press, 2013.
2 Biophysics, M.A. Subramanian, MJP Publishers, 2005.
3 Bioinstrumentation, L.Veerakumari, MJP Publishers, 2006.