PH.D SYLLABUS

PAPER I: RESEARCH METHODOLOGY

Objective : This paper highlights the various postulates of research problems, research design, writing a thesis and modern statistical methods. This helps to carry out research problem individually in a perfect scientific method.

Unit-I: Meaning of Research - 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

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.

Unit- III: Research Design

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-IV: Interpretation and Report Writing

Meaning and Technique of interpretation – Precautions in interpretation – Significance of report writing – Different steps in writing a report – Layout of a Research report.

Types of report – Mechanics of writing a research report – Precautions for writing a research report – Conclusion.

Unit -V: Statistical Techniques and Tools

Introduction of statistics – Functions – Limitations – Measures of central tendency - Arithmetic mean – Median – Mode – Standard deviation – Co-efficient of variation (Discrete serious and continuous serious) – Correlation - Regression – Multiple Regression.

Sampling distribution – Standard error – Concept of point and interval estimation – Level of significance – Degree of freedom – Analysis of variance – One way and two way classified data – 'F'-test.

Text Books and References:

1. A Hand Book of Methodology of Research, Rajammall, P. Devadoss and K. Kulandaivel,
RMM Vidyalaya press, 1976.
2. Research Methodology Methods & Techniques, C.R. Kothari – New Age international Publishers, Reprint 2008.
3. Thesis and Assignment Writing, J. Anderson, Wiley Eastern Ltd., 1997.
4. Research Methodology, Mukul Gupta, Deepa Gupta – PHI Learning Private Ltd., New Delhi, 2011.
5. Fundamentals of Mathematical statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons,
New Delhi,1999.
6. Statistical Methods , G.W. Snedecor and W.G. Cochrans, Lowa state University Press,1967.

PAPER II : ADVANCED PHYSICS

Objective : This paper helps the students to understand the ongoing advancements in the research fields through the respective theory and experiments.

Unit – I : Second Order Differential Equations and Dirac Delta Functions

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

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

Autonomous and Nonautonomous systems – Phase plane trajectories – Stability, attractors & repellers – Equlibrium points and stability – Limit cycle- Bifurification – Period doubling phenomenon – Onset of chaos – Logistic map – Route to chaos – Lorentz systems – Sensitive dependence on initial condition – Controlling of chaos.

Unit – IV : Production of low temperatures

The range of low temperature – Need of vaccum : Differnet pumps to produce vacuum of required order (Rotary pump and Diffusion pump) – Properties of liquid oxygen, liquid nitrogen and liquid helium – Construction of Thermostat and Cryostat – Measurement of low temperature using different techniques.

Unit – V : Methods of Producing and Measurement of High Pressure

Definition of pressure – Hydrostaticity – Generation of static pressure, pressure units – Piston cylinder – Bridgmann Anvil – Multi-anvil devices – Diamond anvil cell.

Primary gauge – Secondary gauge – Merits and demerits – Thermocouple pressure gauge – Resistance gauge – Fixed point pressure scale – Ruby fluorescence – Equation of state.

Text Books and References:

1. Mathematical Physics, B.D.Gupta, Vikas Publishing House Pvt. Ltd., 1995.
2. Mathematical Physics, B.S.Rajput, Pragati Prakashan, Meerut 20th edition, 2008.
3.Mathematical Physics, Sathya Prakash, Sultan Chand and Sons, Educational Publishers,2nd Revised Edition, New Delhi, 2000.
4. Advanced Quantum Mechanics, B.S.Rajput, Pragathi Prakashan, Meerut Publication, 1994.
5. Nonlinear Dynamics, Integrability, Chaos and Patterns, M.Lakshmanan and S.Rajasekar, Springer, 2003.

6. Solitons, Nonlinear Evolution Equations and Inverse Scattering, M.J.Ablowitz and PA Clarkson, Cambridge University Press, 1991.
7. The Physics of High Pressure, P.W.Bridgmann, G.Bell and Sons Ltd., London, 1931.
8. High Pressure Science and Technology, B.Vodar and Ph.Marteam, Vol.I and II, Pergamon Press, Oxford, 1980.
9. High Pressure Experimental Methods, M.I.Eremets, Oxford University Press, New York, 1996.

PAPER III : INSTRUMENTATION

Objective : This paper highlights the concept of instrumentation and functioning of various analytical instruments in diversified fields.

Unit-I : Introduction to instrumentation methods

Chemical analysis - Basic important terms - Instrumental technique- Classifications- Important Considerations - Principal types- Major steps in solving analytical problems-Basic function of instrumentation.

Signal to noise ratio - Sensitivity and detection limit-Sources of noise-Software techniques- Hardware techniques - Statistical method and their applications-Accuracy and instrument calibration

Unit-II : Absorbtion and Emission

AAS, AES, FES – Introduction - Principle, Instrumentation, Sample preparation, Applications, Advantages and disadvantages.

ICP-AES, ICP-MS – Introduction - Principle, Instrumentation, Sample preparation, Applications, Advantages and disadvantages.

Unit-III : Chromatography

Gas Chromatography – Classification of separation methods, classification of Chromatographic methods – Comparison – Gas Chromatography – Basic principle – Instrumentation –Basic parts of Gas Chromatography.

Liquid Chromatography- Optimization of experimental condition – Basic components of liquid Chromatography - High performance Liquid chromatography (HPLC) - Working and applications, Advantages.

Unit-IV : X- Rays

X- Ray fluorescence spectrometry, Electron probe Microanalyser – Principle, working- Application and advantages.

X- Ray spectrometers, X-ray spectrum, - Instrumentation for X-ray spectrometry, X-ray Diffractometer, X-ray absorption meter.

Unit-V : Analytical Instruments

FTIR, FT-Raman, SEM, TEM, TG, DTA and DSC : Principle – Theory – Working – Measurements and applications.

Text Books and References:

1. Instrumental methods of analysis, H. Willard, L. Merritt, A-Dean and A. Settle, CBS publishers and Distributer, 1980.
2. Handbook of Analytical Instruments, R.S. Khandpur, Tata Mc Graw- Hill Publishers Company Ltd, 2001.
3. Instrumentation methods of chemical analysis, Chatwal – Anand, Himalayan Publishing Home, 2000.
4. Instrumental methods of chemical analysis, Galen W.Ewing, Mc Graw-Hill, 1985.
5. Instrumentation, V. Ramasamy, Sowmi Publications, 2005.
6. Chromatography, B.K. Sharma, Goel Publishing House, 2000.

PAPER IV a : AREA OF SPECIALIZATION - APPLIED SPECTROSCOPY

Objective : Spectroscopy is a branch of study which gives an insight above to the activation of atoms and molecules. This applied spectroscopy helps the students to understand the importance, necessity and the changes that undergoes during interaction.

Unit I: Infrared and Raman Spectroscopy

Introduction - The range of Infrared radiation - Nomenclature of Infrared spectra – Requirements for Infrared radiation absorption – Mathematical theory of IR absorption spectroscopy – Observation of IR spectra – FTIR spectrophotometer – Mode of vibration of atoms in polyatomic molecules – Attenuated Total Reflectance (ATR) – Application of IR spectroscopy to quantitative analysis.

Raman effect and its salient features-Observation of Raman spectra-Raman spectrophotometer-Comparison of Raman and Infrared spectra-Classical theory of Raman effect- Quantum theory of Raman effect-Probability of energy transition in Raman effect-Vibrational Raman spectra-Pure rotational Raman spectra-Vibrational rotational Raman spectra-Structure determination from Raman and Infrared Spectroscopy.

Unit II: Spin Resonance Spectroscopy

Introduction – Nature of spinning particles – Interaction between nuclear spin and magnetic field – population of energy levels – The Larmor Precession – Study of resonance spectra – Nuclear magnetic resonance – Chemical shift – Relaxation mechanisms- Observation of NMR spectra- NMR spectrometer –Nuclear quadruple

resonance spectroscopy- Observation of NQR spectra- NQR spectrometer -Electron spin resonance – Hyperfine structure of ESR absorption – Fine structure of ESR spectra – double resonance in ESR- Observation of ESR spectra- ESR spectrometer – General Applications.

Unit III: Ultra-violet and Luminescence Spectroscopy

Origin and Theory of Ultra-Violet spectra – Types of transitions of inorganic molecules – Types of transition of organic molecules – The shape of UV absorption curves – Transition probability – Solvent effects – choice of solvent – UV-Vis spectrophotometer – General applications of UV-vis Absorption Spectroscopy.

Principle of Fluorescence and Phosphorescence - Mesurement of Fluorescence and Phosporescence - Microprocessor based Spectrofluorometer - Comparison of absorption and fluorescence methods - Comparison of Fluorimetry and Phosphorimetry - Applications.

Unit IV: Advanced Microscopic techniques

Scanning Electron Microscope(SEM), Scanning Tunneling Microscope(STM), Transmission Electron Microscope(TEM) and Atomic Force Microscope(AFM) : Principles, instrumentation, sample preparation and applications to characterization of materials, devices and biological molecules.

Unit V: Environmental and Theoretical Studies

Pollution - water, soil and air pollution sources – classification of water pollutants - Heavy metals Pollution - Effect of radioactive pollutants - Automated Wet chemical air analysis - Types of pollutants and techniques.

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

Text Books and References:

1. Handbook of Analytical Instruments, R.S.Khandpur, M.C. Graco – Hill Publishing Company Limited, New Delhi, 2001.
2. Elements of Spectroscopy: Atomic, Molecular and Laser Physics, Gupta, Kumar & Sharma, Paragati Parakashan, 2007.
3. Instrumental Methods of Chemical Analysis, (Analytical Chemistry), Gurdeep R Chatwal and Sham K. Anand, Himalaya Publishing House, New Delhi, 2003.
4. Instrumental Methods of Analysis, Hobart H. Willard, Lynne L. Merritt, John A. Dean and Frank A. Settle., CBS Publishers & Distributors, New Delhi, 1986.

5. Vibrational Spectroscopy : Theory and Applications, D.N.Sathyanarayana, New Age International Publishers, New Delhi, 1996.
6. Spectroscopy, Vol.1, 2 & 3. B.P.Straughan and S.Walker-Chapmann and Hall, 1976.
7. Introduction to IR and Raman Spectroscopy, B. Norman Colthup. H. Lawrance Daly and E. Stephen Wiberly, Academic press, 1975.
8. Spectroscopy, luminescence and radiation centers in minerals A.S. Marfunin, Springer – Verlag, 1970.
9. Transmission Electron Microscopy, D.B Williams and C.B. Carter, Plenum Press, 2004.
10. Scanning Electron Microscopy and X-Ray Microanalysis Joseph Goldstein, Dale E. Newbury, David C. Joy and E.Charles, Springer Science, 2003.
11. Environmental Chemistry by A.K.De, New Age International Publishers, 5th Edition, 1994.
12. A text book of Environmental Chemistry and Pollution Control – S.S. Dara - S.Chand and Company Ltd., 2002.
13. Introductory Quantum Chemistry-A.K.Chandra,Fourth Edition, Tata McGraw Hill Publishing Company Ltd., 1994.
14. Quantum Chemistry, R.K.Prasad, New Age International Publishers, 2006.

PAPER IV b : AREA OF SPECIALIZATION - MATERIALS SCIENCE

Objective:

This paper covers the key concepts in the preparation of crystals, thin films and materials characterization.

Unit I – Crystal growth

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

Unit II – Thin films

Condensation nucleation and growth of continuous thin films – Substrate materials selections and their cleaning method. Preparation of thin films : Solution growth – Vacuum evaporation – Sputtering – Electroplating, 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 – Nanoparticles

Introduction to nanomaterials - Top down and bottom up approaches for synthesis of nanostructured materials – Nanorods – Nanotube/wire – Quantum dots – Nanomaterial preparation – Plasma arching – Chemical vapour deposition – Sol-gel – Electro deposition – Ball milling technique – Ultrasonic precipitate method - Nanocomposites : Metal - Metal, Polymer-Metal, Dielectric and CMR based nanocomposites - Core-Shell structured nanocomposites.

Unit IV – Magnetic materials

Classification of magnetic materials – Influence of temperature on magnetic behavior – Origin of domain and Hysteresis - VSM technique - Low and High temperature studies using SQUID. Ordinary and anisotropic magneto-resistance, Giant magneto-resistance (GMR): basic properties, mechanism, applications - Spin valves and Spin switches

Dielectric behaviour, Field vectors and polarization – Types of polarization – electronic and ionic polarizability – Orientational polarization, frequency and temperature dependence of the dielectric constant - Measurement of Dielectric constant - Scheiber Bridge method - X-Band microwave bench – Determination of dielectric permittivity and loss.

Unit IV – Characteristisation of Crystals, Thinfilms and Nano materials

Structural characterization : FTIR, FTRAMAN and XRD - Optical properties : UV-Vis spectrophotometer - Surface analysis : SEM, TEM and AFM - X-ray energy dispersive analysis (EDX)

Text Books and References :

1. Materials Science and Engineering, V.Raghavan, Prentice Hall of India Pvt. Ltd, Third edition, 1995.
2. Growth of Crystals from the vapour, M.M.Faktor and I.Garrett, Chapman Hall, London, 1974.
3. Thin film Fundamentals, A.Goswami, New Age international Publishers, 1995.
4. Springer Handbook of Nanotechnology, BharathBhusan, 3rd edition, Springer-Verlag , 2009.
5. Chemistry of Nanomaterials : Synthesis, Properties and Applications, CNR Rao and T. Cheetham, Wiley & Sons, 2005.
6. Crystal Growth, Brain R. Pamplin, Pergamon Press, Oxford, 2nd Edn., 1980.

7. Thin Film Deposition: Principles and Practice, Donald L. Smith, McGrawHill, 1995.
8. The Materials Science and Thin Films, Milton Ohring, Academic Press, 1992
9. Dielectric properties and molecular behavior, N.E.Hill, W.E.Vaughan, A.H.Price, Mansel Davies, Van Nostrand Reinhold Company, London, 1969.
10. Modern Magnetism, L.Bates, Cambridge University Press, 3rd edition, 1951.

PAPER – IV c : AREA OF SPECIALIZATION - CHEMICAL PHYSICS

Objective:

This paper provides detailed information about dielectric theories, Frequency as well as Time domain techniques, Dipole moment, H-bonding studies in liquids and solids.

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 the Complex plane.

UNITE-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's method – Application to molecular structure – Dipole moment of molecular complexes – Few and Smith method – Huyskens method.

UNITE-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.

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

Introduction to Proteins and poly peptides – H-bonding in Proteins – Hydrophobic interactions – 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 and References:

1. Dielectric properties and Molecular behavior, Nora.E.Hill, Van Nostrant Company, London, 1969.
2. Dielectric behaviour and Molecular structure, C.P.Smyth, McGraw Hill Publications, 1955.
3. Hydrogen Bonding, S.N.Vinogradov and Robert H.Linnell, Van Nostrand Reinhold Company, 1970.
4. Electric Dipole Moment, J.W.Smith, Butter worth Publications, 1955.
5. I.R.Spectra of complex molecules, L.J.Bellamy, 1980.
6. X – band Microwave Bench, Laboratory Manual, Sisodia, M.L, Raghuvansi, G.S., Wiley Eastern Ltd., New Delhi, 1987.
7. Molecular Interaction Vol.I, H.Rataczak and W.J. Orwille Thomas. John Wiley and Sons, 1978.
8. Moleculer Interactions Vol.2, H. Rataczak and W.J. Orwille Thomas. John Wiley and Sons , Newyork, 1980.
9. The theory of Rate processes, S.Glasstone, K.J.Laider and H.Eyring, Mc Graw Hill, New Delhi, 1941.
10. Dielectric Materials and Applications, Von Hippel.A.T., John Wiley and Sons Inc., Newyork, 1974.
11. Dielectric Relaxation, Daniel.V.V., Academic Press, London, 1967.
12. Hydrogen Bonding, New Insight: (New Insights Google e Book), Stawomir J.Grabowsk, Springer, 2006.
13. Hydrogen Bonding and Transfer in the Excited State Google e Book, Ke , I Han, Guang, Jiu Zhao, John Wiley & Sons, 2011.

PAPER – IV d : AREA OF SPECIALIZATION – ULTRASONICS

Objective: This paper aims at providing the fundamentals of production and propagation of ultrasonic waves in liquids and solids in order to understand the physico-chemical properties and also 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 nano filters – Organic/Inorganic hybrid materials – Macro and micro composites – Shape memory alloys.

UNIT - V :Applications

Scientific – Echo sounding – Sound signalling – depth sounding –SONAR– Cleaning of dirt – Cavitations – Biological and medical applications – Ultrasonic flow meter – 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 and References :

1. Fundamentals of Ultrasonics, Jack Blitz, Butter Worths, London, 1967.
2. Introduction to Chemical Ultrasonics, M.J.Blandamer, Academic press, London,1973.
3. Absorption and Dispersion of Ultrasonic waves, A. Litvoitz and K.F. Herzfeld, Academic Press, London, 1959.
4. Ultrasonic methods in Solid Physics, Rohntrunell, Charlleselabaum and Bruce B. Chick , Academic press, 1969.
5. Molecular interaction, H. Ratajczak and W.J.O. Thomas. John Wiley and Sons, Britan, 1980.
6. SEM : A user's manual for Material Science, Barbra, L. Gabriel American Society for metals, 1985.
7. Instrumental methods of analysis, Williard et al., CBS Edition, 1988.
8. Nanostructures and Nanomaterials : Synthesis, properties and applications, Guozhong Cao, Ying Wang,World Scientific Publishing Co. Pt. Ltd., 2011.

PAPER-IV e : AREA OF SPECIALIZATION - BIOPHYSICS

Objective:

This paper deals with the fundamentals of cell organization and the applications of various microscopic tools in cell biology. This helps in characterizing 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 and References:

1) The Cell: A Molecular Approach, Geoffrey M.Cooper, ASM Press, 2013.
2) Biophysics, Vasantha Pattabhi, N. Gautham, Narosa Publishing, 2009.
3) Biophysics P.S. Mishra, VK Enterprises, 2010.
4) Biophysics, M.A. Subramanian, MJP Publishers, 2005.

5) Bioinstrumentation, L.Veerakumari, MJP Publishers, 2006.
6) Fundamentals of Biochemistry, A.C. Deb, New central book agency, 2011.

PAPER IV f : AREA OF SPECIALIZATION - PETROPHYSICS

Objective :

To understand the nature of the Earth, the composition of rocks, origin of magnetism and exploration of metals, minerals and ores.

UNIT – I : Rocks and Minerals

Classification of rock forming minerals – Physical properties of minerals with special reference to optical properties – Thin section analysis – Preparation of thin section – Elementary details of a Polarizing microscope and Petrographic analysis.

UNIT – II : Prospecting Methods

Geophysical prospecting – Different methods – Electrical properties of rocks and minerals – Laboratory measurement of resistivity of rocks – Measurement of dielectric constant of rocks – Resistivity methods – Potentials in homogeneous media – Single current electrode at depth and at surface – Two current electrode at surface – Different electrode layouts – Measuring equipment – Application to ground water and petroleum survey.

UNIT – III : Magnetic Instruments

Laboratory and field instruments for magnetic measurements – Astatic magnetometer – Spinner magnetometer – Optical pump (Alkali Vapour) magnetometer – Fluxgate magnetometer, Proton precession magnetometer – Theory, practice and applications.

Hysteresis at low and high fields – Initial susceptibility of rocks – Single and multi domain cases – Curie point determination and its importance – Spinel oxide systems.

UNIT – IV : Geochronology

The geological time scale – Archaeomagnetic dating – Radioactive methods of dating – Rubidium - Strontium method – Potassium - Argon method – Decay of uranium and thorium series method – Thermo luminescence dating.

UNIT – V : Spectroscopy and Neutron Diffraction Techniques

Principle, theory and practice of Mossbauer effect - Mossbauer as a fingerprint technique in mineralogy and geochemistry. Applications of Mossbauer technique to the determination of iron content in soils and ceramic ware.

Principle, theory and practice of Neutron Diffraction – Application to the identification of elements.

Scanning principle in Mass spectrometry. Simple type Mass spectrometer – Use of an internal standard and quantitative estimation of elements.

Text Books and References:

1. Introduction to Geophysics, Howell, Mc Grew Hill Book Co., 1959.
2. Introduction to Geophysics, G.D. Garland, 2nd Edn., W.B. Sounder's Book Co., 1979.
3. Principles and Applications of Palaeomagnetism, T.H. Tarling, Chapmann and Hall, 1971.
4. Introduction to Geophysical Prospecting, Dobrin, McGraw Hill Book Co., 1960.
5. Solid state Physics, A.J. Dekker, Prentice Hall, 1969.
6. Applied Geophysics, Eve and Keys, Cambridge Univ. Press, 1956.
7. Rock and Mineral magnetism, W.O. Reillly, Blackmoore, 1984.
8. Text Book of Geology, Santhosh Kumar Garg, Khanna Pub., 1991.
9. Applied Geophysics, W.M. Telford, L.P. Geldant, R.E Sheriff and D.A. Keys, Cambridge University Press, 1983.
10. Methods in Rock magnetism and Palaeomagnetism, D.W. Collinson, Chapman and Hall- London, 1983.

PAPER IV g : AREA OF SPECIALIZATION - NANOSCIENCE AND APPLICATIONS

Objective: This paper aims at providing a deep knowledge on nanomaterials, methods of preparation, characterization and their applications.

Unit –I Nanochemistry

Introduction to nanomaterials - Properties of materials and nanomaterials - Role of size in nanomaterials – Nanoparticles - Semiconducting nanoparticles – Nanowires - Nanoclusters.

Nanostructures: Zero, One, Two and Three - dimensional structure - Size control of metal Nanoparticles and their optical, electronic and magnetic properties - Surface plasmon resonance - Change of bandgap.

Unit –II Semiconductor Nanostructures and Nano-particles

Semiconductor nanoparticles: Size dependant physical properties, Melting point - Solid-state phase transformations – Excitons - Band-gap variations - Quantum confinement and effect of strain on band-gap in epitaxial quantum dots.

Optical luminescence and fluorescence from direct band gap semiconductor nanoparticles - LED and Solar cells – Electroluminescence - Barriers to nanoparticle lasers - Doping nanoparticles.

Unit –III Synthesis of nano structure

Chemical Routes for Synthesis of Nanomaterials: Chemical precipitation and co-precipitation: Metal nanocrystals by reduction - Sol-gel synthesis - Reverse micelles - Myle formation - Solvothermal synthesis - Thermolysis routes - Bio synthesis.

Fabrication of Nanomaterials by Physical Methods: Inert gas condensation - Arc discharge - Plasma arc technique - Laser abalation - Ball Milling - Molecular beam epitaxy- Chemical vapour deposition and Electro deposition methods.

Nanocomposites: An Introduction-Types of Nanocomposite (i.e. metal oxide, ceramic, glass and polymer based) - Core-Shell structured nanocomposites.

Unit – IV: Characterization of Nanostructures

X-ray diffraction - Small angle X-ray Scattering - Optical Microscope and their description – X-ray Photoelectron Spectroscopy(XPS) – Secondary Ion Mass Spectroscopy(SIMS), Scanning Probe Microscopy (SPM) - TEM and EDAX analysis - Atomic force microscopy (AFM).

Unit –V Applications of Nanomaterials

Solar Cells - Band Diagram and Operational principle of nanocrystalline solar cells - Principles of Operation, Energy Conversion and storage devices - Lithium Ion Batteries- Magnetic nanoparticles as contrast agents for medical diagnosis - Nanoparticles in medicine – Size dependent effects of magnetic particles- Energy storage.

Text Books and References:

1. Nanochemistry: A chemical approach to nanomaterials, G. A. Ozin, A. C. Aresnault, L. Cadematriri, RSC Publishing, Cambridge UK, 2005.
2. Chemistry of nanomaterials: Synthesis, properties and applications, CNR Rao, Achim Muller, Anthony K.Cheetham, John Wiley & Sons, 2006.
3. Nanoparticles: From theory to applications, G. Schmidt, Wiley Weinheim, 2004.

4. Instrumentation, E L Principe, P Gnauck and P Hoffrogge, Microscopy and Microanalysis Cambridge University Press, 2005.
5. Nanocomposite science and technology, P.M. Ajayan, L.S. Schadler, P.V. Braun, Wiley, New York, 2003.
6. Nanostructures and Nanomaterials : Synthesis, Properties and Applications, Guozhong Cao, Ying Wang, World Scientific Publishing Co. Pte. Ltd, 2011.
7. Solar cells: Operating principles, technology and system applications, Martin A Green, Prentice Hall Inc, Englewood Cliffs, NJ, USA, 1981.
8. Semiconductor for solar cells, H.J Moller, Artech House Inc, MA, USA, 1993.
9. Hand book of Batteries and fuel cells, Linden, Mc Graw Hill, 1984.
10. Thermal Analysis of Materials, Robert F Speyer, New York, 1993.