M.PHIL 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 and Techniques, C.R. Kothari, New Age international
Publishers, 2008.
3. Thesis and Assignment Writing, J. Anderson, Wiley Eastern Ltd., 1997.
4. Research Methodology, Mukul Gupta, Deepa Gupta , PHI Learning Private Ltd., 2011.
5. Fundamentals of Mathematical statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand and Sons, 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 and 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, 20th edition, 2008.
3.Mathematical Physics, Sathya Prakash, Sultan Chand and Sons, Educational Publishers,2nd Revised Edition, 2000.
4. Advanced Quantum Mechanics, B.S.Rajput, Pragathi Prakash 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., 1931.
8. High Pressure Science and Technology, B.Vodar and Ph.Marteam, Vol.I and II, Pergamon Press, 1980.
9. High Pressure Experimental Methods, M.I.Eremets, Oxford University Press, 1996.

PAPER-III a : APPLIED SPECTROSCOPY

Objective: Spectroscopy is a branch of study which gives an insight about to the activation of atoms and molecules. This applied spectroscopy taught the students about the importance, necessary and the method of changes that undergoes during interaction.

Unit-I: Emission and Absorption Spectroscopy

Emission: Principle – Description of modern AE spectrometer –Qualitative and quantitative estimation of elements – Internal standard method – Application of AES to mineral identification.

Absorption: Instrumentation – Block diagram of Atomic absorption spectrometer – Sample preparation for estimation of typical elements like Mg, Fe, Ca, Al, K and Na.

Unit-II: UV-Visible and Flourescence Spectroscopy

UV-Visible: Principle and experimental techniques- Study of molecular structure.

Fluorescence: Principle - Measurement and instrumentation - μp based spectrofluorometer -Sample preparation - Application to biological and environmental Physics.

Unit-III: Infrared Spectroscopy and Raman Spectroscopy

Features of infrared spectra – Instrumentation – Double beam spectrometer – FTIR: Principle- Instrumentation– Sample preparation for gases, liquids and solids – Quantitative analysis of FTIR spectra.

Laser Raman and FTRAMAN spectrometer: Principle- Instrumentation-Sample preparation – Quantitative Analysis –Comparison of Raman with Infrared spectroscopy – Application of Raman on structural analysis.

Unit-IV: NMR and ESR Spectroscopy

Nuclear magnetic resonance: Theory-Chemical shift – Relaxation mechanisms-Principle and instrumentation of NMR spectrometer- Application of NMR on structural analysis.

Electron spin resonance: Theory- Hyperfine structure of ESR absorption – Fine structure of ESR spectra – double resonance in ESR- Principle and instrumentation of ESR spectrometer – Applications.

Unit-V: Mossbauer Spectroscopy and NQR Spectroscopy

Mossbauer Spectroscopy: Theory- Chemical isomer shift – Quadrupole splitting – Principle and instrumentation of Mossbauer spectrometer-Application to structure analysis..

NQR Spectroscopy: Principle and instrumentation of NQRspectrometer– Application to biological samples.

Text Books and References:

1. Molecular Spectra and Structure, Vol I & II, G. Herzberg, Vol III – D. Van Nostard Company. 3rd edition, 1996.
2. Spectroscopy, Luminescence and radiation center in minerals, A. S. Marfunin, Springer-Verlag, 1979.
3. Introduction to IR and Raman Spectroscopy, B. Norman Colthup, H. Lawrence Daly and E. Stephen Wiberly, Academic press, 1975.
4. High resolution NMR, Popple et al., Prentice Hall, 1992.
5. Nuclear Magnetic Resonance-Andrew, Cambridge University Press, 1956.
6. Spectroscopy Vol I, Straughan and Walker, Chapman and Hall1976.
7. Instrumental methods of analysis, Willard, L. Merritt, A-Dean and A. Settle, CBS Edition, 1986.
8. Molecular Spectroscopy- Ira Levin, John Wiley, 1975.
9. Spectroscopy and Molecular Structure, G.W. King Holt. Rinehart and Winoton Inc. London, 1964.
10. Instrumental Approach to Chemical Analysis, A.K. Srivastava and P.C. Jain, S. Chand and Company Ltd., 2012.

PAPER-III b: MATERIALS SCIENCE

Objective: To equip the students in understanding the properties of materials with their structure at the atomic and electronic levels as well as the behaviour of materials.

Unit-I: Materials Characterization

X-ray diffraction studies- Powder and Single crystal method – Interpretation of data. Scanning electron microscopy: Principle – Experimental methods and sample preparation- Thermal analysis: Thermogravimetry- Differential thermal analysis - Differential scanning colorimetry - Interpretation of thermograms.

Unit-II: Magnetic and Dielectric Properties

Magnetic susceptibility: Theory and Principle of Measurement of Magnetic susceptibility and Magnetic anisotropy – Curie balance and Krishnan's torsion method.

Dielectric constant: Non polar and Polar molecular crystalline solids- Measurement of dielectric constant- Microwave and Bridge method.

Unit-III: Thin Films

Preparation of thin films: Vacuum evaporation - Sputtering-Chemical methods- Electroplating- Spray Pyrolysis- Solution growth.

Characterization of thin films: Thickness measurement: Microbalance method- Multiple beam interferometry- Optical properties of thin films.

Unit-IV: Super Conductivity

Superconductivity: Flux quantization in super conducting ring – BCS theory (Quantum Mechanical Treatment) - Josephson's effect – High Tc superconductors - La-Ba-Cu-O, Y-Ba-Cu-O, Bi-Sr-Ca-Cu-O preparation. Formal valance in cuprates – One electron structures of La_2, CuO_4 and $Yba_2 Cu_3 O_{7-x}$.

Unit-V: Nano Materials

Introduction to nanoparticles – Types of nanoparticles – Quantum confinement effect, surface to volume ratio.

Synthesis of silver and gold nanoparticles – Synthesis of cadmium telluroid, cadmium sulphide and silver sulphide nanoparticles. Synthesis of ZnS : Mn, ZnS:Cu and ZnS : Ni nanoparticles – Nano manipulator – Nano tweezers.

Text Books and References:

1. The Growth of Crystals from Melt, J. C.Brice, John Wiley and Sons, 1965.
2. Growth of Crystals from Vapour – M.M. Faktor and I. Garrett, Chapman Hall, 1974.
3. Modern Magnetism – L.Bates, Cambridge University Press, 3rd edition, 1951.
4. Solid State Physics, A.J. Dekker, Prentice Hall, 1951.
5. Solid State Physics, Singhal, New edition, Kedar Nath Ram Nath and Co., 2001.
6. Solid State Physics, Saxena, Gupta, Saxena, Pragati Prakashan, 1970.
7. Instrumental methods of analysis,H. Willard, L. Merritt, A-Dean and A. Settle, CBS publishers, 1980.
8. Thin film Technology- Robert W. Berry D. Van, Nostrand Company Ltd., 1968.

9. Nanotechnology, M. Wilson, K. Kannangara, G. Smitt, M. Simmonss. and B .Boguse, Overseas Press, 2005.
10. Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Guozhong Cao, Ying Wang, World Scientific Publishing Ltd, 2011.
11. Nanomaterials and Mechanics, W. Kamliu, John Wiley, 2006.

PAPER-III c: CHEMICAL PHYSICS

Objectives: This paper provides detailed information about dielectric, infrared studies of molecular interaction in liquid phase and importance of H bonding.

Unit-I: Theories of Static Permittivity

The molecular orgin of permittivity and loss – Polarization types – Debye's theory of static permittivity – Onsager's theory of internal field and permittivity – Kirkwood's theory and Frohlich's theory for non polarizable dipoles – Relation between Kirkwood's and Frohlich theory.

Unit-II: 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 and Huyskens method.

Unit-III: Frequency Domain and Time Domain Techniques

X – Band microwave bench: Principle – Experimental arrangement – Dielectric relaxation – Higasi's and Cole-Cole plot methods – Rate theory of dielectric relaxation and Viscosity-

Time domain Reflectometry: Principle – Experimental arrangement – Procedure – Dynamic permittivity – Davidson – Cole model, – Havariliak – Negami model – Applications.

Unit-IV: Fundamentals of H-Bonding

Nature of H-bonding – Models of hydrogen bonding (Electrostatic model, Quantum mechanical models) – Potential energy curves and symmetrical hydrogen bonds – Proton transfer and ion pair formation – Thermodynamics of H-bonding – Equilibrium constant.

Unit-V: IR Spectra in 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.

Text Books and References:

1. Dielectric properties and Molecular behaviour, Nora. E. Hill, Van Nostrant Company, 1969.
2. Dielectric behavior and Molecular structure, C.P. Smyth, McGraw Hill Publications, 1955.
3. Electric dipole moments, J.W.Smith, Butter worth publications, 1955.
4. I.R. Spectra of complex molecules, L.J. Bellamy Chapman and Hall, 1980.
5. X–Band Microwave bench, Laboratory manual, Sisodia, M.L, Raghuvansi, G.S., Wiley Eastern Ltd., 1987.
6. Moleculer Interactions, C. RatajCzak and Orville, A. Thomas, Wiley Interscience Publications, 1980.
7. Theory of rate processes, S. Glasstone, K.J. Laider, and H. Eyring, Mc Graw Hill, 1941.
8. Dielectric materials and applications, A.T. Von Hippel, John wiley and Sons Inc., 1974.
9. Dielectric Relaxation, V.V. Daniel, Academic Press, 1967.

PAPER – III d: 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: Generation, Detection and Propagation of Ultrasonic Waves

Production of Ultrasonic waves: Low and high frequency waves – Longitudinal and transverse modes – Piezoelectric and magnetostriction transducers – Detection of ultrasonic waves-Crystal receivers.

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

Unit-II: Molecular Interaction in Liquids and Liquid Mixtures

Theories of physical and thermodynamic properties – Adiabatic compressibility- Molar sound volume- Intermolecular free length- Free volume- Internal pressure- Acoustic impedance and their excess properties of aqueous and non-aqueous solutions– Apparent molal compressibility-Apparent molal volume– Viscosity B-coefficient – Hydration number.

Complex formation –Types of bonding in liquids – Hydrogen bonding –Nature of H-bond – Detection of H-bonding using ultrasonic method.

Unit-III: Propagation of Ultrasonic Waves in Solids

Velocity and attenuation measurement in solids – Stationary and continuous wave method – Pulse echo method – Stress, strain and displacement relations – Elastic constants – Equations of motion –Solutions – Propagation of ultrasonic waves in ferromagnetic and ferroelectric materials – Absorption due to lattice imperfections – Pressure and temperature dependence on velocity and attenuation.

Unit-IV: Preparation and Analysis of Glasses

Types of glasses – Metallic glasses – bioactive glasses – Composition and preparation of glass specimen – Characterization of glasses using microhardness, XRD, DSC, FTIR and SEM analysis.

Unit-V: Applications and Introduction to Nanomaterials

Non-destrctive testing (NDT): Importance in characterization of materials – Flaw detection and thickness gauging – Metallurgical applications with special reference to soldering and welding – Biological and medical applications – Ultrasonic flow meter – Ultrasonic delay lines – UTT (Ultrasonic Trans Tomogram)

Nanomaterials - Synthesis and characterization of micro and nano filters – Organic/Inorganic hybrid materials – Macro and Micro composites – Shape memory alloys.

Text Books and References:

1. Fundamentals of Ultrasonics, Jack Blitz, Butter Worths, 1967.
2. Introduction to Chemical Ultrasonics, M.J. Blandamer, Academic press, 1973.
3. Absorption and Dispersion of Ultrasonic waves, A. Litvoitz and K.F. Herzfeld - Academic Press, 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. Hardcover, 1980.

6. Instrumental methods of analysis, Williard L. Merritt, A-Dean and A. Settle, CBS Edition, 1988.
7. SEM – A user's manual for material science, Barbra, L. Gabriel American Society for metals, 1985.

PAPER-III e: BIOPHYSICS

Objective: This paper helps to understand the applications of various microscopic tools in cell biology. This paper helps the reader to understand the fundamentals of macromolecular structure and the analytical techniques in characterizing biomolecular interactions and its structure.

Unit-I: Macromolecular Structure

Proteins**:** Organization of protein- Primary structure – Secondary structure– Tertiary structure – Quaternary structure – Sequencing of proteins.

Nucleic Acids**:** Organization of nucleic acids – Primary structure of DNA – Secondary structure of DNA – Tertiary structure of DNA – Structure of RNA – Sequencing of nucleic acids.

Unit-II: Tools in Cell Biology

Principle and working : Phase contrast microscope, Polarization microscope, Fluorescence microscope, Electron microscope, Transmission Electron microscope, Scanning electron microscope, Atomic force microscope and Confocal laser microscope.

Unit-III: Seperation Techniques

Centrifugation**:** Principle of centrifugation –Analytical ultracentrifugation – Differential centrifugation – Density gradient centrifugation.

Chromatography**:** Principles of chromatography– Paper chromatography – Thin layer chromatography (TLC) – Gas liquid chromatography (GLC) – High performance liquid chromatography (HPLC).

Electrophoresis: Principles – Factors affecting the migration of substances – Supporting media in electrophoresis – Gel electrophoresis – Polyacrylamide gel electrophoresis (PAGE) – Sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE).

Unit-IV: Spectroscopy-I

Beer– Lambert's Law– Calorimeter – Double beam Spectophotometer– Ultraviolet and Visible spectroscopy – Origin and theory of UV spectra– Instrumentation– Biomedical applications.

Fluorescence Spectroscopy– Principle of Fluorescence – Spectrofluorimeters – Principle and Instrumentation – Biomedical applications.

Unit-V Spectroscopy-II

Infrared Spectroscopy– Basic concept of IR Spectroscopy – IR Spectrophotometer: Principle and instrumentation – Sample handling technique – FTIR: Principle and instrumentation – Biomedical applications.

Raman Spectroscopy – Raman Spectrometer: Instrumentation and working – Biomedical applications.

Text Books and References:

1) Biophysics, Vasantha Pattabhi, N. Gautham, Narosa Publishers, 2009.
2) Biophysics P.S. Mishra, VK Enterprises, 2010.
3) Biophysics, M.A. Subramanian, MJP Publishers, 2005.
4) Bioinstrumentation, L.Veerakumari, MJP Publishers, 2006.

PAPER-III f: NANOMATERIALS

Objectives: This paper deals with the various techniques for characterizing nanoparticles and also aims to provide a deep knowledge on preparation of nanomaterials and its applications.

Unit-I: Material Characterization

Introduction - Electron microscopy – Principle and working : Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Probe Microscopy (SPM), Scanning Tunneling Microscopy (STM), Dynamic Light Scattering (DLS) and X-Ray Diffraction (XRD).

Unit-II: Quantum Size Effect

Electron confinement in infinitely deep square well- Confinement in two and one dimensional well-Idea of quantum well structure- Quantum dots – Quantum wires.

Determination of particle size- Increase in width of XRD peaks of nanoparticles- Shift in photoluminescence peaks- Variations in Raman spectra of nanomaterials.

Unit-III: Infrared and Raman Spectroscopy

Principle and condition for IR absorption- Instrumentation and working of FT-IR spectrophotometer- Importance of group frequencies in relation to molecular structure- General applications.

Raman spectroscopy- Principle- Instrumentation- Molecular structure determination.

Unit-IV: Nano Materials

Introduction – Nano rods - Nano particles - Nano materials preparation - Plasma arching - Chemical vapour deposition.

Synthesis of metal Nano particles-Background on quantum semiconductors - Background on reverse miceller solution - Synthesis of semiconductors - Cadmium telluroid nano crystals - Cadmium sulfide nano crystals - Silver sulfide nano crystals - Nano manipulator - Nano tweezers - Nanodots.

Unit-V: Nano Biology

Introduction- Interaction between biomolecules and nanoparticle surface electronic effects of biomolecule nanoparticle interaction- Different types of inorganic materials used for the synthesis of hybrid nano bioassemblies- Magnetic nanoparticles- Application of nano in biology- Diagnostic applications of immunotargeted nanoparticles- Targeted drug delivery using nanoparticles.

Text Books and References:

1. Instrumentation methods of analysis, Willard, L. Merritt, A-Dean and A. Settle, CBS Edition, 1986.
2. Quantum dot heterostructures, D. Bimerg, M. Grundmannand, N.N. Ledentsov, John Wiley and sons, 1998.
3. Physics of Nanostructures, K.P. Jain, Narosa, 1997.
4. Nanotechnology, M. Wilson, K. Kannangara, G. Smitt, M. Simmonss and B. Boguse, Overseas Press, 2005.
5. Nanosystem - E. Dexler, John Wiley, 1992.
6. Nanomaterials and Mechanics - W. Kamliu, John Wiley, 2006.