

M.Phil. Physics

List of papers with Subject Code

S. No.	Semester	Title of the Paper	Subject Code	Credits
1	I	Research Methodology	MPhlPH1	6
2		Advanced Physics	MPhlPH2	6
Special Papers				
3		Nanoscience and Nanotechnology	MPhlPHNT	6
		Applied Spectroscopy	MPhlPHSP	6
		Radiation Physics	MPhlPHRP	6
		Principles and Methods Of Crystal Growth	MPhlPHCG	6
4	II	Project Work	MPhlPHPH	10
5		Project Viva voce	MPhlPHPV	10

M.Phil. Syllabus (from 2013 onwards)

Paper I – Research Methodology

(Paper Code: MPhlPH1)

Unit-1- Principles of Scientific Research

Writing review of literature- Writing abstract-Summary & synopsis- Reference citing-Different systems of reference citation-citation in the text-Listing references-Preparing manuscript for publication-Poster presentation-Oral presentation-Writing a research grant proposal

Unit-2- Numerical Methods

Solution to simultaneous linear algebraic equations - Gauss elimination method – Gauss Jordan method – Iterative methods – Gauss Jacobi and Gauss Siedel methods of iteration - Numerical solution of differential equations –Euler’s method - Runge-Kutta method –Interpolation - Lagrange interpolation –Newton’s forward and backward interpolation- Numerical differentiation and integration – Trapezoidal rule- Simpson rule

Unit-III - C’ Programming

Introduction to C – basic structure of a C program – numerical integration by trapezoidal rule - Simpson rule – least squares – Euler’s and Runge-Kutta method – Lagrange interpolation - Newton’s forward and backward interpolation.

Unit – IV- Group Theory

Definition of Group, sub group and classes – symmetry elements and symmetry operations – matrix representation of a group – reducible and irreducible representations – Great Orthogonality Theorem – character of representation – construction of character table for XY₂ and XY₃ type molecules -- application to molecular vibrations – XY₂ and XY₃ type molecules- IR and Raman activities – Space group symmetry – application to crystallography – assignment of space group to crystallographic system.

Unit-V- Data Analysis

Statistical measure-Central measure-Mean, Median, Mode-Dispersion measures-Range-Standard deviation-Normal Distribution-Correlation Analysis-Types of Correlation-Methods of studying Correlation-Regression analysis-Test of significance-t test-Chi-square test-Paired t test-Curve fitting-Principle of Least square

Books for Study

1. Scientific thesis writing & paper Presentation- N.Gurumani ,MJP Publishers
2. Research & Writing Across the Disciplines-P.Ramadoss & A.Wilson Aruni, MJP Publishers
3. Research Methods- Tips and techniques G.Vijayalakshmi, C.Sivapragasam, MJP Publishers
4. Introductory methods of numerical analysis-S.S.Sastry, Prentice Hall of India,2007
5. Computer applications inPhysics with FORTRAN &C BasicSuresh Chandra, Narosa Publishers, 2nd Edition
6. Group theory for Physicist-A.W.Joshi, Wiley Eastern Ltd,3rd Edition
7. Numerical methods-P.Kandasamy, K.Thilagavathy, K.Gunavathy, S.Chand Publications, 3rd Edition (2008)

Books for Reference

1. Research methodology- C.R.Kothari, New Age international Publishers, 2nd Edition,2013 Reprint..

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Paper II – Advanced Physics

(Paper Code: MPh1PH2)

Unit I – Nuclear Physics

Alpha decay – Gamow's theory – Beta decay – Fermi's theory of beta decay – gamma decay – internal conversion – units of radioactivity- radiation dosimetry – External :TLD,Film badge, NTA and direct reading dosimeters- Internal : in vitro and in vivo techniques – radiation shielding - radiation hazards-Waste disposal

Unit II – Quantum Mechanics

Relativistic wave equation – Klein – Gordan equation - Klein – Gordan equation for a charged particle in an electromagnetic potential – Dirac equation – plane wave solution and its normalization - covariant form of Dirac equation and its solution – electron spin and magnetic moment – approximation in atomic structure – central field approximation – Thomas Fermi approximation – Hartree self-consistent field – Hartree Fock method

Unit- III- Material Science

Band theory of solids-Electron in a Periodic field of crystal-Dielectric materials-Local field on internal field-Clausius-Mossotti relation-Dielectric breakdown-Ferroelectric materials-Applications-New Materials-Metal matrix Composite (MMC)-Surface acoustic Wave materials (SAW)-SMART Materials

Unit IV – Advanced Analytical Techniques

Analytical Technique - Principles of single crystal and Powder X-ray diffraction, FT-IR, Raman and UV-Visible spectrometers – AAS spectroscopy and NMR spectroscopy - application in structural determination of organic, pharmaceutical and biological materials –SEM, TEM, EDAX, AFM, EPMA - instrumentation – Sample preparation – Analysis of materials – Study of dislocation – Ion implantation uses.

Unit V – Micro controllers & embedded systems

8051 Architecture - Addressing modes-Input-output ports-Interrupts-Timer-Serial communication- Complex systems & Microprocessor-The Embedded design-Life cycle-Selection process-Model Train controller.

Books for study

1. Nuclear Physics- S.N. Ghoshal,S.Chand Publications,Reprint 2009

2. Quantum Mechanics – Satya Prakash, Kedar Nath and Ram nath, 5th edition
3. Text book of Quantum Mechanics – Mathews & Venkateshan, Tata Mcgraw Hill
4. Material Science- Arumugam, Anuradha Publications, 3rd Edition(2008)
5. Material Science & Engineering- V.Raghavan Prentice Hall of India Pvt ltd, 5th edition
6. Computers as components, Principles of Embedded Computing system design- Wayne wolf-2nd edition, Elsevier Inc.2008
7. Embedded system design-An Introduction to processors, tools & techniques, -Arnold S Beyer-Replika Press Pvt Ltd, India 2005

Books for Reference

1. Quantum Mechanics- Aruldas, PHI Learning Pvt Ltd, 2nd edition 2008
Solid state physics- S.O.Pillai, New age International Publishers, 5th edi

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Special Paper – I

NANOSCIENCE AND NANOTECHNOLOGY (Paper Code: MPhilPHNT)

UNIT I: BASICS OF NANOSCIENCE AND NANOTECHNOLOGY

Introduction - Overview of Nanoscience and Nanotechnology - Theory, Definitions and History – Properties at nanoscale - Classification of Nano materials – 0D, 1D, 2D and 3D nanomaterials - Nanoparticles – Size and confinement Effects – Fraction of surface atoms – Specific surface energy and surface stress – Carbon based nanomaterials.

UNIT II: SYNTHESIS OF NANOMATERIALS

Top down and Bottom up approach (Elementary ideas) -Synthesis of nanoparticles: Chemical reduction method – sol-gel method - Sonochemical Reactor – Ball milling– Spray Pyrolyser - Nano crystalline thin film by spin coating- Chemical bath deposition – Dip coating- Effect of particle size on Physical / Chemical properties.

UNIT III: CHARACTERIZATION OF NANOMATERIALS

Diffraction technique: XRD – Structure and Determination of grain size using X-ray line broadening – Imaging technique: SEM and TEM – Scanning probe microscopic technique: STM and AFM – Optical microscopic technique: Confocal microscopy – Spectroscopic techniques: UV-Visible spectroscopy, Infrared surface spectroscopy – Raman spectroscopy – Photoluminescence study.

UNIT IV: NANOELECTRONICS

Nano sensors - MEMS/WEMS – Electrochemical sensors – Sensors based on physical properties – Sensor of the future – Smart dust – Moore's law – FET to SET – Magnetic RAM – Vertical Magnetic resistive RAM (VMRAM) – Millipede drive – Holographic data storage system – Phase change memory – Nanotube RAM – Molecular memory.

UNIT V: APPLICATIONS AND SOCIETAL IMPLICATIONS

Polymer based Nano composites - Nano Solar cells - Nano catalyst – Food and Agriculture – cosmetic& consumer goods – Water treatment and environment –

Nano medical applications – Drug Delivery – Photodynamic therapy – Health and social impact - Structural applications.

Books for study

1. Nano material – B.Vishwanathan, Narosa publishing House
2. Introduction to Nano science (Indian edition) – S.M. Lindsay, Oxford university Press
3. Nanotechnology – A Gentle Introduction to the next big idea – Mark Ratner, Daniel Ratner, Pearson
4. Nano – The essentials Understanding Nanoscience and Nano technology – T. Pradeep, Tata Mc-Graw Hill publishing Company Ltd.
5. Text book of nanoscience & nanotechnology – B.S. Murthy, P. Shankar, Baldev Raj, University Press, edition 2012.
6. Introduction to Nanoelectronics science, Nano Technology, Engineering and applications – Vladimir V. Mitin, Viatcheslav A.Kochelap, Michael A. Stroscio, Cambridge University Press.

Books for reference

1. Introduction to Nano Science & Nano technology – Gabor L. Hornyak, Harry F. Tibbals, Joydeep Dutta, John J. Moore, CRC Press.
2. Handbook of Crystal growth - Springer Publications 2010.

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Special Paper - II

APPLIED SPECTROSCOPY

(Paper Code: MPhlPHSP)

UNIT I - Normal Coordinate Analysis

Symmetry operations and their matrix representation - Group multiplication table - Point groups and their classification - Character table - Rules for construction - C_{2v} , C_{3v} and C_{4v} character table - Normal modes of vibration - IR - Raman Activity.

Introduction to NCA - secular equations - Potential energy matrix - Kinetic energy matrix - G matrix for bent XY_2 molecule - Ab initio method.

UNIT II - Infra Red & Raman Spectroscopy

Vibration of diatomic and simple polyatomic molecules - anharmonicity - Interpretation of vibrational spectra - Fourier transform - Basic theory - Application of FTIR spectroscopy-

Vibrational and rotational Raman spectra - Mutual exclusion principle - Polarization of Raman scattered light - Structure determination through IR and Raman spectroscopy - surface enhanced Raman spectroscopy - Resonance Raman spectroscopy- Coherent Anti Stoke's Raman spectroscopy - Photo-acoustic Raman spectroscopy- applications of Raman Spectroscopy

UNIT III - UV- Visible, Atomic Emission and Absorption Spectroscopy

Basic concepts - Law of absorption - Beer's law - Instrumentation - Factors affecting the position of UV bands - Characteristic of organic compounds - Applications of UV - Visible spectroscopy.

Atomic Absorption Spectroscopy: Principle - Measurement of atomic absorption - Sensitivity- Applications - Flame emission Spectroscopy -Principle- Instrumentation-Analytical applications.

UNIT IV - NMR and ESR Spectroscopy

Theory of NMR Spectroscopy - Relaxation process - Bloch equation - chemical shift -Interpretation of NMR spectra - applications - ESR spectroscopy - ESR spectrometer - Total Hamiltonian - hyperfine structure - ESR spectrum of free radicals - analytical applications.

UNIT V - Fluorescence & Phosphorescence Spectroscopy

Fluorescence & Phosphorescence - Fluorescence Spectroscopy - Internal and external conversion-Quenching- Spectro Fluorometer - Applications of fluorimetry - phosphorimetry- Applications- Chemiluminescence.

Books for study

1. Introductory Raman spectroscopy – M.Ferraro, K.Nakamoto, W.Brown, Academic press 2003
2. Introductory Raman spectroscopy – Gurudeep R.Chatwal , Sham.K. Anand, Himalaya publishing house, 5th edition 2008
3. Spectroscopy – B.K. Sharma, Goel Publishing house, 13th edition
4. Molecular structure and Spectroscopy - G. Aruldoss, Prentice – Hall India 5th edition
5. Principles of instrumental analysis – Douglas A. Skoog, Donald M. West, Saunders publishers
6. Vibrational spectroscopy – DN Satyanarayana – New age international 2005.
7. Instrumental Methods of Chemical Analysis – G. R. Chatwal & S. K. Anand, Himalaya Publishing House
8. Instrumental Methods of Analysis – 7th edition, Willard, Merritt, Dean, Settle, CBS Publishers and Distributors
9. Application of Absorption Spectroscopy of Organic Compounds – John R. Dyer, Prentice Hall of India

Books for Reference

1. Instrumental Methods of Chemical Analysis – Willard Merrit and Settle
2. Instrumental Methods of Analysis – N.Gray, M.Kalvin , S.C. Bhatia , CBS Publishers and Distributers, 2009
3. Molecular spectroscopy – K.V. Ramanan, R. Gopalan, P.S. Raghavan, Vijay Nicole Imprints Pvt Ltd 2004

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Special Paper – III

RADIATION PHYSICS

(Paper Code: MPh1PHRP)

Unit I : Radiation Sources

Fast electron sources – Beta decay – Internal conversion – Auger electrons – Heavy charged particle sources – Alpha decay – Spontaneous fission – Sources of electromagnetic radiation – Gamma rays- Annihilation radiation – Gamma rays following nuclear reactions – Bremsstrahlung – Synchrotron radiation – Neutron sources – Spontaneous fission – Photo neutron sources – Radio isotope (α , n) sources.

Unit II : Radiation Interactions

Interaction of heavy charged particles – Nature of the interaction – Stopping power – Energy loss characteristics – Particle range – Scaling laws – Interaction of fast electrons – Specific energy loss – Electron range and transmission curves – Positron interactions – Interaction of gamma rays – Interaction Mechanisms – Gamma ray attenuation – Interaction of neutrons – Slow and fast neutron interactions – Neutron cross sections.

Unit III: Radiation Dosimetry

Units – Absorbed dose – Grad – Rad – Exposure –Roentgen – Exposure measurement – Free air chamber – Air wall chamber – Exposure dose relationship – Absorbed dose measurement – Bragg Gar principle – Kerma – The role of ICRP – Maximum permissible doses – Dose limits – Dose measuring instruments – TLD – Chemical Dosimeters – Pocket dosimeter – Film badge dosimeter.

Unit IV: Radiation Detectors

Scintillation Detectors – Organic scintillators – Inorganic scintillators – Cryogenic and super conducting detectors – Bolometers – Track etch detectors – Bubble detectors – Detectors based on Integrated circuit components – Direct ion storage dosimeter – MOSFET dosimeters as detectors – Memory cells as detectors – Cerenkov detector.

Unit V: Waste Management, Protection and Shielding

Storage of radioactive waste – Disposal of solid waste – Disposal of liquid waste – Releases to the atmosphere – Radiation protection in Medicine – Protection against sealed sources – Protection against unsealed sources – Control and disposal of radioactive materials – Techniques of external radiation protection – Shielding – X ray shielding – β ray shielding – Neutron shielding.

Books for Study:

1. Radiation Detection and Measurement by Glenn F.Knoll ,John Wiley & Sons Inc , Third edition.
2. Introduction to Health Physics by Herman Cember ,Pergamon Press ,Second edition.
3. An introduction to radiation protection by Alan Martin & SamuelA.Harbison , John Wiley &Sons Inc

Books for Reference:

1. Introduction to Radio analytical Physics by G.Deconnk , Elsevier.

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Special Paper – IV

PRINCIPLES AND METHODS OF CRYSTAL GROWTH

(Paper Code: MPhlPHCG)

UNIT – I: FUNDAMENTALS OF CRYSTAL GROWTH

Importance of crystal growth – Classification of crystal growth methods – Basic steps: Generation, transport and adsorption of growth reactants – Nucleation: Kinds of nucleation – Classical theory of nucleation: Gibbs Thomson equations for vapour and solution – Kinetic theory of nucleation – Becker and Doring concept on nucleation rate – Energy of formation of a spherical nucleus – Statistical theory on nucleation: Equilibrium concentration of critical nuclei, Free energy of formation.

UNIT – II: THEORIES OF CRYSTAL GROWTH

An introductory note to Surface energy theory, Diffusion theory and Adsorption layer theory – Concepts of Volmer theory, Bravais theory, Kossel theory and Stranski's treatment – Two-dimensional nucleation theory: Free energy of formation, Possible shapes and Rate of nucleation – Mononuclear, Polynuclear and Birth and Spread models – Modified Birth and Spread model – Crystal growth by mass transfer processes: Burton, Cabrera and Frank (BCF) bulk diffusion model, Surface diffusion growth theory.

UNIT – III: EXPERIMENTAL CRYSTAL GROWTH - I

Melt Growth Techniques:

Basics of melt growth – Heat and mass transfer – Conservative growth processes: Bridgman-Stockbarger method – Czochralski pulling method – Kyropoulos method – Non-conservative processes: Zone-refining – Vertical and horizontal float zone methods – Skull melting method – Vernueil flame fusion method.

UNIT – IV: EXPERIMENTAL CRYSTAL GROWTH - II

Solution Growth Techniques:

Growth from low temperature solutions: Selection of solvents and solubility – Meir's solubility diagram – Saturation and super saturation – Metastable zone width – Growth by restricted evaporation of solvent, slow cooling of solution and temperature gradient methods – Crystal growth in Gel media: Chemical reaction and solubility reduction methods – Growth from high temperature solutions: Flux growth Principles of flux method – Choice of flux – Growth by slow evaporation and slow cooling methods – Hydrothermal growth method.

UNIT -V: EXPERIMENTAL CRYSTAL GROWTH - III

Vapour Growth Techniques:

Basic principles – Physical Vapour Deposition (PVD): Vapour phase crystallization in a closed system – Gas flow crystallization – Chemical Vapour Deposition (CVD): Advantageous and disadvantageous – Growth by chemical vapour transport reaction: Transporting agents, Sealed capsule method, Open flow systems – Temperature variation method: Stationary temperature profile, Linearly time varying temperature profile and Oscillatory temperature profile.

BOOKS FOR STUDY AND REFERENCE

1. Crystal Growth Processes, J.C. Brice, 1986, John Wiley and Sons, NY
2. Crystallization, J.W. Mullin, 2004, Elsevier Butterworth-Heinemann, London.
3. Crystal Growth: Principles and Progress, A.W.Vere, 1987, Plenum Press, NY
4. Crystals: Growth, Morphology and Perfection, Ichiro Sunagawa, 2005, Cambridge University Press, Cambridge.
5. Introduction to Crystal Growth Methods, B.R. Pamplin, 1975, Pergamon Press, Oxford.
6. Crystallization, J. W. Mullin, Plenum Press, New York, 1976
7. Crystal growth – Methods and Processes, P. Santhanaraghavan & P. Ramasamy, KRU Publications, Kumbakonam (2000).
8. Crystal Growth from Gels, H. K. Heinisch, Cambridge University Press, USA, 1988
9. Crystal Growth from Solution, J. C. Brice, North Holland Publishing Co., Amsterdam
10. Vogel's Textbook of Quantitative Chemical Analysis, Mendham, Pearson Education, 2004
11. The Science of Engineering Materials, J. E. Goldman, Wiley, NY, 1957
12. Electrical Engineering Materials, A. J. Dekkar, Prentice Hall of India, 2003
13. Handbook of crystal growth-Dhanraj, Springer, edition 2010