M.Phil. Physics
Courses offered

Semester I	Subject code	Title of the paper	Hours/week		Credit
			Contact	Library	
C1	**MPP181**	Professional Skills for Teaching - Learning	**3 + 2**	**2**	**3 +1**
C2	**MPP182**	Research Methodology	**5**	**3**	**4**
C3	**MPP183**	Advanced Physics	**5**	**3**	**5**
C4	**MPP184**	**Indepth paper** Principles and Methods of Crystal Growth	**3**	**4**	**5**
	MPP185	Research Trends in Nanoscience and Technology			
	MPP186	Electronic Structure Calculations For Solids			
II	**MPP18 D**	**Project**	20		12
		TOTAL			**30**

Semester I
C1: Professional Skills for Teaching – Learning
Sub Code: MPP181

No. of hours per week			Credit	Total no. of hours	Marks
T	**P**	**Library**	3 + 1	75	100
3	2	2			

Objectives

1. To empower scholars with soft skills.
2. To introduce the teaching and dynamics of teaching – learning
3. To facilitate e- learning/ e-teaching with the ICT tools
4. To acquire practical skills (in subject) aiming at gaining confidence to handle practical classes
5. To develop teaching skills and gain confidence in teaching.

Unit I: Soft Skills

Introduction to Soft Skills, Soft Skills Vs Hard Skills, types of Soft Skills.

Communication Skills: Basics in communication, structure of written and oral sentences, Verbal, non-verbal, body language, Intrapersonal and Interpersonal Communications, Activities in Effective Communication.

Behavioral Skills: Leadership skills, Time Management, Creativity and Lateral thinking.

Interview Skills: Resume Writing, Different types of interviews, Etiquettes in interviews, Mock interviews.

Team Building and Group Discussion: Progressive stages of Team Building, Parameters of GD (special reference to attending, listening, responding skills).

Language skills (LSRW): Strategies to acquire LSRW skills.

Unit II: Techniques and Dynamics of Teaching- Learning

Emerging trends in Educational Psychology: Meaning, Scope and Methods

Learning: Different Theories of learning, Approaches to learning (Classical Conditioning- Ivan Pavlov; Operant conditioning-B.F.Skinner); kinds of learning, factors affecting learning.

Motivation: Intrinsic and extrinsic motivation, Development of memory and intelligence.

Unit III: Incorporating Teaching and Learning via Modern Gadgets:

An Overview of Microsoft Office-2007: MS WORDS-2007- MS Excel-2007- MS Powerpoint-2007. Concepts in e-Resources :Making use of Web Resources .

ICT for Research: On-line journals, e-books, Courseware, Tutorials, Technical reports, Theses and Dissertations.

Unit IV: Instructional Technology:

Definition, Objectives and Types – Difference between Teaching and Instruction – **Lecture Technique:** Steps, Planning of a Lecture, Delivery of a Lecture – Narration in tune with the nature of different disciplines – Lecture with power point presentation –LCD Projector- AV aids – Smart class room. Teaching – learning Techniques: Team Teaching, Group discussion, Seminar, Workshop, Symposium and Panel Discussion – Modes of teaching: CAI, CMI and WBI

Unit V: Learning, Teaching and Evaluation Practice

Teacher assisted class room teaching- assignment – (5 classes) and Teacher evaluation and suggestions.-Teacher assisted laboratory practice –assignment – (5 lab sessions) and teacher evaluations and suggestions

Reference Books

Don Skinner (2005), Teaching Training, Edinburgh University Press Ltd, Edinburgh
Sharma, R.A. (2006) Fundamentals of Educational Technology, Surya Publications, Meerut
Vanaja, M. and Rajasekar, S (2006), Computer Education, Neelkamal Publications, Hyderabad
Bela Rani Sharma (2007), Curriculum Reforms and Teaching Methods, Sarup and sons, New Delhi

Semester I
C2: Research Methodology
Sub. Code: MPP182

No. of hours per week		Credit	Total no. of hours	Marks
Contact	Library	4	75	100
5	3			

Objective

1. To understand the essential knowledge and skills needed for Physics research.
2. To apply their skills to develop new materials and devices.

Unit I: Research Methodology

Research and its importance – Research methods and research methodology – Types of research – Identification of a research problem – Literature survey – Reference collection.

Mode of approach : research design – Possible approaches – Actual investigation – Results and conclusions – Presenting a scientific seminar – oral report – The art of writing a research paper and thesis – Outline of a report – Layout of a report – Writing a research paper for publication in a journal.

Unit II: Mathematical Physics

Special functions – Laguerre Differential equation and Laguerre Polynomials - Generating function, Rodrigue's formula - Recurrence relations. Green's function – Green's function for Poisson's equation - Quantum mechanical scattering problem – Numerical Analysis: Finite differences – Interpolation and extrapolation – Numerical differentiation – Integration

Unit III: Photonics

Postulates of ray optics and wave optics - Holography - Principles of electro optics– Photonic Crystals Basics concepts - Features of photonic crystals - Methods of fabrication - Nonlinear photonic crystals - Photonic crystal fibers - Photonic crystals and optical communications -Photonic crystal sensors.

Unit IV: Astrophysics

Spectral classification of stars - Boltzmann's formula – Saha 's equation of thermal ionization – Harvard system of spectral classification – Theory of sunspots – Solar flares – Stellar temperatures - Classification of variable stars – erupting and exploding stars – Distribution of novae in our galaxy – Cosmology – red shift and the expansion of universe – Big bang – Dark matter and dark energy – Elementary particles and their interactions – Van Allen Belt – Evolution of stars.

Unit V: Recent Trends in Thin Film Technology

Thin Film optics – theory – optical constants of thin films – filters – Anti reflection coatings. Thin film solar cells: Role and progress and production of thin film solar cells-photovoltaic parameters. Thin film silicon (Polycrystalline) solar cells. Current status of bulk silicon solar cells – fabrication technology photovoltaic performance – Emerging solar cells: GaAs and CuInSe.

Reference Books

Rajasekar, S. & Philominathan. P. Chinnathambi V. (2003). *Research Methodology*. (1st ed.) New Delhi: Prentice-Hall of India private Ltd.

Satya Prakash. (2005). *Mathematical Physics*. (4th ed). New Delhi: S. Chand & Company Pvt. Ltd.

Sastry, S.S. (2009). *Introductory Methods of Numerical Analysis*. (3rd ed). India: Prentice Hall Pvt. Ltd.

Bahaa, E. A & Saleh. (2003). *Fundamentals of photonics*. (2 nd ed). Germany: John Wiley & Sons publications.

Saleh B.E.A & Teich, M.C. (1991). *Fundamentals of Photonics*. (1 st ed). Germany: John Wiley & Sons publications.

Prasad, P.N. (2003). *Nanophotonics*. (1 st ed). Germany: Wiley & Sons publications.

Baidyanath Basu. (1997). *An Introduction to Astrophysics.* (5th ed). New Delhi: Prentice Hall of India.

ArtherBeiser & ShobhitMahajan., RaiChoudhury. S. (2012).*Concepts of Mordern Physics.* (6th ed.) New Delhi: Tata McGraw Hill Pvt Ltd.

Milton Ohring. (1992). *The Materials Science of Thin Films.* (2nd ed). New Delhi: Academic Press.
Chopra.K. L. (1979).*Thin Film Phenomena* .(2nd ed). New Delhi: Tata McGraw Hill Pvt Ltd.
Chopra K. L. & Das. S. R. (1983). *Thin Film Solar Cells.* (1st ed).London: Plenum press

Semester I
C3: Advanced Physics
Sub. Code: MPP183

No. of hours per week		Credit	Total no. of hours	Marks
Contact	Library	5	75	100
5	3			

Objectives

1. To highlight a variety of topics such as solid state theory, high temperature superconductivity, crystal growth studies.
2. To analyze the material properties and various sensing mechanisms.

Unit I: Solid State Theory

Fermi surfaces – Construction of Fermi surfaces – Electrons in an uniform magnetic field - Anomalous skin effect- Cyclotron resonance – Closed orbits and open orbits – De HAAS-van ALPHEN effect - Nearly Free electron approximation - The density of states in the Band model – band structure of metals – band structure of semiconductors and insulators.

Unit II: High Temperature Superconductivity

High temperature superconductors: Cuprates – charge carriers – Structure and doping of $La_{2-x}Ba_xCuO_4$ – Preparation and structure of $YBa_2Cu_3O_{7-x}$ – More layer-like cuprate superconductors ($Bi_2CaSr_2Cu_2O_8$) – Applications of high temperature superconductors in microwave technology – superconducting aerials.

Unit III: Modern Crystal growth Techniques

Vapour growth (physical and chemical) – Crystal growth by hydrothermal method – Introduction – Growth apparatus – Determination of growth parameter – Growth techniques.
Electro crystallization: Introduction – Electrochemical potential – Diffusion – Crystallization mechanism – Double layer – Faradaic and Non-Faradaic system – Equilibrium exchange current density i_0 – Non – equilibrium current density – Over potential – Multinuclear multilayer deposition - Gel growth – Technology of Epitaxy.

Unit IV: Sensor Materials and Applications

Sensor, signals and systems – Sensors classification – Radar sensors – ultrasonic sensors – Hall effect sensors – Thin film sensors – liquid level sensors – Concepts of pressure – Optoelectric sensors – Basic flow dynamics – Microflow sensors – Fibre optic – Micro phone – Concept of Humidity – Optical hygrometer – semiconductor pn junction sensor – Acoustic temperature sensors – Chemical sensors characteristics – Specific Difficulties – Classification of Chemical sensing mechanism – Enchanced Catalystic gas sensor – Smart chemical sensors. Materials - Surface processing.

Unit V: Characterization of Materials

X-ray diffraction - Scanning electron microscopy - Transmission electron microscopy – Scanning probe microscopy- Thermo gravimetric Analysis – Differential Thermal Analysis - Differential Scanning Calorimetry – Microthermal Analysis - Spectroscopy of semiconductors; excitons-Infra red surface spectroscopy - Raman spectroscopy- Electron spectroscopy .

Reference Books

Otfriedmadelung. (1996). Introduction to Solid State theory. (3rd Ed.) Springer services printing.
Ford, P.J., Saunders, G.A. (2005). The Rise of the Superconductors. CRC Press, USA.
Kakani, S.L., Shubhra Kakani. (2007). Superconductivity. New Age International (P) Ltd., New Delhi.
Keshra Sangwal. (1994). Elementary Crystal Growth. Saan Publishers
Santhanaragavan, P., Ramasamy,P. (2000). Crystal growth process and Methods.
Brice, J.C. (1986).Crystal growth process. Newyork: John Wiley and sons.
Jacob Fraden. (2003). Handbook of Modern Sensors Springer. (3rd Ed.)
ParagDiwan, AshishBharadwaj. (2006). Nano Medicines. Pentagon Press.
Guozhong Cao. (2004).Nanostructures and Nanomaterials - Synthesis Properties & applications. Imperial College Press.
Skoog, Holler , Crouch. (2007). Instrumental Analysis.
Fensler, J. H. F. (1998). Nano particles and nano structured films Preparation characterization and applications. John Wiley & Sons.
Charles P.Poole, Jr., Frank J.Owens. (2008). Introduction to Nanotechnology. Wiley and Sons.

Semester I

C4: Principles and Methods of Crystal Growth (In-depth paper)

Sub. Code: MPP184

No. of hours per week		Credit	Total no. of hours	Marks
Contact	Library	5	45	100
3	4			

Objectives

1. To understand the basic concepts and theories of crystal growth.

2. To develop the ability to preparing crystals with preferred orientation.

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-Part-I: Melt Growth Techniques

Basics of melt growth – Heat and mass transfer – Conservative growth processes: Bridgman-Stockbarger method – Czochralski pulling method – Kyropolous method – Non-

conservative processes: Zone-refining – Vertical and horizontal float zone methods – Skull melting method – Vernueil flame fusion method.

Unit IV: Solution Growth Techniques

Growth from low temperature solutions: Selection of solvents and solubility – Meir's solubility diagram – Saturation and supersaturation – 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: Vapour Growth Techniques

Basic principles – Physical VapourDoposition (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.

Reference Books

Brice, J.C. (1986). Crystal Growth Processes, New York : John Wiley and Sons.
2 Mullin, J.W. (2004). Crystallization. London: Elsevier Butterworth-Heinemann.
Vere, A.W. (1987). Crystal Growth: Principles and Progress New York: Plenum Press.
Ichiro Sunagawa. (2005). Crystals: Growth, Morphology and Perfection. Cambridge: Cambridge University Press.
Pamplin, B.R. (1975). Crystal Growth. Oxford: Pergamon Press.

Semester I

C4: Research Trends in Nanoscience and Technology (In-depth paper)

Sub. Code: MPP185

No. of hours per week		Credit	Total no. of hours	Marks
Contact	**Library**	5	45	100
3	4			

Objectives

1. To understand the basic properties, structure and behavior of nanoparticles.
2. To study the various nanostructures and their properties.

Unit I: Basic Properties and Measuring Methods of Nanoparticles

Size effect and properties of Nanoparticles - Particle size - Particle shape - Particle density - Melting point, surface tension, wettability - Specific surface area and pore - Composite structure - Crystal structure - Surface characteristics - Mechanical property - Electrical properties - Magnetic properties - Optical property of nanoparticle

Unit II: Structural Control of Nanoparticles

Structure construction and function adaptation of Nanoparticles - Particle size - Particle shape - Composite structure - Pore structure - Nanoparticle design for DDS - Nanotubes (CNT).

Unit III: Characteristics and Behavior of Nanoparticles and its Dispersion Systems

Introduction of nanoparticle dispersion and aggregation behavior - Single nanoparticle motion in fluid – Brownian diffusion - Adsorption properties and wettability of nanoparticle surface - Interactions between particles - Aggregation and dispersion, characterization and control - Rheology of slurry - Simulation of colloidal dispersion system.

Unit IV: Control of Nanostructure of Materials

Assembly of nanoparticles and functionalization - Nanoparticles arranged structures - Nanopore structure - Nanocomposite structure - Structure control of nanoparticle collectives by sintering and bonding - Self-assembly.

Unit V: Evaluation Methods for Properties of Nanostructured Materials

Functionality of nanostructures and their characteristic evaluation - Mechanical properties - Thermo physical properties - Electric properties - Electrochemical properties - Magnetic properties - Optical properties - Catalytic property - Properties of gas permeation and separation membranes

Reprints

Text Book

Masuo Hosokawa., Kiyoshi Nogi., Makio Naito., Toyokazu Yokoyama. (2007). Nanoparticle Technology Handbook. Elsevier Publishers.

References Books

William, A., Goddard Ill., Donald, W., Brenner, Sergey, E., Lyshevski, Gerald, J., Iafrate. (2007) .Handbook of Nanoscience. Engineering and Technology. CRC Press.

Robert, W., Kelsall, Ian W. Hamley, Mark Geoghegan. (2005). Nanoscale Science and Technology. John Wiley & Sons Ltd.

Semester I

C4: Electronic Structure Calculations for Solids (In-depth paper)

Sub. Code: MPP186

No. of hours per week		Credit	Total no. of hours	Marks
Contact	Library	5	45	100
3	4			

Objective

1. To emphasize the use of first principles in the theoretical calculations of electronic structure in the understanding of structural, cohesive, optical and vibrational properties of solids under high pressure.
2. To improve the computational skill and the theoretical calculations for providing scientific advances and discoveries which play a key role in the future employability and worldwide progress of students.

Unit I: Basic Theories of Electronic Structure

Zeroth Born-Oppenheimer approximation – Density functional theory – Self interaction correction and optimized effective potentials – Gradient corrections – Local density

approximation- Atomic sphere approximation- Hartree approximation - Hartree-Fock approximation.

Unit II: The FP-LMTO Method

The energy band problem - Partial waves for a single muffin-tin- The muffin-tin orbitals - Energy independent muffin-tin orbitals- One center expansion and structure constants- Korringa-Kohn - Rostoker (KKR) condition- Total energy and enthalpy determination - McMillan's formula- Superconducting transition temperature calculation.

Unit III: Reprints

Five recent reprints of electronic structure calculations

Unit IV: Pressure Induced Structural Changes

Murnaghan's equation of state (EOS) – NaCl structure to CsCl structure pressure induced transitions – ZnS to NaCl andNaCl to CsCl transitions – BCC to FCC transitions – HCP to BCC transitions – Transitions in and from Wurtzite structures – Force theorem and elastic constants of solids.

Unit V: Metallization and Fermi Surface

Metallization in alkali halides – silver halides – Group III-V compounds – Group II-VI compounds – Measurement of Fermi surface – Bohr-Somerfield quantization rule – Oscillation of the Density of states at the Fermi energy – Determination of Fermi surface – electronic and optical properties of Alkali metals and noble metals.

Text Books

O.K. Andersen, O. Jebsen and M.Sob, Electronic band structure and its applications, Editors. M.Yussouff, Springer Verlag Lecture Notes (1987).

H. L. Skriver, 'The FP-LMTO method', Springer, Heidelberg (1984).

Reference Books

Andersen, O.K. , Jebsen, O., Glotzel, D. (1985).Highlights of condensed matter theory. North-Holland:

Christensen, N. E., Novikov, D. L. , Alonso, R. E., Rodriguez, C. O. (1999). Solids under Pressure - Ab Initio Theory. Heidelberg Springer.