भौतिक विज्ञान 32 (26)

Proposed Pre-Ph.D. Course Work (as per NEP 2020)
for

Doctor of Philosophy
in
PHYSICS

(Academic Session: 2022-23 onwards)

Examined and approved by:

Board of Studies- Physics

Maharaja Suhel Dev State University, Azamgarh-276 128, Uttar Pradesh (INDIA)

(31)

Pre-Ph. D. Course Work for Ph. D. in Physics

The Pre-Ph. D. course work for **Doctor of Philosophy in Physics** shall comprise of only one semester (i.e., Sem-I) in which there shall be three compulsory papers and one major research project.

Distribution of Courses in Semester-I

Semester-I				
Course Code	**Subject/Course Work**	**Paper No.**	**Title of the Paper**	**Credit hr.**
PHY-101	Major/Compulsory	I	Advanced Physics	6
PHY-102	Major/Compulsory	II	Computer Application & Programming	6
PHY-103	Research Methodology/Qualifying	III	Research Methodology &Publication Ethics	4
PHY-104	Major Research Project	IV	Research Projects	Non-Credit

Note: *The research work and Ph. D. thesis shall be completed as per the then effective UGC Regulation (Minimum Standards and Procedure for Award of Ph. D.) and in accordance with the Ordinance made for the same by the university.*

Name of the Subject: Physics					
Course/ Paper Code:	PHY-101	**Course/ Paper title:**	Advanced Physics	**Credit assigned**	6
Type of Course	Compulsory	**Semester**	I		
Course Objectives& Outcomes:	To provide systematic and core knowledge of the Semiconducting and Nano-materials based on firm theoretical foundation with particular emphasis on their applied research prospects so as to produce good researchers and teachers for the future.				

Unit	Topic	M. L.
I	**Semiconductor Physics:** Energy Bands, Intrinsic carrier concentration. Donors and Acceptors, Direct and Indirect band semiconductors. De-generate and compensated semiconductors. Elemental (Si) and compound semi-conductors (GaAs). Replacement of group III element and Group V elements to get tertiary alloys such as $Al_xGa_{(1-x)}As$ or $GaP_yAs_{(1-y)}$ and quaternary $In_xGa_{(1-x)}P_yAs_{(1-y)}$ alloys and their important properties such as band gap and refractive index changes with x and y. Doping of Si (Group III (n) and Group V (p) compounds and GaAs (Group II (P), IV (n.p.) and VI (n compounds). Diffusion of Impurities - Thermal Diffusion, Constant Surface Concentration, Constant Total Dopant Diffusion, Ion Implantation.	25
II	**Nano Materials:** Introduction and importance of nanostructured materials, Quantum confinement, surface effect, synthesis techniques and properties of 0D, 1D , 2D and super lattice structures, Applications of nanostructured materials, Size dependent optical, electronic and magnetic properties of nanostructured materials, Carbon nano-tubes, quantum wires, Functional materials and nanocomposites.	20
III	**X-ray Technique and Other Methods:** X-ray Diffraction Method (XRD), X-ray Fluorescence Analysis (XRF), UV-visible, IR spectroscopy and Raman Spectroscopy, High Resolution NMR, Ionization Chamber, Scintillation Counter, Spark Counter, Solid State Detectors, Gamma Ray Spectrometer	20
IV	**Mathematical Physics:** Differential Equations: Solutions of Legendre and Associated Legendre equations. Hermite equation, Laguere equation, Bessel's equations, Fourier and Laplace Transforms, Laplace equation and its solution, Poisson, Diffusion and Wave equations, Vibrating membrane, Matrices and Tensors, Solution of Linear equations, Eigen values and Eigen Vectors, Matrix Inverse, Coordinate transformation, Covariant and contra-variant Tensors, addition, multiplication and contraction of tensors, Associated tensors, Numerical Methods: Interpolation, Numerical Differentiation, Integration, Solution of Linear Equations.	25

References:

1. The Physics of Semiconductor Devices by D.A. Eraser, Oxford Physics Series (1986)
2. Semiconductor Devices - Physics and Technology, by SM Sze Wiley (1985)
3. Handbook of Materials Characterization, S. K. Sharma, D.S. Verma, Lati U. Khan, S. Kumar, S.B. Khan, published by Springer Nature, Switzerland.
4. Detection and measurement of Nuclear Radiation – G.D. O'Kelley – National Academy of Science, Washington D.C., USA.
5. G. Arfken: Mathematical Methods for Physicist (Academic Press)

Name of the Subject: Physics					
Course/ Paper Code:	PHY-102	**Course/ Paper title:**	Computer Application & Programming	**Credit assigned**	6
Type of Course	Compulsory	**Semester**	I		
Course Objectives& Outcomes:	To provide a systematic knowledge of Computer Application & Programming to facilitate the research work and produce efficient researchers for the betterment of the society.				

Unit	Topic	M. L.
I	**Curve Fitting, Random Numbers in Computer Simulation:** **Curve Fitting:** Principle of least square fitting, Linear regression, Polynomial regression, Exponential and Geometric regression. **Random Numbers in Computer Simulation:** Generation of random numbers: Basic Strategy, Mid-Square generator, Multiplicative Congruential Generator, Monte Carlo Simulation of Radioactive Decay, Diffusion of particle in one dimension.	25
II	**Numerical Solution of First and Second Order Differential Equations:** **Numerical Solution of First Order Differential Equations:** First order Taylor Series Method, First-order, Second-order and Fourth-order Runge-Kutta Methods, Applications: Charging and discharging of a condenser, Motion of a body falling in viscous medium, Effect of air drag on motion of a falling body. **Numerical Solution of Second Order Differential Equations:** Initial Value problems, Applications: Motion of one dimensional simple harmonic oscillator, Motion of Damped Harmonic Oscillator, Motion of Anharmonic Oscillator, Solution of Radial part of Schrödinger equation for hydrogen atom, Solution of Poisson equation for spherical potential.	20
III	**Boundary Value Problems, The Dynamics of Many Particle System, The Chaotic Motion of Dynamical Systems:** **Boundary Value Problems:** Shooting method, Numerov method. **The Dynamics of Many Particle System:** Molecular dynamics programs for trajectories of the particles. **The Chaotic Motion of Dynamical Systems:** Chaotic motion of damped harmonic oscillator under external force.	20
IV	**Computational Methods:** Application of Scientific and Mathematical Software: Python, Mathematica and MATLAB.	25

References:

1. Computer Simulation in Physics, R.C. Verma, Anamaya Publ., New Delhi, 2004.
2. Computer Simulation Methods, Harvey Gould and Jan Tobochnik, Addison-Wesley Publishing Company, New York, 1988.

Name of the Subject: Physics					
Course/ Paper Code:	PHY-103	**Course/ Paper title:**	Research Methodology &Publication Ethics	**Credit assigned**	4
Type of Course	Compulsory	**Semester**	I		
Course Objectives & Outcomes:	To make the students aware of the significance of doing honest/true research with firm faith in the norms of Research Methodology & Publication Ethics. The students will be able to serve the society through their own research contribution.				

Unit	Topic	M. L.
I	**Introduction:** Definition of Research, Need and Purpose of Research, Types of Research (Experimental/Theoretical Research, Fundamental/Advanced Research, Assessment/Evaluation Research, Trend Developmental Study Research, etc.,) Various Approaches in Scientific Research. **Research Writing**: Role of Literature Survey, Basic Principles of Research Paper/Review Article, Synopsis and Research Proposals writings.	10
II	**Data Collection and Data Analysis:** Concept of data, data collection through experiments/surveys, Qualitative/Quantitative Data analysis, Drawing graphs and diagrams through computer. **Materials Preparation Techniques:** **Thin films:** Chemical vapor Deposition (CVD), Plasma enhanced chemical vapor deposition, Physical vapor Deposition: Thermal Evaporation, Molecular Beam Epitaxy (MBE), Sputtering, Spin Coating **Nanomaterials:** Sol gel technique, Plasma arc discharge, evaporation, Pulsed laser deposition, Electro-deposition. **Characterisation Techniques:** SEM, TEM, XRD, UV, IR and Raman Spectroscopy, Thermal methods: DTA, TGA, DSC, Nuclear techniques: NMR, ESR, Mossbauer and Positron annihilation, Heat treatments, quenching and annealing; Radiation damage, Elemental Analysis.	15
III	**Publication Ethics:** **Philosophy And Ethics:** Introduction to philosophy: definition, nature and scope, concept, branches, Ethics: definition, moral philosophy, nature of moral judgments and reactions **Scientific Conduct:** Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP), Redundant Publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data **Publication Ethics:** Publication ethics: definition, introduction and importance, Best practice/standards setting initiatives and guidelines: COPE, WAME, etc., Conflicts, Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types, Violation of publication ethics, authorship and contribution, Identification of publication misconduct, complaints and appeals, Predatory publication and journals	15

IV	**General Practice:** **Open Access Publishing:** Open access publications and initiatives: SHERPA/RoMEO online resource to check publisher copyright & self-archiving, Policies, Software tool to identify predatory publications developed by SPPU, Journal finder/journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggested, etc. **Publication Misconduct:** Subject specific ethical issues, FFP, authorship, Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad B. Software tools (2hrs.) Use of plagiarism software like Turnitin, Urkund and other open source software tools **Databases And Research Metrics:** **A. Databases** 1. Indexing databases 2. Citation databases: Web of Science, Scopus, etc. **B. Research Metrics** 1. Impact Factor of journal as per Journal Citation Report, SNIP SJR, IPP, Cite Score 2. Metrics: h-index, g index, altmetrics.	20

References:

1. Techniques for Nuclear and Particle Physics Experiments by W.R. Leo (M/S/ Springer Verlag, 1987)
2. Nuclear Radiation Detectors by S.S.Kapoor and V.S. Ramamurthy (M/S Willey Easter Ltd., 1986
3. The Physics of semiconductor Devices by D.A. Eraser, Oxford Physics Series (1986)
4. Semiconductor Devices - Physics and Technology, by SM Sze Wiley (1985)
5. Thin film phenomena by K.L.Chopra
6. Deposition techniques for films and coating, R.F. Bunshah (Noyes publications)

Major Research Projects

The Major Research Project is of qualifying/non-credit nature. As mentioned in point 1.4 of the P.G. Programme, NEP 2020, the project work will be related to the main subjects of Inter or Intra faculty and Interdisciplinary/Multidisciplinary fields. The project may be carried out through Industrial training or Internship or Survey work. The work will be completed under the guidance of respective guide of the concerned area of research. Additionally, the other co-supervisor may be from some industry, company, technical/research institute.