PURNEA UNIVERSITY, PURNIA

Paper-I

Research Methodology + Physics

Full Marks: 100

Duration of Examination: 2 Hours

Questions shall consist of 3 parts:

Part-A : Short Questions (06 in number of which 04 to be answered, each carrying 10 marks) = 40

Part-B : Long Answer Question (04 to be asked of which 02 to be answered, eachcarrying 30 marks) = 60

1. Introduction to Research: What is Research; Why is Research Conducted; Stages in Research; Changing Nature and Expanding Scope of Research; Why Research Methodology.

2. Introduction to Major Research Methods: Natural Observation; Historical Research; Ethnographic Research; Cross-Sectional Study; Longitudinal Study; Cohort Study; Case Study; Correlational Research; Action Research; Quantitative and Qualitative Research; theoretical research, applied research and empirical research; Experimental Research: Cause and Effect Relationships, Hypothesis in Experiments, Principles of Experimentation, Classification of Experiments, Experimental Design, Requirements of a Good Experiment; Reasoning in Research : Introduction to Logical Terms; Evidences; Inductive and Deductive Reasoning; Fallacious Reasoning; Formal and Informal Fallacies; Common Fallacies.

3. Research Design: Study designs in quantitative research; Study designs in qualitative research; Other commonly used philosophy-guided designs; Choice of Variables; Constructing hypotheses, Mechanisms and Design for Data Collection; Collection of Primary Data: Observation, Interview, questionnaire and schedule Sample Surveys and Designed Experiments, Estimation without Sampling, Methods of data collection in qualitative research; Collection of Secondary Data; Data Integration; Using Publications and the Library; Using Academic Databases: Search Engines, Citation Indexes and Citation Analysis, Government of India Initiatives for

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Knowledge Management- INFLIBNET: e-ShodhSindhu, Shodhganga, ShodhGangotri, and N-List Projects.

4. Data analysis: Statistical analysis; Thematic analysis; Analysing narrative; Discourse analysis; Content analysis; Grounded Theory; Using computers in data analysis.

5. Ethics and Related Issues in Research: Concepts in Ethics in Research; Intellectual Property Rights; Scientific Values: Needed a Code of Conduct; Fraud and Misconduct in Science; Plagiarism: What is Plagiarism, Acknowledge Sources Appropriately, Paraphrasing, Direct and Indirect Quotations, Plagiarism Checking: ShodhShuddhi, UGC (Promotion of Academic Integrity and Prevention of Plagiarism in Higher Educational Institutions) Regulations, 2018, LNMU Plagiarism Policy and Regulations-2018.

6. Writing a Research Proposal: Introduction; The research problem; Objectives of the study; Hypotheses to be tested; Study design; Measurement procedures; Analysis of data; Structure of the report; Problems and limitations.

7. The Structure of a Thesis: Thesis Vs Dissertation; Parts of a Thesis; Preliminary Pages of a Thesis: Title Pages, Certificate Pages, Acknowledgements, Table of Contents, List of Tables, List of Figures, Dedication; The Subject Proper: Introduction, Review of Literature, Materials and Methods, Results, Analysis/ Discussion, Summary/Conclusion, References, Appendixes; The Abstract; Formatting Requirements of a Thesis: Margins, Page Numbering, Design and Formatting of Chapters, Numbering the Sections, Lay-Out of Tables, Language and Style, Typeface and Fonts, Paper and Text Spacing; Thesis Editing.

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UNIVERSITY DEPARTMENT OF PHYSICS

Syllabus for Pre- Ph.D Course work: Physics (Paper-II)

Duration of the Course- 06 Months

1. **Fundamentals of Physics:**
   Small oscillations, normal modes, Lagrangian and Hamiltonian formalism, Schrodinger equation (time- dependent and time- independent), Tunneling through a barrier, Time dependent perturbation theory, Maxwell's equations in free space and linear isotropic media, boundary conditions on the interfaces, Phase space, micro- and macro- states, Micro-canonical, canonical and grand-canonical ensembles and partition functions, Special function and applications (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transforms, Partial differential equation, Semiconductor devices, diode junctions, Field effective devices, Opto- electronic devices. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, Selection rules.

Books Recommended:

a. Classical Mechanics: By- J.C. Upadhaya
b. Introduction to Quantum Mechanics: By- D.J. Griffith
c. Introduction to Electrodynamics: By- D.J. Griffith
d. Statistical Mechanics: By- R. K. Patharia
e. Mathematical Physics: By- Arfken Weber and M.L. Boas
f. Physics of Semiconductor: By- S.M.Sze
g. Atomic and Nuclear Physics: By- Rajkumar.

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2. PHOTONICS:

Fourier and Non- linear optics, Propagation of light in free space, Optical Fourier Transform, Fourier transform holography, Transfer matrix method, Glerkin method, Optics of anisotropic media, Electro- optics of anisotropic media, Non-linear optical media, second order non-linear optics-SHG, Third order non- linear optics, Discovery of solitary waves and soliton interactions, Importance of solitons, chaos and its examples.

Books Recommended:

a. Optical Electronics (Cambridge University Press): By- A. Ghatak & K. Thayagrajan
b. Fundamentals of Photonics: By- B.E.A. Saleh and M.C. Teich
c. Quantum Electronics (Wiley, New York): By- A. Yariv
d. Solitons an Introduction: By- P.G. Drazin and R.S. Johan (Cambridge University Press, 1989)
e. Chaos in Dynamical systems: By- E. Ott. (Cambridge university press, 1993)

3 THEORETICAL TECHNIQUES IN CONDENSED MATTER 'HYSICS:

heory of NMR and ESR techniques, DFT: Many body Schrodinger equation, density function theory, equilibrium structure of materials, vibrations of molecules and solids, Band structure and dielectric function, free electron theory, electron density of states, electronic specific heat, band theory, K.P. model, Brillouin zones, Introduction to different crystal growth techniques, Nucleation and growth, Properties of 0D, 1D, 2D and super lattices structures, Functional materials and nano-composites.

Books Recommended:

a. The electromagnetic interaction in Nuclear Spectroscopy: By- W.D. Hamliton.
b. X-rays in Atomic and Nuclear Physics: By- N.A. Dyson.
c. Thin Films Phenomena: By- K.L. Chopra.

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d. Characterization of Semiconductor Materials: By- Ohilips F. Kare and Greydon B. Lausbee, Mc Graw Hill
e. Optical properties of Solid: By- M. Fox (Oxford University Press)
f. Mathematica: By-S. Wolfram Addison, Wesely.
g. Application of the Monte Carlo Method, K. Binder, Springer Veriag
h. Materials modeling using density functional theory: By- Feliciano Giustino, Oxford Press.

4. CHARACTERIZATION OF MATERIALS:

Diffraction phenomena as applied to solid state problems, Scattering and Absorption of X-rays and electrons, X-ray methods for orienting crystals, applications of XRD, crystal structure analysis, Raman Spectroscopy, Photoluminescence, Scanning Electron Microscopy (SEM), Auger Electron Spectroscopy, X-Ray Photoelectron Spectroscopy, AFM, ESR, Electron Diffraction, LEED, RHEED, TEM, STM, Landau's criteria; Superconductivity; BCS Theory; High Tc superconductivity

Books Recommended:

a. Experimental Techniques of Surface Science: By- Woodruff and Delchar
Physics: By- Ashcroft and Mermin
als of Surfaces and Thin Films Analysis: By- L.C. Feldman and J.W.Mayer.
d. Quantum Theory of Solids: By- C. Kittel, John Wiley and sons.

5. COMPUTATIONAL METHODS and NUMERICAL TECHNIQUES:

Practical approach of learning of Operating Systems (DOS, LINUX, WINDOWS), Graphical packages including 3D plots, Programming using FORTRAN 77/ C++ to deal with different types of numerical techniques, Introduction to Modeling, Procedure of a systematic study in Modeling, Accuracy and Precision in Modeling, Hartree-Fock Theory, Density Functional Theory, Modeling using SCILAB, GAUSSIAN, ABINIT, Quantum Espresso, etc software packages.

Recommended Books:

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a. Fortran Programming by V. Rajaraman.
b. The C++ Programming Language/Addison Wesely by Bharne Stroustrup.
c. Computer based Numerical Methods 3rd Ed. Prentice Hall India 1980 by V. Rajaraman.
d. Computational Physics by S. E. Koonin.
e. Materials modeling using density functional theory by Feliciano Giustino, Oxford Press.
f. Modeling and Simulation of systems using Matlab and Simulink by D. K. Chaturvedi.
g. Gaussian 16 Users Reference on gaussian.com
h. ABINIT on abinit.org
i. The VASP manual on vasp.at