COURSES OF STUDIES

Pre-Ph.D. Course (PPC) EXAMINATION

(2019-2020 Session)

PHYSICS

POST GRADUATE DEPARTMENT OF PHYSICS

NORTH ORISSA UNIVERSITY

SRIRAM CHANDRA VIHAR

TAKATPUR, BARIPADA-757003

CURRICULUM STRUCTURE

of

Pre-Ph.D. Course (Physics)

Paper Code	Course Title	Credit	Marks
PHY-801	Research Methodology-I	05	50
PHY-802	Research Methodology-II (Elective)	05	50
PHY-803	Dissertation/Review with Seminar	10	100
	Total	**20**	**200**

Electives:

(a) Experimental Physics

(b) Theoretical Physics

(Candidate has to choose **one** of the elective)

Phy-801 Research Methodology-I Marks-50

Course objectives: To show the scholars roadmaps of research from the objectives of research to the publication of research paper.

Unit-I [12]

Research objectives and process: Objectives of Research, Research Approaches, Types of Research, Literature survey, Identification of research problem; Design of experiments, testing and characterization; Measurement - Standardization, calibration and sampling; Primary and secondary data

Unit—II [14]

Numerical Techniques: Approximation and Errors in Computation, Roots of Nonlinear equations, Solution of linear systems by Matrix method, Numerical Differentiation and Integration, Numerical solution of Ordinary and Partial Differential Equations, Boundary value and Eigen-value problems, Least square fitting of linear parameters.

Unit-III [14]

Statistical techniques: Classification and tabulation of data, Arithmetic mean, Median, Mode, Mean deviation, Standard deviation, Correlation, Simple Regression Analysis, Chi-Square Test for comparing a variance to a theoretical variance.

Unit-IV [10]

Thesis writing: Writing of thesis and report, its framework, essentials and presentation, Journal paper–types of available publishing services, Journal abbreviations, Bibliography

Software for documentation: Create and typeset a simple LATEX document, graphs, graphics, drawing and presentation, scientific ethics, copyrights and plagiarism

Course outcome: After completion of the course a scholar will learn how to plan research objectives, research procedure, necessary computational and statistical tools, and to communicate research findings with ethical aspects of research.

References:

1. Research Methodology: The Aims, Practices and Ethics of Science, P. Pruzan, Springer, 2016
2. Research Methods for Science, M. P. Marder, Cambridge University, 2011.
3. Research Methodology-A step by step Guide for Beginners- Ranjit Kumar, Pearson Education, Singapore
4. Thesis and Assignment Writing – J Anderson, B.H. Burston and M. Poole, Wiley Eastern (1977).
5. Fundamentals of Statistics by S.C. Gupta, Himalaya Publishing.
6. Numerical Algorithms- E.V Krishnamurthy, S.K.Sen
7. Computer Application in Physics- Suresh Chandra
8. Numerical analysis for Scientists & Engineers- M.K. Jain

Phy-802 Research Methodology-II Marks-50

Elective (A) – Experimental Physics

Course Objectives: To teach scholars some of the basic concepts of experimental methods of physics in research; and prepare them for research in advanced fields of experimental physics

Unit-I (10)

Structural Characterization: X-ray diffraction technique, theory and methodology, determination of lattice parameters, Debye Scherrer formula and its use, dislocation density.

Thermal analysis: Principle and methodology of Thermogravimetric Analysis (TGA), Differential Thermal Analysis (DTA), Differentail Scanning Calorimetry (DSC).

Unit-II (12)

Spectroscopic analyses: Principle and methodology of UV-Visible spectroscopy, determination of band gap and Urbach energy, correlation of band gap with particle size. Principle and methodology of Raman Spectroscopy.

Scanning Electron Microscopy: Basic design of Scanning electron microscope, mode of operation, back scattered electrons, secondary electrons, imaging of samples. Atomic Force Microscopy: Principle and methodology, different modes of operation: contact, non-contact and taping mode, imaging of samples.

Unit-III (12)

The attractive interaction between electrons in superconductor, London equation, Type-I and Type-II superconductor. Ginzburg landau theory: coherence length, penetration depth, relation between coherence length, penetration depth and critical field. BCS theory: transition temperature and energy gap. Critical current density by critical state model, Bean model, reversed critical state and hysteresis.

Unit-IV (14)

Concepts of magnetism, Diamagnetism, Paramagnetism, Ferromagnetism, Antiferromagnetism, Ferrimagnetism, Measurement techniques: Susceptibility Balance, Faraday method, Vibrating sample magnetometer, SQUID magnetometer.

Reconstructive and displacive transitions with examples, thermodynamics of phase transitions, G-T diagrams: Stable and metastable phases, Ubbelohde's classification, representation of phase transition on phase diagrams, Kinetics of phase transitions

Course outcomes: After successful completion of this course student will be able to explore on material properties particularly on crystal symmetry, phase transition, magnetism, superconductivity associated with different parameters by using theoretical models.

References:

1. Elements of X-ray Diffraction- BD Cullity and SR Stock, Prentice Hall, New Jersy, 2001
2. Microstructural Characterization of materials- David Brandon and Wayne Kaplan, John Wily and Sons, New York, NY, 1999
3. Scanning Electron microscope and X-ray micro analysis- Joseph I Goldstein, 3rd Ed., Dale E Newbury Academic/Plenum Publishers, New York, 2003
4. Superconductivity Physics and Application: K. Fossheim and A. Sudbo
5. Solid State Chemistry & Applications- A.R. West, John Wiley & Sons.
6. Introduction to Solid State Physics- C. Kittel, John Wiley & Sons.

Phy-802 Research Methodology-II Marks-50

Elective (B) – Theoretical Physics

Unit – I

Particle Physics: [10]

Classification of Matter: lepton and quark, colour, Isospin, Strangeness and Hypercharge, Gellmann-Nishijima Formula, Lepton and Baryon number conservation, Fundamental interaction and conservation laws. Symmetry transformation and conservation laws: Symmetries, Group and Conservational laws, Angular Momentum-classification of elementary particles. Discrete symmetries, Parity, pion spin and parity, Charge conjugation, CP-violation, time reversal, CPT theorem, G-parity,

Unit – II [10]

Relativistic Quantum Mechanics:

Dirac equation, properties Dirac equation, free particle solution of Dirac equation, energy projection operator, helicity and chilarity, covariant form of Dirac equation, charge conjugation, space and time reversal symmetries of Dirac equation, Bilinear covariant

Unit – III [10]

Quantum Field theory:

Second quantization of Dirac field unequal space time commutators anticommutators propagator function and their integral representation, Feynman propagator

Properties of scattering matrix (S-matrix), Wick's theorem, Feynman diagrams, Feynman diagram rules in coordinate and momentum space, Compton scattering and Bhaba scattering

Unit – IV

Mean field theory: [10]

Hartree-Fock Theory, Density Dependent Hartree-Fock Theory, Dynamic Mean Field Theory, The Relativistic Hartree Equation for Different Symmetries, Solution of Relativistic Hartree Equation, The Dirac-Hartree-Fock-Bogoliubov Equation, Paring Correlations, Relativistic Theory In Rotating Frame, Super Formed Bands, Super-Deformations and Pairing

Course Outcomes: After attending the course the scholars will have some of the concepts of Particle physics, relativistic quantum mechanics, quantum field theory and mean field theory likely to be useful in forefront areas of theoretical research.

References:

1 Elementary Particle Physics- D.J. Griffiths
2 Nuclear and Particle Physics- W. E. Burcham and M. Jobes
3 Relativistic Quantum Mechanics: Jorken and Drell
4 Quantum Field Theory: Mandel and Shaw
5 https://www.researchgate.net/publication/223295185_Relativistic_mean_field_theory_for_finite_nuclei

Phy-803 Dissertation/ Review work Marks-100

At the semester end, the student will submit dissertation/report on review work which will be examined through the process of open *viva voce* by both the external and internal examiner selected by Board of Studies. Student may submit the report either independently or under the supervision of faculty members.