BERHAMPUR UNIVERSITY
BHANJA BIHAR

COURSES OF STUDIES

M. Phil. Examination -2017(PHYSICS)

SEMESTER I 16 Credits

CC-1 Research Methodology (4 credits)
CC-2 Advanced level course (4 credits)
CC-3 Seminar Presentation (4 Credits)
CE-1 Elective Course (4 Credit)

SEMESTER 2 16 Credits

CC-4 Review of Research Progress through PPT (4 Credits)
Dissertation (12 Credits)

Detail Syllabus

CC-1

RESEARCH METHODOLOGY

UNIT-1

Motivation and Objectives of Research; Types of Research; Research Approaches; Significance of Research; Research Methods vs. Methodology; Research and Scientific Method; Research Process; criteria of good research.

UNIT-2

Meaning of Research Design; Need for Research Design; Features of a Good Design; Concepts Relating to Research Design; Basic Principles of Experimental Design ; Different Research Design.

Methods of Data Collection:- Primary and Secondary Data Collection;

Report Writing:-Significance of Report Writing; Different steps in Writing a Report; Layout of a Research Report; Types of Report; Oral Presentation; power-point presentation.

UNIT-3

Document Preparation by Latex-2£; Basic of Latex File; Command Name and Arguments; Environment; Declaration; Length; Special Character; Document Class; Standard Class Option; Page Style; Title Page; Tables; Mathematical Environment; Constant and Variable; Exponent and Indices; Fraction; Roots; Mathematical Symbols; Binary Operations; Relations; Function Names; Matrix.

UNIT-4

In homogeneous problems, Green's function: - Solution of Sturm-Liouville Differential Equation; Solution of Simple Harmonic Oscillator; Circular drum problem; Green's function in electrodynamics.

Integral equation: -Classification; Degenerate Kernels, Neumann and Fredholm series.

UNIT-5

Numerical Methods: - Differences of a Polynomial, forward differences, Newton's forward and Backward Interpolation; Newton's formulae for Backward interpolation ; Interpolation with Unequal Differences:- Divided differences; Relation between Divided Differences and

Simple Differences ; Newton's General Interpolation formula; Lagrange's Interpolation Formula; Numerical integration:- A general Quadrature formula for Equidistant Ordinates; Simpsons Rule; Weddle's Rule the Trapezoidal Rule; solution of differential equation equations numerically:- The Runga-Kutta method 1st order and 2nd order only.

Graefe's Root Square Method for Solving Algebraic Equations:- Principles of the Method ; Root Squaring Process; All Real and Equal Roots.

BOOKS

1. Mathematical Methods of Physics by Mathews and Walker (chapter 9 and 11)
   W.A Benjamin, INC, California.
2. Numerical Mathematical Analysis by J.B. SCARBOROUGH
   Oxford and IBH Publishing Co.
3. Research Methodology: Methods and Techniques, Kothari, C.R.(2008), Second Edition
   .New Age Publishers, New Delhi.

REFERENCE BOOKS

4. Introductory methods of numerical Analysis by S.S. SASTRY
   Prentice-Hall of India.

CC-2: Advanced Experimental Techniques in Physics

Unit I: Data Analysis

Line Shapes in Spectroscopy: Lorentzian and Gaussian Fitting of the spectras. (curve fitting) Deconvolution of spectrum, Derivative peak shapes. Some examples of generating spectra and analysis of spectra by taking examples of X-ray photo-electron spectra. Software/analysis using Origin.

Resolution of spectrometer/ instrument (General): Resolving power and influence of different experimental parameters on it. Sensitivity of Measurement. Accuracy of measurements. Instrumental errors and measurement errors. (static & dynamic) Examples of UV-vis-NIR, IR, XRD spectra, vis-avis Instrumental parameter like slit width, relaxation time, scan speed etc.

Unit II: Compositional analysis

Atomic absorption, emission spectroscopy - fundamental of optical atomic spectrometry, Atomic emission spectroscopy. Atomic fluorescence spectrometry. Comparison of Atomic spectroscopies. UV-vis-NIR absorption spectroscopy, Electronic transition in solids, Transmission reflection and absorption coefficient Infrared spectroscopy, Molecular vibration spectroscopy, Rotational spectroscopy, Bond analysis. Raman spectroscopy.

Unit III: **Crystal structural and microstructure analysis**:

X-ray diffraction principles, Type of the cameras. Intensity dependence. Rietveld analysis for powder diffraction. Particle size determination using Scherrer formula, Microstructure analysis. Scanning electron and Transmission electron microscopy, Field emission microscopy, scanning Tunneling microscopy, Atomic force microscopy. Analysis of experimental results.

Unit IV: Detectors and Accelerators

Introduction, Gas-filled Ionization Detectors, Proportional Counters, Geiger-Muller Counter, Cherenkov Detectors, Basic Principles of Accelerators, Classification of Accelerators, Basic Components and Ion Sources, Applications of Accelerators, Linear Accelerators, Orbital Accelerators (Conventional Cyclotrons), Synchro Cyclotrons, Isochronous Cyclotrons (AVF/SFC Cyclotrons), Electron Synchrotron, Proton Synchrotron, Large Hadron Collider.

Reference Books

1. Methods of experimental Physics, M.I. Pergament, CRC Press, Taylor and Francis

2. Experimental Methods in Physical science, Editor Anita Kuch, Elsevier

3. Characterization of Materials, John B. Watchman (Butlerworth-Heinemann Manning Greenwich)

4. Introduction to Nuclear and Particle Physics: Ashok Das, Thomas Ferbel, John Wiley & sons.

5. Fundamentals of Nuclear Physics- Jahan Singh, Pragati Prakashan.

CC-3 SEMINAR PRESENTATION(4 CREDITS)

CE-1,ELECTIVE COURSE(4 CREDITS)

The candidate has to choose any one of the following ELECTIVE papers

A. Solid State Physics
B. Nuclear Physics
C. Particle Physics

A. SOLID STATE PHYSICS

Unit-I

Energy bands, Properties of Bloch functions, Luttinger-Kohn wavefunctions and $\vec{k}.\vec{p}$ method(**k** is electron wave vector and **p** momentum), Two band model in the $\vec{k}.\vec{p}$ method, Electronic Density of States and Specific Heat

Representation Theory: Crystal Momentum representation (CMR), Effective Mass Representation (EMR), Wannier functions, Local Representation(LR)

Book: Quantum Theory of Solid State by J. Callaway, 1st Edition

Unit-II

Aspects of electron-electron Interaction, ,single particle Green's function at T=0K, Two particle Green's function, Equations of motion, The interaction picture-perturbation theory

Book: Quantum Theory of Solid State by J. Callaway, 1st Edition

Unit-III

Hubbard Model, Atomic Limit of Hubbard model, Transition from Atomic Limit to Band Limit

Book: Greens's function for Solid State Physicists by Doniach and Sondheimer

Unit-IV

Anderson Hamiltonian, Hartree-Fock Solution, Solution of equation of motion, Existence of localized moments, Limiting cases, Susceptibility and Specific Heat

Book: Theoretical Solid State Physics by Jones and March

OR

B. NUCLEAR PHYSICS

1. Basics of Shell Model, Hartree-Fock, Pairing, Rotational and Vibrational Spectra, Giant Resonance, Halo Nuclei

2. Nuclear Reactions, Potential Scattering, formal theory of reaction resonances and compound nucleus, direct reactions(inelastic stripping, pickup etc)extracting nuclear information from reactions,dissipation and fluctuation

3. Nuclear Matter
a. The independent particle approximation
b. The independent pair approximation, The Bethe-Goldstone approximation
c. Energies and wavefunctions in the independent pair approximation
d. The solution of Bethe-Goldstone equation
e. Properties of Nuclear Matter with realistic potential
f. The energy gap in nuclear matter
g. Neutorn Star (elementary ideas)

4, Quark models, (bag), quark equation of state, relativistic heavy ion collision, signature of QGP

Books:

1. Structure of Nucleus by Preston and Bhaduri
2. Theoretical Nuclear Physics by Blatt and Weisskoff
3. Buclear Structure by Bohr and Mottelson
4. Nuclear Models by Geiner and Eisenberg
5. Physics of Quark Gluon Plasma-Muller
6. Theory of Nuclear Reactions by P. Fröbrich and R. Lipperheide
7. Theoretical Nuclear Physics-Vol-I, Nuclear Structure by Amos De Shalit,Herman Feshbach

OR

C. PARTICLE PHYSICS

Unit-1

1. Classification of Elementary particles: Baryon Number, Lepton number, Strangeness, Isotopic Spin, Gellmann-Nishijima Scheme, Associated Production

2. The Eight-fold way: Charge independence and charge symmetry, SU(3) and its multiples, The mass formula, the Baryon dectouplet, the octet mass formula, electromagnetic mass differences

Unit-II

3. Weak Interactions: beta decay, Fermi Theory of beta decay, Form of beta decay Hamiltonian, Parity violation in beta decay, Two component theory of neutrino

Unit-III

4. Elements of Neutral K-meson theory: Decay of Neutral K-mesons, Regulation of K-mesons, CP violation in neutral K-decay, The $K_0 - K_0$ system

Unit-IV

5. Electro-weak theory: Gauge models of weak and electromagnetic interaction, spontaneously broken symmetries, The Higgs Mechanism, The Weinberg-Salam Model

Unit-V

6. Introduction, electron scattering by external potential, influence of proton recoil, Influence of finite extension and anomalous magnetic moment of proton, Form factors for the proton and neutron.

Books:
1. Elementary Particle Physics by G. Kallen
2. Elementary Particles by William R. Frazer
3. An Introduction to Relativistic quantum Field Theory by S. S. Schweber

SEMESTER -2

CC-4 :Review of Research Progress through PPT-4 Credits
Dissertation:12 credits