M.Phil. Syllabus

PHYSICS

UTKAL UNIVERSITY

Department of Physics

Utkal University

2016

Head of the Post Graduate
Department of Physics
Utkal University
Bhubaneswar-751004

M. Phil. Physics Syllabus

Utkal University

2016

Courses of Study for M.Phil.

A candidate has to secure at least 50 marks in each paper to pass the examination.

M.Phil. is a two semester course (no mid-semester examination).

FIRST SEMESTER

Paper - I: Numerical Methods in Physics 100 marks

Paper - II: Experimental Methods in Physics 100 marks

SECOND SEMESTER

Paper - III: Literature study 100 marks

One elective is to be chosen by the student out of the following subjects for the literature study.

ELECTIVES :

- Particle Physics
- Condensed Matter Physics
- Nuclear Physics
- Astrophysics
- Cosmology
- Solid State Electronics
- Instrumentation
- General Theory of Relativity

PAPER - IV **100 Mark**

SEMINAR PRESENTATION ON THE DISSERTATION 50 marks

VIVA-VOCE EXAMINATION 50 marks

Paper - I: NUMERICAL METHODS IN PHYSICS 100 Marks

Basics of data encoding and storage, Machine architecture and machine language, Operating systems, LINUX commands, GNU plot. Curve fitting.

Programming languages: Introduction to programming languages, F77, C, C++

Programming with FORTAN:

Programme solving on computers – algorithm and flow charts in FORTAN 77 data types, expressions and statements, input/output commands, sub programmes,

Numerical Analysis :

- Errors in numerical calculations
- Numerical linear algebra, eigen values and eigenvectors
- Interpolation techniques
- Generation and use of random numbers
- Sorting and searching
- Integration (including Monte Carlo techniques)
- Root finding algorithms
- Optimization, extrema of a function of many variables
- ODE's and PDE's : including FET and finite difference methods, integral equations
- Introductory Monte Carlo techniques
- Solution of Quantum Mechanical problems
- Solution of Nonlinear differential equations

Reference Books:

1. Computer Science , an overview - J.G. Brookshear and D. Bryslow (Pearson)
2. Fundamentals of Computers – V. Rajaraman (Prentice Hall, India)
3. Fortran 77 and Numerical methods – C. Xavier (New Age International)
4. Programming and Computing with FORTRAN 77/90 – P.S. Grover (Allied Publishers)
5. Elements of Parallel Processing - V. Rajaraman (Prentice Hall)
6. FORTRAN 77 - R.N. Reddy & C.A. Ziegler (Jaico Book)
7. MATHEMATICA - S. Wolfram (Wolfram Products)
8. Computer Oriented Numerical Methods- R.S.Salaria (Khanna Publishing)

PAPER - II EXPERIMENTAL METHODS IN PHYSICS 100 Marks

1. Determine the spectroscopic splitting of DPPH using ESR technique.
2. Determine the Curie temperature of the given ferromagnetic substance.
3. Study the thermoelectric power generation in the given sample.
4. Study the mono-atomic and di-atomic lattice using the given LC-set up.
5. Determine the forbidden energy gap of a given semiconductor by using a PN-junction diode.
6. Determine the magnetic susceptibility of copper sulphate by using Guoy balance.
7. Study the magnetic characteristics of the given sample using Hysteresis loop tracer.
8. Determination of the Optical Properties of various thin film and bulk samples by UV-Visible Spectrophotometer
9. Determination of Lande's g-factor for a given sample using ESR apparatus in MHz range.
10. Study of Gamma ray spectrum for the supplied source and determination of the resolving power of the spectrometer.
11. Calibration of the apparatus with standard Gamma ray sources and determination of the energy of the unknown supplied source.
12. Calibration of the magnetic field by using Hall apparatus and hence finding the Hall coefficient R_H for the given crystal.
13. Determination of the energy gap of Germanium using four probe method.
14. Determination of velocity of ultrasonic wave through the given liquid at different temperatures and the measurement of the temperature coefficient of viscosity.
15. Structural analysis study of samples by X-ray Diffractometer. (Utkal University)
16. The J/Ψ, the C and the charmonium; Analysis
17. Quarks, gluons and jets; Analysis
18. Neutral current and weak vector bosons; Analysis.
19. UV, Visible spectrophotometer, Photoluminescence.

Thin film preparation techniques, thermal evaporation, rf sputtering, magnetron sputtering, pulsed laser deposition, ion bean sputtering. High vacuum techniques.

Astrophysics- Observational astronomy, optical, radio, X-ray, IR, gamma ray, telescopes and lectors.

Reference Books:

Experiments in Modern Physics – A.C. Mellisinos and J. Napolitano (Academic Press)

Techniques for Nuclear and Particle Physics Experiments – W.A. Leo (Springer India)

PAPER - III: LITERATURE STUDY 100 Marks

A. PARTICLE PHYSICS:

Quantization of free fields, (Klein Gordon, Dirac and Vector fields),
QED : Coupling of Dirac field to electromagnetic field, gauge invariance, quantization, Feynman rules, spectrum and S-matrix from the Green's function, Second order correction and renormalization, Compton scattering.
Yang - Mills theory
Gravitation
Basic String theory

B. CONDENSED MATTER PHYSICS :

Nano particle, Quantum confinement, Estimation of particle size from UV, visible spectrophotometry, XRD, line width analysis, Single electron spectroscopy, Magnetic nanoparticles, Ferroelectric nano particles, application of nanopaticles, synthesis routes.
High Tc superconductivity, phase diagram, hole and electron doped systems, s- wave and d- wave superconductivity, gap anisotropy, pairing mechanism,
Anomalies in normal state properties, Organic and heavy Fermion superconductors.
Colossal magneto resistance - phase diagram, magnetic, charge and orbital ordering, hole and electron doped systems.
Ion matter interaction - elastic and inelastic mode of energy loss in material medium, Ion induced modification of materials.
Elemental and compound semiconductors, transport, conductivity in magnetic field, Life times, recombination, optical properties of semiconductors.

C. NUCLEAR PHYSICS:

Nuclear binding energy and forces, Weiszaecker mass formula
Two nucleon problem, Alpha, beta and gamma decay, Nuclear reactions.
Nucleon-nucleon scattering, effective range theory
Nuclear shell model, collective model and deformed nuclei, BCS model
Nuclear reaction theory, interacting boson model, heavy ion collision, quark- gluon plasma.

D. ASTROPHYSICS :

Introduction to celestial objects, coordinates, and the concept of time.
Radiative transfer: Equations of radiative transfer, Blackbody/ thermal radiation, Opacity and optical depth, solutions of the radiative transfer equations in the limiting cases, Rosseland mean opacity.
Thermal and Bremsstahlung emission, synchrotron emission, self absorption and the emergent spectrum, Thomson scattering, Compton and inverse Compton scattering, Scattering in a region with magnetic field, Faraday rotation.
Stellar structure, Mass radius relation for main sequence stars, Minimum and maximum mass for nuclear synthesis, Hertzsprung Russel diagram, Evolution of a star on the HR diagram, Novae and

Supernovae, End points of stellar evolution, Interstellar medium, Phases of interstellar medium, Thermal photo ionization, chemical and pressure equilibrium, Star formation, feedback and the evolution of ISM.

Orbits around massive bodies, Tidal disruption, restricted 3-body problem, Roche limit, Orbits in external potentials, potential density pairs, AN overview of

models of Galaxies, Accretion of matter on to a point mass, spherical accretion, Eddington limit.

Introduction to Cosmology, Friedmann models, equations, Hubble's law, A brief overview of the thermal history of the universe.

E. COSMOLOGY :

Einstein's equations of GTR

Observational cosmology

Standard Friedmann-Robertson-Walker cosmology and its problems

Inflation, solutions of problems of standard cosmology.

Present day acceleration, Dark matter, Dark energy, Explanation of dark matter and dark energy.

Brans-Dicke theory, general framework, cosmological implications.

F. SOLID STATE ELECTRONICS:

Unipolar and microwave devices, Metal semiconductor contacts, MIS devices, C-V, I-V characteristics, Interface state Density.

Photonic devices, LED material and Device configuration efficiency, LED structures, Semiconductor LASERs, Heterojunction Lasers.

Thin film deposition techniques, evaporation, sputtering, PECVD, CVD, MBE, MOCVD.

G. INSTRUMENTATION :

Basic concepts of measurement- system configuration, problem analysis, Characteristics of measuring devices, calibration.

Transducers- Classification, Requirements, Different types of transducers, strains, vibration, pressure, flow, temperature, Force and torque.

Instrumentation amplifiers- Basic characteristics, operational amplifiers, Instrumentation amplifiers, signal conditioning.

Data acquisition and conversion - Signal conditioning of inputs, single channel data acquisition, Multi channel data acquisition, Data conversion, Digital to analog and analog to digital converters, Multiplexers, sample and hold circuits.

Microprocessor - Introduction, accessories, internal structure,

Application fields.

Displays

General purpose test equipments.

H. GENERAL THEORY OF RELATIVITY:

Review of special theory of relativity.

Riemannian geometry of Euclidean signature, Manifolds,: tensors on Euclidean manifolds and their transformation laws; Christoffel symbol and Riemann tensor, Geodesics, parallel transport along open lines and closed curves, general properties of the Riemannn tensor.

Generalization to manifolds of Lorentzian signature: Comparison of geodesic motion and motion

under Newtonian gravitational potential in the non-relativistic limit.
Equivalence principle and its application: Gravity as a curvature of space-time, geodesic as trajectories under the influence of gravitational field;
generalization to mass less particles; gravitational red shift; utility of equivalence principle for studying gravity plus other interactions: motion of a charged particle in curved space-time in the presence of an electric field; Maxwell's equation in curved space-time.
Einstein's equation.
Schwarzschild solution: construction of the metric and its symmetries, motion of a particle in the Schwarzschild metric, precession of the perihelion; bending of light; horizon, its properties and significance.
Cosmological models : Principles of homogeneity and isotropy; FRW metric:
open , closed and flat universes; relation between distance, red shift and scale factor, role of equation of state; equations of state for matter, radiation, and the cosmological constant, and their effect on the evolution of scale factor,
explicit solution radiation and matter dominated era.

Paper - IV 100 Marks

DISSERTATION WORK UNDER A RECOGNISED GUIDE:

SEMINAR PRESENTATION ON THE DISSERTATION & VIVA-VOCE