Scheme and Syllabi for Ph.D. Course work in Physics

(Effective from the Session 2018-19)

SCHEME OF COURSE WORK

Paper No.	Title	Hours per week	Max. Marks	Internal Assessment	Total Marks
18 PHYPC - I	Research Methodology	4	80	20	100
18 PHYPC - II	Electronic Properties of Materials	4	80	20	100
18 PHYPC - III	Characterization Techniques	4	80	20	100

Marks of Internal Assessment = 20. The internal assessment in each paper shall be based on assignment(s) and seminar(s) presented by each candidate and their participation.

Note: Nine questions are to be set by selecting two questions from each unit. Question No.1 is compulsory and will consist of 4 to 8 questions covering whole of the syllabus

18 PHYPC - I
Research Methodology

Max. Marks: 80
Time: 3 hours

UNIT - I

Introduction of research methodology: meaning of research, objectives of research, types of research, significance of research,research and scientific method, research process; research problem: definition, necessity and techniques of defining research problem, formulationof research problem, objectives of research problem.

UNIT - II

Scientific communications: publishing research papers, selection of a journal, writing of research papers: abstract,introduction/ formulation of problem, experimental details, results &discussion, references, submission of manuscript and handling of reviewer's comment; writing of thesis: format of a thesis, review of literature, writing methods, preparation of tables and figures, writing discussion; conclusions, summary and synopsis, research ethics: copyright, plagiarism.

UNIT - III

Presentation: poster and oral, presentation tools, introduction to presentation tool, mspower pointfeatures and functions, creating presentation, customizing presentation, presentation, reference citing and listing bibliography, computer applications in research: introduction to origin software; MS office, word basics. mail merge, macros, math type, equation editor; MS excel: excel basics, data sort, functions; measurements and uncertainty, error analysis; web search internet basics, internal protocols, pre-requisites, search engines, searching hints.

UNIT IV

MATLAB: Introduction, working with arrays, creating and printing plots, Interacting computations: matrices and vectors, matrices and array operations, built in functions, saving and loading data, plotting simple graphs programming in MATLAB: script files, function files, Compiled files, p-code, variables, loops, branches, and control flow, input/ output, advanced data objects, structures, cells, solution of ordinary differential equation; first order linear ODE, second order nonlinear ODE, tolerance, ODE suite

References:

1. Getting Started with MATLAB by RudraPratap (Oxford University Press).
2. A concise introduction to MATLAB by William J Palm III (McGraw Hill).
3. Scientific Thesis Writing and Paper Presentation by N. Gurumani (2010) MJP Publishers
4. Research Methodology (Methods and Techniques) New Age International Publishers by C.R. Kothari
5. Applied numerical analysis. 6th Ed. byC.F. Gerald and P.O. Wheatley, Addison Wesley (2002).
6. Numerical Solution of partial differential equations by G.D Smith Oxford University Press (1982)
7. Numerical analysis of symmetric matrices. H. R. Schwartz E. Stiefel&Rustishausar Prentice Hall (1976)

18 PHYPC - II

Electronic Properties of Materials

Max. Marks: 80
Time: 3 hours

Unit – I

Drude model: basic assumptions, collision or relaxation times, Hall-effect and magnetoresistence, electrical conductivity, dielectric function and plasma resonance, Sommerfeld model: density of allowed wave vectors, thermal properties of a free electron gas, theory of conduction, Wiedemann-Franz law, effect of periodic lattice potential: Bloch's theorem, crystal momentum, band index and velocity, density of levels and van Hove singularities.

Unit – II

Magnetic behavior: ferromagnetism and antiferromagnetism, exchange interaction and magnetic domains, anisotropy energy, transition between domains, solitons, origin of domains, coercivity and hysteresis, ferrimagneticorder, ferrites and garnets, hard and soft magnets, single domain magnets, geomagnetism and bio-magnetism, magnetic force microscopy, spin waves, surface magnetism.

Unit – III

Dielectric constants of solids and liquids, dipole theory of ferroelectricity, thermodynamics of ferroelectric transitions, ferroelectric domains, Claussius-Mossoti relation, dielectric dispersion and losses, classification of ferroelectric materials, piezo-, ferro- and pyroelectricity, electrostriction

Unit – IV

Optical constants: index of refraction, reflectivity, transmittance, damping constant, penetration depth and absorbance, atomistic theory of optical properties, free electrons with and without damping, bound electrons, Hagen-Rubens relation, quantum mechanical treatment, band transitions, dispersion, plasma oscillations

References:

1. Principles of Electrical Engineering Materials and Devices by S.O Kasap
2. Electronic Properties of Materials by R.E Hummel
3. Solid State Physics by N.W Ashcroft and N.D Mermin
4. Introduction to Solid State Physics By Charles Kittel
5. Solid State Physics By A J Dekker
6. Electrical Properties of Materials by Solymar, L. and Walsh

18 PHYPC - III
Characterization Techniques

Max. Marks: 80
Time: 3 hours

Unit-I

Basic principle and instrumentation of UV-Vis. spectroscopy, photoluminescence spectroscopy, and ellipsometry, determination of optical band gap and other optical parameters, basic principle of FTIR and Raman spectroscopy, brief idea of set up (includes source, detector, operating conditions and excitation wavelength choice), deconvolutionof the peaks, analysis of the spectra based on peak position, FWHM of the vibrational modes. (case study of each technique)

Unit-II

Review of magnetic materials, basic principle and brief idea about set-up of vibrating sample magnetometer (VSM) and SQUIDmagnetometer,magnetization vs. temperature profiling for zero field cooling (ZFC) and field cooling (FC), M-H hysteresis loops, AC magnetic susceptibility, electrical characterization: two probe, four-probe and van-der pauw method for resistivity measurements, Hall effect experiment, dielectric characterization using impedance analyzer,electrochemical techniques: cyclic voltammetry(case study of each technique)

Unit-III

Brief review of crystal structure, X-ray diffraction methods, modern X-ray diffractometer, indexing of X-ray diffraction peaks, data analysis and interpretation, crystallite size and strain measurement in nanomaterials, basic principle of scanning electron microscopy, energy dispersive X-ray analysis, basic principle of transmission electron microscopy, brief idea of set up, sample preparation, imaging modes: bright field imaging, dark field imaging, selected area electron diffraction etc. (case study of each technique)

Unit-IV

Basic principle of atomic force microscopy, brief idea of set up, different modes of AFM (contact &tapping mode) and their importance,basic principle of scanning tunneling microscopy, brief idea of set up/components, different modes of STM and its importance, TGA and DSC/DTA: principle, practical aspects, experimental variables, data analysis and interpretation(case study of each technique)

References

1. Transmission Electron Microscopy: Diffraction, Imaging, and Spectrometry by C. Barry Carter · David B. Williams (Springer).
2. Elements of X-ray Diffraction by B. D. Cullity (Pearson).
3. Scanning Electron Microscopy and X-Ray Microanalysis by Joseph I. Goldstein (Kluwer Academic).
4. Electronic Properties of Materials by Rolf E. Hummel (Springer)
5. Characterization of Materials, (Volumes 1 & 2) Elton N. Kaufmann, John Wiley and Sons Publication
6. Materials Characterization, Introduction to Microscopic and Spectroscopic Methods by Yang Leng, JohnWiley & Sons (Asia) Pvt Ltd
7. Encyclopedia of Materials Characterization: Surfaces, Interfaces, Thin Films by C. Richard Brundle and Charles A. Evans, Jr. (BUTTERWORTH-HEINEMANN).