Ph.D. Coursework-PHYSICS

w.e.f. Academic Year2010-11

Paper I

RESEARCH METHODOLOGY AND CHARACTERIZATION TECHNIQUES

Unit I – RESEARCH METHODOLOGY

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Research formulation:

Motivation and objectives of the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, and monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis. Research design – Basic Principles- Need of research design –– Features of good design – Important concepts relating to research design – Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan - Exploration, Description, Diagnosis, Experimentation, Methods of data collection – Sampling Methods- Data Processing and Analysis strategies

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Reporting and thesis writing:

Structure and components of scientific reports -Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables- Bibliography, referencing and footnotes - Oral presentation – Planning – Preparation –Practice – Making presentation – Use of visual aids - Importance of effective communication – Ethical issues - Reproduction of published material – Plagiarism - Citation and acknowledgement

UNIT – II: Advanced Mathematical methods

Fourier and Laplace transforms:

The Fourier series, Fourier integral theorem, Fourier transform, properties, applications of Fourier transforms. Laplace transform, properties, applications of Laplace transforms

Errors:

Principle of least squares-Errors and Residuals-Precision Measures and Residuals-Experiments of Unequal Weight Probable Errors of Functions-Rejection of Observations-Empirical Formulas.

Curve fitting methods:

Least squares fit- straight, polynomial and arbitrary curve. Fitting composite curves

Unit –III: Characterization techniques:

Thermal analysis:

Principles of DSC, DTA techniques and their analysis.

X-ray diffraction:

Indexing of powder X-ray diffraction, profiles of cubic and non-cubic crystal analytical method. Determination of lattice parameters - least square method. Determination of structure factor, Rietveld refinement technique.

Electron diffraction:

Electron Microscopy- SEM, TEM.

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Unit –IV: Spectroscopic techniques

Optical spectroscopy –

Principles and applications of IR, Raman UV and Visible spectra

Resonance spectroscopy –

Principles and applications of ESR, NMR, NQR, Mossbauer.

Impedance spectroscopy –

Schearing bridges, Q-meters and auto balancing bridges. Debye's equations and Cole-Cole plots, Distribution of relaxation times. Variation of dielectric properties with frequency, temperature, pressure and composition.

Measurement of magnetic Properties –

Principles and applications of Vibrating Sample Magnetometer, SQUID magnetometer.

REFERENCES

1. *An introduction to Research Methodology*, . Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002 RBSA Publishers.
2. Kothari, C.R., 1990. *Research Methodology: Methods and Techniques*. New Age International. 418p.
5. ARFKEN & WEBER, MATHEMATICAL METHODS FOR PHYSICISTS (ACADEMIC PRESS)
6. Data reduction and error analysis for the Physical Sciences, 3e, Philip R Bevington & D. Keith Robinson. McGraw Hill (2003)
7. Advances in Material research -H.Herman
8. Methods of experimental physics Vol 3, Ed. Williams.
9. Nuclear Magnetic Resonance by E.R.Andrew
10. General aspects of NMR in solids by C.P.Slinchter
11. Electron paramagnetic resonance of transition ions by A.Abragam and B.Bleaney.
12. Spectroscopy at radio and microwave frequencies by D.S.E.Ingram
13. Nuclear quadruple resonance by H.G.Dehmelt
14. Molecular Spectroscopy by Rajkumar
15. Dielectrics by Von Hippel .
16. Dielectrics by J.C.Anderson Chapman & Hall Ltd.
17. Rietveld refinement technique by Young

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Paper II

PHYSICS OF MATERIALS

Unit –I

Amorphous materials:

Introduction preparation techniques of amorphous materials. Glasses and glass transition temperatures. Structure of glass. atomic ordering in amorphous materials. Optical properties of amorphous materials. Applications of amorphous materials

Ferroelectric materials:

Review of types of ferroelectrics and their important features, methods of preparation of bulk ceramic ferroelectrics. Characterization of ferroelectrics - methods of measuring spontaneous polarization -pyroelectricity, polarization reversal. Theories of ferroelectricity. Dipole theory. Devonshire theory and pseudo-spin theory. Application of ferroelectric materials.

Unit-II

Magnetic materials:

Introduction, exchange interaction in magnetic materials. magnetic anisotropy and magnetostriction. Hard and soft magnetic materials different types of hard magnetic materials and their applications. Soft magnetic materials (ferrites) and their properties and applications. Ferrites for microwave applications. Magnetic bubbles – Magento resistance – GMR and CMR materials - spintronic materials

UNIT – III

Semiconductor materials:

Classification of semiconductors - Elemental and compound semiconductors, Direct band and indirect band gap semiconductors, Charge carriers in extrinsic semiconductors, Mobility and its dependence on temperature and doping, Excess carriers in semiconductors, Recombination of electron -hole pairs - various recombination mechanisms. Junction capacitance, carrier concentration across the junctions.

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UNIT-IV

Luminescence and Phosphors materials:
Emission and Excitation spectra of luminescence materials. Rise and Decay of luminescence-Electroluminescence preparation of ZnS. ZnSe phosphors. Thermo luminescence and TLD phosphors. Luminescence and storage phosphors. Cathodo luminescence.
Thin films:

Thin films, different methods of film preparation(Thermal evaporation, sputtering), condensation, nucleation and growth, Thickness measurement methods, characterization, size effect on transport properties.

REFERENCES
1. Principles and applications of ferroelectrics by Lines and Glass.
2. Physics of amorphous materials by S.R.Elliott. '
3. Stimulated luminescence processes by Cheri
4. Condensed matter Physics by Ishihara
5. Glass structure by spectroscopy by J.Long and C.A.Angell
6. Physics of semiconductor materials SM Sze
7. Introduction to Magnetic Materials by Cullity
8. Hand book of thin film technology by L.I.Maissel and R. Glang

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