



**MOTHERHOOD**  
**UNIVERSITY, Roorkee**  
ENLIGHTENING WORLD

**Doctor of Philosophy (Ph.D.)**  
**COURSE WORK SYLLABUS**

**FACULTY OF SCIENCES**  
**( Physics )**

**Implemented from June, 2017 onwards**

**Roorkee-Dehradun Road, Village Karoundi**  
**Post Bhagwanpur, Tehsil Roorkee**  
**District Haridwar, Uttarakhand**

## Compulsory Course - I

### PAPER I- Research Methodology and Computer Applications

**Section I: Research Methodology**

**Max. Marks: 100**

**6 Credits**

(70 External+30 Internal)

**Objective:**

- To enable to student to understand and work methods and concepts related Research.
- To enable the student to develop research proposal and to work with research problem.
- To develop broad comprehension of research area.

**UNIT –I : Concept of Research**

**10 hrs (20 Marks)**

Meaning, Concept, nature steps types and characteristics of research., Types and approaches , Ethics in Research and Plagiarism, Scientific Inquiry, Philosophical and Sociological foundations of research, Interdisciplinary approach and its implications in various research area.

**Unit II: Types and Methods of Research**

**10 hrs (20 Marks)**

Qualitative and quantitative methods of research like Descriptive, Historical, Case study, Ethnography, Ex-post facto, documentary and content analysis, survey field and laboratory experimental studies. Characteristics of methods and their implications in research area.

**Unit III: Development of research proposals**

**10 hrs (20 Marks)**

Research proposal and its elements, Formulation of research problem-criteria of sources and definition, Development of objectives and characteristics of objectives, Development of hypothesis and applications.

Writing a Research Paper, Choosing a Topic, Preparing a Working Bibliography, Outlining and need to write a Research Paper

**Unit IV: Methods of data collection & data analysis**

**10 hrs (20 Marks)**

Concept of sampling and other concepts related to sampling. Probability and non-probability samples, their characteristics and implications. Tools of data collections, their types, attributes and uses. Redesigning, research tools-like questionnaire, observation, interviews, scales and tests etc.

Analysis of qualitative data based on various tools. Analysis of quantitative data and its presentation with tables, graphs etc. Statistical tools and techniques of data analysis-measures of central tendency, dispersion. Decision making with hypothesis testing through parametric and non-parametric tests.

Validity and delimitations of research findings.

## Section II: Computer Applications

### Unit V:

20 hrs (20 Marks)

Basic Knowledge of Computer, Use of Internet for Research Purpose: E-mail, WWW, Web browsing, acquiring technical skills, drawing inferences from data, Use of technology and other equipment in Research, Research publishing tool-MS Word, Adobe acrobat, Graphics tool-MS Excel, Presentation tool-MS Power, Data Analysis Software and Analysis Techniques point. Application of Internet in research : INFLIBNET, Use of Internet, sights (DOAJ), Use of E Journals, Use of E library, use of EBSCO HOST online database of Academic Libraries.

### References:

- Best, J.W. (1995) & Kahan, J.V. – Research Education, Prentice Hall of India Pvt. Ltd., New Delhi.
- Edwards, A.L. (1960) – Experimental Design in Psychological Research, New York, Holts (revised Ed.).
- Ferguson, G.A. and Takane Yoshio (1989) – Statistical Analysis in Psychology and Education.
- Garrett, H.E. (1986) – Statistics in Psychology and Education, Vikils Feffers and Simmons Pvt. Ltd.
- Kaul Lokesh (1984) – Methodology of Educational Research, Vikas Publishing House Pvt. Ltd., New Delhi.
- Sukhiya, S. P. : Melhotra P.V., Elements of Educational Research, New Delhi, Allied Publishers.
- Tuckman, B.W. (1972) – Conducting Educational Research, Harcourt Brace, Javanovich.
- Verma, An Introduction to Educational and Psychological Research, Bombay, Asia Publishing House.
- Lindquist, E.F. (1960) – Elementary Statistical Methods in Psychology and Education, Oxford Book Company, New Delhi.
- Sharma, A.R. (1984) Fundamentals of Educational Research, Loyal Book Depot, Meerut.
- Sanders, D.H., Computer Today, NY: McGraw Hill, 1981
- Sinha, P.K., Computer Fundamentals, New Delhi: BPB Publications, 1992
- Cox, J. And Urban, P. “Quick Course in Microsoft Office. Galgotia Publications, New Delhi, 1990.
- Jain, Satish: “Introduction to Computer Science and basic Programming.” BPB Publications, New Delhi, 1990.
- Rajaraman, V., “Fundamental of Computers”, Prentice Hall of India, New Delhi, 1996.
- Saxena, S., “A First Coursein Computers”, Vikas Publishing House Pvt. Ltd., New Delhi, 1998.

**COURSE WORK SYLLABUS**  
**CORE PAPER –II**  
**Advanced Physics**

**Total Credits : 6**

**Max. Marks 100**

**UNIT-I: Optical, Non-Linear and Electro-Optical Effects of Crystals**

Double refraction - Optical indicatrix – Effect of crystal symmetry on optical indicatrix – Wave surface: Uniaxial and Biaxial crystals Non-Linear Optics: Harmonic generation – Second Harmonic Generation – Phase matching – Third Harmonic Generation – Optical Mixing - Sum and difference frequencies – Parametric generation of light – Self-focusing of intense light beams Electro-Optic Effect: Phase retardation – Longitudinal electro-optic modulators: Amplitude modulation – Phase modulation of light – Transverse electro-optic modulators – Electro-optic beam deflection.

**Unit – II: Fundamentals of Semiconductors**

Carrier effective masses and band structure – Semiconductor statistics; energy distribution functions, density of states function, density of carriers in intrinsic and extrinsic semiconductors, compensation in semiconductors, band tail states – Absorption in semiconductors; matrix elements and oscillator strength for band to band transitions, indirect intrinsic transitions, exciton absorption, donor-acceptor and impurity-band absorption, low-energy absorption - Absorption in quantum well and quantum confined Stark effect

**Unit-III: Material synthesis techniques**

Gas-Phase Synthesis – Vapor condensation synthesis – Vapor reaction synthesis – Aerosol Synthesis Liquid-Phase Synthesis – Chemical precipitation and co-precipitation – Hydrothermal synthesis – Forced hydrolysis – Sol-gel synthesis – Solvothermal synthesis and nonhydrolytic route –Microwave heating synthesis – Synthesis in microemulsions or reverse micelles – Sonochemical synthesis – Electrochemical synthesis – Synthesis in supercritical fluids Solid-Phase Synthesis – Mechanical milling – Mechanochemical processing – Cryochemical processing – Self-combustion method – Solid-state synthesis – Colloidal assembly method – Selective leaching of a single-phase solid-solution method.

**UNIT IV: Characterization Techniques-I**

(Working Principle, Instrumentation and Applications only)

Diffraction Techniques: Powder X-ray diffraction – Single crystal X-ray diffraction – Neutron diffraction. Spectroscopic Techniques:

Optical spectroscopy: Ultraviolet-Visible-near Infrared (UV-vis-NIR) – Diffuse Reflectance Spectroscopy (DRS) - Fourier Transform Infrared (FTIR) – RAMAN - Optical Emission Spectroscopy (OES) - Photoluminescence spectroscopy – Fluorescence spectroscopy.

Surface spectroscopy: Auger Electron Spectroscopy (AES) – X-ray Photoelectron Spectroscopy (XPS) – Extended X-ray Absorption Fine Structure (EXAFS)

Electronic spectroscopy: – Nuclear Magnetic Resonance (NMR) – Electron Spin Resonance (ESR) - Mossbauer spectroscopy Ion spectroscopy: Secondary Ion Mass Spectroscopy (SIMS) - Rutherford back scattering (RBS) – Proton induced X-ray emission (PIXE) - Accelerator mass spectrometry

## UNIT V: Characterization Techniques-II

(Working Principle, Instrumentation and Applications only)

Elemental Techniques: Atomic Absorption Spectroscopy (AAS) - Induction Coupled Plasma-Mass Spectroscopy (ICP-MS) – CHN Analysis – Energy Dispersive X-ray Analysis (EDAX) – Gas Chromatography-Mass Spectroscopy (GC-MS) Microscopic Techniques: Optical microscopy – Atomic force microscopy (AFM) – Field- emission scanning electron microscopy (FESEM) – Transmission electron microscopy (TEM) Thermal, Electrical and Magnetic Techniques: TG/DTA – DSC – Four probe method – Two probe method– Impedance analysis – Hall Effect method – Vibrating sample magnetometer (VSM) – Superconducting quantum interference device (SQUID) – Magneto Optic Kerr effect (MOKE).

### Books for study and reference

1. Physical Properties of Crystals, Their Representation by Tensors and Matrices by J.F. Nye, 1985, Oxford University Press, New York.
2. Lasers and Non-Linear Optics, by B.B. Laud, Chapter-13, Wiley Eastern Ltd., 1985.
3. Quantum Electronics, by Amnon Yariv, Chapter-14, John Wiley & Sons, Inc., 1975, New York.
4. Semiconductor opto-electronic devices (II nd Edition) – P. Bhattacharya, Prentice Hall, 2011.
5. Ceramic Nanoparticle Synthesis, Encyclopedia of Nanoscience and Nanotechnology, X. Feng, M. Z. Hu, Edited by H. S. Nalwa, Volume: 1, Pages (687-726).
6. Elements of X-ray diffraction (Second Edition), B.D. Cullity.
7. Basic Principles of Spectroscopy – Raymond Chang, McGraw Hill International book company.
8. Fundamentals of Molecular Spectroscopy by Banwell.
9. Instrumental Methods of Chemical Analysis, B. K. Sharma, 2001 GOEL Publishing House.
10. Characterization of Nanophase Materials, Zhong Lin Wang, Wiley-VCH.
11. Measurement Instrumentation and Experiment Design in Physics and Engineering, M. Sayer, A. Mansingh, Prentice Hall of India Private Limited, (2000).
12. Analytical Techniques for Thin Films, K. N. Tu, R. Rosenberg, Academic Press, INC. 1988.
13. Fundamentals of surface and thin film analysis – Leonard C. Feldman and James W. Mayer, P T R Prentice Hall, 1986.