

Syllabus for the Ph.D. Qualifying Examination

Nanoscience & Technology, University of Calicut

PAPER 1: RESEARCH METHODOLOGY

UNIT I - RESEARCH METHADODOLOGY AND DATA ANALYSIS

Introduction to Research methodology-objectives and motivation in research, Research approaches, research methods Vs methodology. Defining the research problem-techniques involved. Research design: need for research design, concepts relates to research design. Processing and analysis of data: types of analysis, statistics in research. General awareness of software packages and other scientific application packages. Applications and uses of common software in chemistry, origin, chemsketch.

UNIT- II - CHARACTERIZATION TECHNIQUES FOR MATERIALS RESEARCH-I

UV-Visible, Flourometric and phosphorometric methods - X-ray photoelectron spectroscopy-Mass Spectroscopy- (ESI-MS and MALDI-TOF), Nuclear Magnetic Resonance Spectroscopy, and Raman Spectroscopy. Fourier Transfer Infrared Spectroscopy (FTIR), Dynamic light Scattering Spectroscopy (DLS)

UNIT - III - CHARACTERIZATION TECHNIQUES FOR MATERIALS RESEARCH-II

Introduction-Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Probe Microscopy: Principle of operation, contact and non-contact AFM, Scanning Tunneling Microscopy.

UNIT-IV ANALYTICAL TECHNIQUES FOR CHEMICAL RESEARCH

Electroanalytical methods - Principles and important applications of Cyclic Voltammetry, Electrochemical Impedance Spectroscopy. Thermal methods of

analysis - Principles and applications of Thermogravimetry (TG), Differential thermal analysis (DTA).

References

1. C.R.Kothari; Research methodology methods & techniques ; New age international. (Chapter 1,2,3, and 7th Chapters)
2. T.Pradeep, Nano: The Essentials, Understanding Nanoscience and nanotechnology,Tata McGraw-Hill Education,New Delhi,2007(Chapter2)
3. Peter C Jurs, *Computer Software Applications in Chemistry*, 2nd Ed., John Wiley & Sons, New York, 1996.
4. D A Skoog and M West, *Fundamentals of Analytical Chemistry*, Saunders Golden Sunburst Series.
5. J D Dick, *Analytical Chemistry*, McGraw-Hill, 1972.
6. Instrumental methods of analysis - BK Sharma
7. G W H Hohne, W H Hemminger and H J Flammersheen, *Differential Scanning Calorimetry*, 2nd Ed., Springer.
8. Paul Gabbott, *Principles and Applications of Thermal Analysis*, Wiley.
9. Characterization of Materials Vol 1 &2, by Elton N. Kaufmann, John Wiley and Sons Publication, 2003. New Jersey.
10. Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM
Ray F. Egerton

Ph.D. (PRELIMINARY QUALIFYING) EXAMINATION

(Course work)

MODEL QUESTION PAPER

Nanoscience and Technology

RESEARCH METHODOLOGY

Time: Three Hours

Maximum: 70 Marks

Section A

Answer all questions

2 marks each

11. What is Research Hypothesis?
12. What is FTIR?
13. What is the difference between Research Methods and Research Methodology?
14. Discuss the principle of Scanning Tunneling Microscopy.
15. What is the use of DTA?
16. Describe the source used in Scanning Electron Microscopy.
17. Explain the meaning and significance of the Research Design.
18. What is Mean deviation?
19. Discuss any two applications of Electrochemical Impedance Spectroscopy.
20. What is the difference between contact and non-contact AFM?

(10 × 2 = 20 marks)

Section B

Answer any five questions

4 marks each

1. What is a Hypothesis? What characteristics it must possess in order to be a good Research Hypothesis?
2. What is the difference between electron and scanning probe microscopies?
3. What are the principle and important applications of Cyclic Voltammetry?
4. Discuss the advantage of using TEM in nanotechnology.
5. Explain the principle and importance of Auger Electron Spectroscopy.
6. Describe some important Research designs used in experimental hypothesis-testing research studies.

7. Explain the principle and application of Thermogravimetry.
8. Discuss :
 - (a) Various research approaches.
 - (b) General methods for the presentation of data.

(5 × 4 = 20 marks)

Section C

Answer any five questions.

6 marks each

1. Discuss the significance of small angle and wide angle XRD in material characterization.
2. Discuss the basic statistical tools in research. What is meant by parametric and non-parametric tests?
3. Discuss (a) UV Visible Spectroscopy (b) Fluorescence spectroscopy
4. Describe the working principle of AFM and STM
5. Explain the principle and application of DTA and DSC
6. Describe Transmission Electron Microscopy and Scanning Electron Microscopy.

Compare the two techniques in terms of sample preparation and imaging.

7. Explain the principle of
 - (a) X-Ray Photoelectron Spectroscopy
 - (b) Ultraviolet Photoelectron Spectroscopy
 - (c) Auger Electron Spectroscopy
8. (a) Describe the technique of defining a Research Problem
(b) Explain any two Research Design

(5 × 6 = 30 marks)