Syllabus for PhD Entrance Test

Research Methodology

Fundamentals of Research
Definition/objectives of research; Applied vs Basic research; research types, Fundamental, Descriptive, Analytical, Experimental, Exploratory, Qualitative vs Quantitative, Characteristics of good research, Scientific method: hypothesis, data, analysis, conclusion.

Research Problem and Literature Review
Finding and developing a research question; Finding and researching a gap in the literature; Checking to see if it is feasible; Conducting a literature (or previous research studies) review. The purposes, volumes, and methods used for conducting literature reviews. Writing a comprehensive review of the literature concerning your research question; Developing your research questions or hypotheses following the SMART criteria.

The Research Design
Basic concepts of designing a research proposal. The variables to be used in the design include: independent, dependent, control, confounding; Defining the terms by how they will be measured (operational definitions) in both experimental and non-experimental designs will be of critical importance in the design. Randomizing groups, control groups, Longitudinal studies Vs cross-sectional studies.

Sampling Methods
An understanding of sampling, sampling errors and limitations, how to randomly sample, any sampling methods, and any sampling procedures. Sample type (convenience vs purposive vs snowball). Quota sampling, non-random sampling.

Collection Methodologies
Primary Sources of Data Collection: Observations, Experiments and Surveys. Secondary Sources of Data Collection: Reliability, Ethics, Types of Data and Scales for Measurement (Nominal, Ordinal, Interval and Ratio).

Referencing Lists, Citations (APA, MLA, Chicago and IEEE) and Tools for Managing References (such as Mendeley, EndNote and Zotero).

Ethical Considerations in Research: Plagiarism, Types of Plagiarism and Detection. Ethical Guidelines, Treating People and Animals in Research, Fabricating or Falsifying Data, Authorship and Publishing.

Research Proposal: Types of Research Proposal Components. Research Title, Background, Research Questions, Objectives Physiology, Methods, Dates & Budget, Outcomes & evaluation of the research proposal.

Research Project Management: Time Management, Resource Allocation; Risk Management.

Evaluating Research Results: Making Conclusions and Generalizing Results; Limitations and Implications.

Scientific/Research Writing and Reporting: Theses, Dissertations and Research Articles; Components of a Research Article; Title, Abstract; Introduction, Methods, Results, Discussion/Conclusion and References (i.e., writing style); Use of Tables/Figures.

Data Organization: Coding and Entering Data; Tabulation and Classification of Data; Presenting Data using Graphs (i.e., Histograms, Bar Charts, Pie Charts, Box Plots).

Syllabus for Ph.D. entrance Test

Chemical Sciences (Chemistry)

1. Physical Chemistry

Chemical thermodynamics: applications and laws; Basic principles of quantum mechanics, atomic structure; Kinetic theory of gases; statistical thermodynamics; redox systems, electrochemistry; rate laws and transition state theory in chemical kinetics; Phase equilibria and thermochemistry; Fundamental of rotational, vibrational and electronics spectroscopy, basic principles of spectroscopy; Solid state chemistry: band theory, crystal structure; Fundamentals of polymer chemistry; Analytical applications and problems solving.

2. Inorganic Chemistry

Periodic properties of the elements and chemical periodicity; VSEPR theory and structure and bonding in molecules; Hard and soft acid base theory, basic concepts of acid and bases, and non-aqueous solvents; Elements of main group and their compounds; Bonding, spectral and magnetic properties of transition group elements and coordination compounds; Catalysis and synthesis of organometallic compounds; Metal cluster and cages; Bioinorganic chemistry of metalloenzymes, oxygen transport, fixation of nitrogen; Separation techniques and analytical inorganic chemistry; Radio-analytical methods, nuclear chemistry.

3. Organic Chemistry

Aromaticity, stereochemistry, isomerism, IUPAC nomenclature; Reactive intermediates in organic chemistry (carbocations, radicals, carbenes); SN1, SN2, E1, E2, etc., organic reactions and its mechanistic pathways. Organic rearrangements and name reactions; Retrosynthesis, protecting groups in organic reactions; Asymmetric synthesis and enantioselectivity of organic compounds; Photochemistry and pericyclic reactions; Chemistry of natural products (carbohydrates, proteins, alkaloids, terpenes); determination of structures of organic compounds using IR, UV-Vis, NMR and mass spectroscopy.

4. Interdisciplinary & Modern Chemical Topics

Principles of green chemistry and catalysis; chemistry of nanomaterials, nanotechnology; Basics of medicinal and bioorganic chemistry; supramolecular chemistry; Chemistry of environment (pollution, green processes).