Savitribai Phule Pune University

(Formerly University of Pune)

Syllabus for M.Phil./Ph.D. (PET) Entrance Exam : Instrumentation Science

Research Methodology

1) **Foundation of Research:** Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method - understanding the language of research - Concept, Construct, definition, Variable. Research Process
2) **Problem Identification & Formulation:** definition and formulating the research problem, Necessity of defining the problem, Importance of literature review in defining a problem, Research Question - Investigation Question - Measurement Issues - Hypothesis - Qualities of a good hypothesis - Null hypothesis & Alternative Hypothesis. Hypothesis Testing - Logic & importance
3) **Research Design:** Concept and Importance in Research - Features of a good research design - Exploratory Research Design - Concept, Types and uses, Descriptive Research Design - concept, types and uses. Experimental Design - Concept of Independent & Dependent variables.
4) **Qualitative and Quantitative Research:** Qualitative - Quantitative Research - Concept of measurement, causality, generalization, replication. Merging the two approaches.
5) **Data Collection and analysis:** Execution of the research - Observation and Collection of data - Methods of data collection, hypothesis-testing - Generalization and Interpretation.
6) **Measurement:** Concept of measurement - what is measured? Problem in measurement in research - Validity and Reliability. Levels of measurement - Nominal, Ordinal, Interval, Ratio.
7) **Sampling:** Concept of Statistical population, Sample, Sampling Frame, Sampling Error, Sample size, Non Response. Characteristics of a good sample. Probability Sample - Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample - Practical considerations in sampling and sample size.
8) **Data Analysis:** data Preparation - Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis - Cross tabulations and Chi-square test including testing hypothesis of association.
9) **Interpretation of Data and Paper Writing:** Layout of a Research Paper, Journals in Instrumentation Science, Impact factor of journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.
10) Use of Encyclopedias, Research Guides, Handbook etc., Academic databases for concerned discipline.
11) **Use of tools / techniques for Research:** methods to search required information effectively, Reference Management Software like Zotero/mendeley, Software for paper formating like LaTeX/MSOffice, software for detection of Plagiarism.

12) **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
13) **Application of results and ethics:** Environmental impacts - Ethical issues - ethical committees - Commercialization - Copy right - royalty - Intellectual property rights and patent law - Trade related aspects of intellectual property Rights - Reproduction of published material - Plagiarism - citation and acknowledgement - citation and acknowledgement - Reproducibility and accountability.
14) **Reasoning and Mentalability**: Analogy, Classification, Series, Coding-Decoding, Direction Sense, Representation Through Venn Diagrams, Mathematical Operations, Arithmetical Reasoning, Inserting the Missing Character, Number, Ranking and Time Sequence Test, Eligibility Test**,** Representation through Venn-diagrams, Number & symbols ordering, Comprehension questions, Statement & assumptions, Statement & conclusions, Statement & actions

Books Recommended

1) Research Methodology - C. R. Kothari
2) Research Methodology : An Introduction - Stuart Melville and Wayne
3) Practical Research Methods - Catherine Dawson
4) Select references from the Internet

REFERENCES

1) Garg, B. L., Karadia, R., Agarwal, F. and Agarwal, U. K., 2002. An introduction to Research Methodology, RBSA Publishers.
2) Kothati , C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3) Sinha, S. C. and Dhiman, A. K., 2002. Research Methodology, Ess Ess Publications. 2 columes.
4) Trochim, W. M. K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p
5) Wadehra, B. L. 2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.

Additional reading

1) Anthony, M., Graziano, A. M. and Raulin, M. L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2) Carlos, C. M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3) Coley, S. M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
4) Day, R. A., 1992. How to Write and Publish a Scientific Paper, Cambridge University Press.
5) Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications

6) Leedy, P. D. and Ormrod, J. E., 2004 Practical Research: Planning and Design, Prentice Hall.
7) Satarkar, S. V., 2000. Intellectual property rights and Copy right. Ess Ess Publications.

Subject Concerned Syllabus
Instrumentation Science

Unit 1:

Semiconductor Devices

Diodes, Transistors, JFET, MOSFETS, IGBT, SCR, TRIAC and its applications.

Unit 2:

OP-amp, Op-amp applications, Timer (IC 555)

Unit 3:

AC to DC converter, AC to AC converter, DC to AC converter and DC to DC converter DC motors, Induction motor.

Unit 4:

Logic families, combinational and sequential Circuits, Introduction to PIC microcontroller, PIC Microcontroller core architecture , MPLAB, PIC resources, introduction to embedded and its development , Embedded 'C' programming.

Unit 5:

Units and standard measurement system, static and dynamic characteristics of the system, level transducers, displacement, pressure, temperature, electro-chemical transducers, signal conditioning for resistive capacitive, Inductive, Optical sensors.

Unit 6:

Basic of control system and time domain analysis, process dynamics and process control, process controllers and tuning control schemes, stability analysis, root locus techniques and frequency domain analysis.

Unit: 7

Open control Network, Network at different level , safety Instrumentation system Automation fundamental , PLC Hardware , supervisory control and data acquisition, Nonlinear system, multivariable and intelligent control, distributed control system.

Unit: 8

Radioactive Instrumentation and refractometry, optical absorption and transmission and IR spectroscopy, optical sources and detectors, fiber optic and their applications, principals of lasers and laser types.