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**Detailed Syllabus of  
Ph.D. Coursework Examination in  
Computer Science and Application**



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## 0.1 A model Scheme of Instruction and Examination

**Table 1:** Details of lecture hours per week and marks distribution

Code	Title	Term End	Sessional	Full Marks	Exam Duration
Paper I	Research Methodology	40	10	50	2 Hours
Paper II	Mathematical Foundation	40	10	50	2 Hours
Paper III	Programming and Data Structure	80	20	100	3 Hours

## 0.2 Syllabus of Core Subjects

### 0.2.1 Paper I: RESEARCH METHODOLOGY [F.M. 40+10]

#### Group I

**Introduction**– Meaning, purpose, objectives and characteristics of research, Types of research, Significance of Research, Motivation in Research, Research Approach and Process, Research Methods Vs Methodology, Criteria of good Research, Research Ethics

**The Research Problem**– Definition, finding a problem, stating the problem, identifying sub-problems - Necessity of Defining the Problem- Techniques involved in defining the Problem.

**Literature Review**– Importance of literature review in defining a problem, Including literature in research proposal, Critique, Survey & Peer review process, Identifying gap areas from literature review.

**Research Planning and Design**– Research plan and its components, Developing a research plan, Meaning and importance of Research Design, Different types of research design, Features of a Good research Design

**Sampling**– Steps in sampling, Characteristics of a good sample, Types of sample, Measurement and scaling techniques, Types of data-primary, secondary etc., Methods of data collection, Data collection instruments/tools.

**Development of working hypothesis**– Formulation of Hypotheses, Types of Hypotheses, Methods of testing Hypotheses, Correlation and Regression, Chi-square test, Analysis of variance and Covariance etc.

#### Group II

**Interpretation and Report Writing**– Techniques of interpretation, Types of research documents, Significance of documenting research, Technical reports and thesis, different steps in writing Report, Techniques and issues of writing project proposals, articles, technical reports, white papers, research papers, thesis etc., checklist/precautions for writing research documents, characteristics of a good research document, Writing abstracts, paper presentation, The Quantitative study, Final paper presentation, Soft skills

**Computer Applications and Research Tools**– Internet, e-mail, ICT, WWW, web as a source of data and information, searching the web, using open courseware, online tutorials, eBooks, eJournals etc., Primary and secondary sources, Reviews, treatise, monographs patents, Library, Data analysis with Statistical Packages, MS-Office, MS-Publisher, LaTeX etc., INFLIBNET, Shodhganga, ShodhGangotri, N-LIST, UGC-INFONET Digital Library Consortium etc.

**Intellectual Property Rights**– Invention and Creativity, Intellectual Property, Importance and Protection of Intellectual Property Rights (IPRs), A brief summary of: Patents, Copyrights, Trademarks, Industrial Designs.

**REFERENCES:**

1. Research Methodology Methods and Techniques by C. R. Kothari, Wishwa Prakashan Publishers.
2. An introduction to Research Methodology by Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., RBSA Publishers.
3. Research Methodology Sinha, S.C. and Dhiman, A.K., Ess Publications. 2 volumes.
4. Research Methods: the concise knowledge base by Trochim, W.M.K., Atomic Dog Publishing.
5. How to Write and Publish a Scientific Paper by Day, R.A., Cambridge University Press.
6. Conducting Research Literature Reviews: From the Internet to Paper by Fink, A., Sage Publications
7. Proposal Writing by Coley, S.M. and Scheinberg, C. A., Sage Publications, 1990.
8. Handbook on Intellectual Property Law and Practice by Subbarau NR, S Viswanathan Printers and Publishing Private Limited
9. Research Methodology by Dalip Kumar Bhattacharyya

10. Research Methodology by C.H. Chaudhary, RBSA Publication
11. Statistical Techniques by S.P. Gupta, Sultan Chand & Sons
12. An Introduction to Multivariate Statistical Analysis by Anderson T. W., Wiley Eastern Pvt., Ltd., New Delhi.
13. WWW(Web Sources)

### 0.2.2 Paper II: Mathematical Foundation [F.M. 40+10]

**Mathematical Logic :** Statements and notations, Connectives, Truth Tables, Well formed formulas, tautology, contradiction and satisfiable, equivalence implication, Quantifiers, Universal quantifiers, Normal forms, Theory of Inference for statement calculus, Predicate Calculus, Inference theory of the predicate calculus

**Relation and Ordering:** Function, Recursion, Generating Functions, Recurrence Relations, Solution of homogeneous and inhomogeneous recurrence relation.

*Algebraic Structures :* Groups, Applications of residue arithmetic to computers, Group Codes.

**Graph Theory:** Definition, Path, Reachability, Connectedness, Representation of Graphs, Trees, Storage representation and manipulation of graphs, PERT/CPM and related techniques.

#### REFERENCES:

1. Graph Theory with Applications to Engineering and Computer Science by Deo Narsingh, PHI Learning Pvt. Ltd., 2004
2. Discrete Mathematical Structures for Computer Science by Kolman, Busby, R., Prentice Hall College Div; 2 Sub edition (March 1987)
3. Discrete Mathematical Structures by Kolman, B., Busby, B., Ross, S., Pearson, 6 Edition
4. Discrete Mathematical Structures With Applications to Computer Science by Tremblay, J. P., Manohar, R., McGraw Hill Education (India) Private Limited (2 February 2001)
5. Elements of Discrete Mathematics - A computer Oriented Approach - C L Liu, D P Mohapatra, Tata McGraw-Hill Education Pvt. Ltd., 2008
6. Discrete Mathematics for Computer Scientists & Mathematicians, J. L. Mott, A. Kandel, T.P. Baker, Prentice-Hall, 1999

7. Discrete Mathematics with Applications, Thomas Koshy, Academic Press; 1st edition (December 26, 2003)
8. Discrete Mathematics and its Applications by Kenneth H. Rosen, McGraw-Hill Education; 7 edition (June 14, 2011)
9. Logic and Discrete Mathematics by Grass Man & Trembley, Pearson

### 0.2.3 Paper III: Programming and Data Structure [F.M. 80+20]

A programming language like C/C++/Java may be followed. The same language must be used for the laboratory

#### Group I

**Programming Fundamentals:** Conditional statements, Control statements, Functions, Arrays, Preprocessor, Pointers, Variation in pointer declarations, Function Pointers, Function with Variable number of arguments

**Programming Advanced Features:** Structures and Unions, File handling concepts, File read, write, binary and Stdio, File Manipulations

**Object Oriented Programming Concepts:** Programming features, Data Abstraction, Encapsulation, class, object constructors, Polymorphism, Inheritance, static members, constant members, member functions, overloading and overriding, virtual functions, references, Role of this pointer, Storage classes, function as arguments, String Handling, dynamic memory allocation, Nested classes.

**Advanced Features:** Abstract class, Exception handling, Standard libraries, Generic Programming, templates, class template, function template, STL, containers, iterators, function adaptors, allocators, Parameterizing the class, File handling concepts.

#### Group-II

**Linear Data Structures List:** Abstract Data Types (ADTs), List ADT, array-based implementation, linked list implementation, singly, doubly, and circularly linked lists, applications of lists, Polynomial Manipulation, different operations on Lists

**Linear Data Structures Stacks, Queues:** Stack ADT, Evaluating arithmetic expressions, other applications, Queue ADT, circular queue implementation, double ended Queues, applications of queues

**Advanced Non-Linear Data Structures:** AVL trees, B-Trees, Red-Black trees, Splay trees,

Binomial Heaps, Fibonacci Heaps, Disjoint Sets, Amortized Analysis, accounting method, potential method, aggregate analysis.

**Graphs:** Representation of Graphs, BFS, DFS, Topological sort, Minimum Spanning Trees, Kruskal and Prim algorithm, Shortest path algorithm, Dijkstras algorithm, Bellman-Ford algorithm, Floyd, Warshall algorithm.

**Sorting, Searching and Hash Techniques:** Different sorting and searching algorithms and their performance analysis, Hash Functions, Separate Chaining, Open Addressing, Rehashing, Extendible Hashing

**REFERENCES:**

1. C: The Complete Reference by Herbert Schildt, 4th ed., Tata McGraw-Hill, 2000.
2. Theory and Problems of Programming in C by Gottfried, B., Schaum Series.
3. Programming in Ansi C by Balgurusamy, TMH
4. The C++ Programming Language by Bjarne Stroustrup, 3rd Edition, Pearson Education, 2007.
5. Programming with Java:A Primer by Balaguruswamy E, Tata McGraw Hill
6. Java: The Complete Reference by Herbert Schildt, 8th Edition, Tata McGraw Hill, 2011.
7. Data Structure Using C AND C++ by Yedidyah, L., Moshe, J. M., M Aaron, Tenenbaum, 2/E (English) 2nd Edition
8. Data Structures Using C Hardcover by Aaron M. Tenenbaum, TMH, December 11, 1989
9. Fundamentals of Data Structures in C++ by Ellis Horowitz, S. Sahni, D. Mehta, Galgotia, New Delhi.
10. Data Structures by S. Lipschutz, Mc-Graw Hill International Editions, 1986.
11. Data Structures and Algorithm Analysis in C++ by Mark Allen Weiss, 2nd Edition, Pearson Education, 2005