

UNIVERSITY OF MUMBAI



**Revised Syllabus for
Ph.D Entrance Exam (PET)
in
Computer Science
Paper 1 and 2**

With effect from the academic year **2020–2021**

AC _____
Item No. _____

UNIVERSITY OF MUMBAI



Sr. No.	Heading	Particulars
1	Title of the Course	PET (Computer Science)
2	Eligibility for Admission	M.Sc.(Computer Science / I.T/ Electronics/ Statistics/Mathematics)
3	Passing Marks	40
4	Ordinances / Regulations (if any)	Nil
5	No. of Years / Semesters	NA
6	Level	P.G. (Strike out which is not applicable)
7	Pattern	Semester (Strike out which is not applicable)
8	Status	Revised (Strike out which is not applicable)
9	To be implemented from Academic Year	From Academic Year 2020-21

Date

Dean Science & Technology Dr Anuradha Majumdar

Signature

Chairman, BOS of Computer Science Dr.J.W.Bakal

PREAMBLE

The University of Mumbai offers research programs in different subjects and in interdisciplinary areas under the various faculties leading to the degree of Doctor of Philosophy (Ph.D.). A candidate to qualify for enrollment into this program shall have to enrol for the PET exam and qualify in it to register at a recognized place of research which includes the University Departments, research Institutes and Affiliated Colleges recognized as “Research Centre” by the University.

The PET course work for Ph.D. in Computer Science shall have two courses namely Course-I and course- II. Course I shall be on Research Methodology, research aptitude, logical reasoning, comprehension, communication and general knowledge while course II shall be subject specific

The mode of assessment for the evaluation of coursework would be as follows

- PET shall be of Multiple Choice Questions (MCQ) and of 100 marks.
- Each paper will have 50 questions and the qualifying marks shall be 50% of the aggregate, taking Paper I and II together.
- Relaxation of 5% of marks from 50% to 45% shall be allowed for those belonging to reserved category / Differently/Abled and other categories of candidates as per policies of the Government of Maharashtra prescribed from time to time.

The revision of this syllabi has been undertaken to enable assessment of the research undertaking capabilities of candidate besides evaluating his basic and advanced knowledge .

Dr Anuradha Majumdar (Dean, Science & Technology)

Prof Shivram Garje (Associate Dean , Science)

Dr J.W. Bakal Chairperson , BOS of Computer Science

Dr.Vaibhav Narawade, BoS Member

Dr.Ambuja Salgaonkar, BoS Member

Dr.Rajendra Patil, BoS Member

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Dr.Paritosh Pandya, BoS Member

Mumbai University Syllabus for PhD(PET) Entrance Exam : Computer Science

PAPER 1

Research Methodology

1. Research terminology and fundamentals:

Definition & Objectives of research, scientific thinking, general characteristics of research, classification and types of research, types of research methods, Research methods verses methodology, Criteria of good research, Identification and formulation of research problem, Study designs.

2. Defining Research problem:

Formulation of a hypothesis, understanding the structure, elements, classification, functions of hypothesis based on scientific laws and principles.

Meaning and nature of hypothesis, Functions of hypothesis, Importance of hypothesis, Kinds of hypothesis, Characteristics of good hypothesis, formulation of hypothesis

3. Research Formulation – Defining and formulating the research problem, selecting the problem, importance & types of literature review in defining a problem. Critical literature review, Primary and secondary sources of literature: reviews, treatise, monographs-patents. Web as a source, searching the web, Identifying gap areas from literature review.

4. Data collection and processing:

Definition, scope and limitations of data collection and processing, Methods and techniques of data collection: types of data, methods of primary data collection (observation/ experimentation/ questionnaire/ interviewing/ case/pilot study, methods), methods of secondary data collection (internal/ external). Representation of data; Its types and its representations, importance of measurement scales, variables & their measurements

5. Sampling and sampling distributions

Sampling frame, importance of probability sampling, simple random sampling, systematic sampling, stratified random sampling, cluster sampling, problems due to unintended sampling, ecological and statistical population in the laboratory.

6. Data analysis and report writing

Experimental data collection and data processing: Processing operations, Problems in processing, elements of analysis in data processing, software for data processing.

Types of research reports, guidelines for writing a report, formats for poster and oral presentations.

General structure of scientific reports: - Different types of scientific documents - journal articles, books, thesis, conference and project reports. Components of a research paper: Publication process, copyright transfer, Open access, , Formulation of research proposal
Style of referencing (citation styles): Harvard, Vancouver, APA, MLA reference writing,.

7. Statistics in research

Statistical methods for data analysis; Mean, Standard deviation & standard error. Concept of probability and its significance. Measures of central tendency -mean, median, mode, geometric mean, Measures of dispersion- Range, Q.D., M.D., Variance, standard deviation, Correlation and Regression analysis

Hypothesis testing: Null and alternate hypothesis, Type-I & Type-II errors, Level of significance, Power of test, p value. Parametric tests: Large sample Tests, Small sample Tests, t-test, F-test and ANOVA

Books recommended

1. Research Methodology-C R Kothari
2. Research Methodology: An Introduction-Stuart Melville and Wayne
3. Practical Research Methodology-Catherine Dawson
4. Research Methods for Science Michael P Marder
5. Research Methodology: Principle, Methods and Practices-Joshua O.Miluwi and Hina Rashid
6. Research Methodology: A Step By Step Guide for beginners- Ranjeet Kumar
7. How to Write and publish a Research Paper- Seventh Edition-Robert Day And Barbara Gastle
8. Introduction to Bio-statistics and Research Methods- P S S Sunder Rao
9. Research Methodology and Scientific Writings- C George Thomas

References:

- 1) Garg, B. L.Karadia R. Agrawal, F. and Agrawal 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

Paper 2: Subject Concerned Syllabus Computer Science

1. Analysis of Algorithms

Analyzing algorithms, Designing algorithms. Growth of Functions: Asymptotic notation, Standard notations and common functions. Divide-and-Conquer: The maximum-subarray problem, Strassen's algorithm for matrix multiplication, the substitution method for solving recurrences.

Dynamic Programming, Greedy Algorithms: An activity-selection problem, Elements of the greedy strategy, Huffman codes. Elementary Graph Algorithms: Representations of graphs, Breadth-first search, Depth-first search. Minimum Spanning Trees: Growing a minimum spanning tree, Algorithms of Kruskal and Prim. Single-Source Shortest Paths, Number-Theoretic Algorithms and NP – Completeness, research ethics, reviewing literature, design and creation, experiments, Quantitative data analysis

2. Advanced Networking Concepts

Networking Protocol layer and their services, Network Applications like Web, HTTP, FTP and Electronic Mail in the Internet, Domain Name System, Transport-Layer Services, Multiplexing and Demultiplexing, UDP, TCP, Internet Protocol (IP), Routing Algorithms, Routing in the Internet, Network Virtualization: The Virtual Enterprise, Transport Virtualization-VNs, Central Services Access: Virtual Network Perimeter, A Virtualization Technologies primer: theory, Network Device Virtualization, Data-Path Virtualization, Adhoc Networking: Routing protocols, Wireless Sensor networks, Wireless Sensor networks: sensing and communication range, design issues, localization scheme, clustering of SNs, Routing layer, Sensor networks in controlled environment and actuator

3. Database Systems

DBMS, RDBMS, Distributed Database Concepts, DDBMS Architecture, Distributed database design, Transaction Management, Concurrency Control, DBMS reliability, Database System,

Parallel query evaluation, Object Oriented Database, Languages and Design, Temporal and Spatial Database, Introduction to Temporal Database, Spatial Database, Deductive Database, Interpretation of model, Active Database, OLTP,OLAP, Datawarehousing, Data mining

4. Artificial Intelligence and Machine Learning

State space search: Generate and test, Simple search, Depth First Search (DFS), Breadth First Search (BFS), Comparison and quality of solutions. Heuristic Search: Heuristic functions, Best First Search (BFS), Hill Climbing, Local Maxima, Beam search, Tabu search. Finding Optimum paths: Brute force, branch & bound, refine search, Dijkstra's algorithm, A* algorithm. Admissibility of A* algorithm. Learning-Standard Linear methods, Selection and improvements of linear learning methods, Non-Linear Learning methods, Support Vector machines, Principle Component Analysis and Clustering

5. Operating Systems

Operating system booting process GRUB-I, GRUB-II. File Systems: Files, Directories, File System Implementation, Security, Protection mechanisms in different Linux versions, The Linux Kernel – its functions, essential hardware drivers. Libraries - Surface Manager, Media framework, SQLite, WebKit, OpenGL. Android Runtime - Dalvik Virtual Machine, Core Java Libraries. Application Framework - Activity Manager, Content Providers, Telephony Manager, Location Manager, Resource Manager.

6. Compiler Construction Theory

The structure of a compiler, A simple approach to the design of lexical analyzers, Regular expressions, Finite automata, From regular expressions to finite automata, Minimizing the number of states of a DFA, Context-free grammars, Derivations and Parse trees, Parsers, Shift-reduce parsing, Operator-precedence parsing, Top-down parsing, Predictive parsers. LR parsers, The canonical collection of LR(0) items, Constructing SLR parsing tables, Constructing canonical LR parsing tables, Constructing LALR parsing tables, Using ambiguous grammars, An automatic parser generator, Syntax-directed translation schemes, Implementation of syntax-directed translators, Tiger compiler, bindings for the Tiger compiler, type checking expressions, type-checking declarations, activation records, stack frames, frames in the Tiger compiler, The principle sources of optimization, Loop optimization: The DAG representation of basic blocks, Dominators, Reducible flow graphs,

Depth-first search, Loop-invariant computations, Induction variable elimination, Some other loop optimizations.

7. Cloud Computing

Web Service as distributed application, SOAP Based Web Services, Web Services Security, Wire-Level Security, WS-Security. Architecting on AWS, Building complex solutions with Amazon Virtual Private Cloud (Amazon VPC), Leverage bootstrapping and auto configuration in designs, Architect solutions with multiple regions.

8. Network and Communication Security

Principles of Security, Different Attacks: malicious and non-malicious program, Types of Computer Criminals. Security: Security requirements, Integrity, Confidentiality, Availability, Reliability of Database, Sensitive data, Multilevel database, Proposals for multilevel security. Firewall (ACL, Packet Filtering, DMZ, Alerts and Audit Trails) – IDS,IPS and its types (Signature based, Anomaly based, Policy based, Honeypot based). Virtualization System Security Issues: e.g. ESX and ESXi Security, ESX file system security-storage considerations, backup and recovery- Virtualization System Vulnerabilities, Mobile system architectures, Overview of mobile cellular systems, GSM and UMTS, Security & Attacks, Vulnerabilities in Cellular Services, Cellular Jamming Attacks & Mitigation, Security in Cellular VoIP Services, Mobile application security. Securing Wireless Networks: Overview of Wireless Networks, Scanning and Enumerating 802.11 Networks, Attacking 802.11 Networks

9. Signal and Image Processing

Signal Representation, Filter Design, Image pre-processing Spatial and Frequency domain operations, morphology, segmentation, classification and clustering.

10. Simulation and Modelling

Model Verification and Validation, Modeling and simulation modeling, Design and behaviour of models

REFERENCES

- 1) Introduction to Algorithms, Third Edition, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, PHI Learning Pvt. Ltd-New Delhi (2009).
- 2) Researching Information Systems and Computing, Brinoy J Oates, Sage Publications India Pvt Ltd (2006).
- 3) Computer Networking: A Top-Down Approach 6th edition, James F. Kurose, Keith W. Ross, Pearson (2012).
- 4) Network Virtualization, Victor Moreno, Kumar Reddy, Cisco Press (2006).
- 5) Ad Hoc and Sensor Networks: Theory and Applications 2nd edition; Carlos de Morais Cordeiro, Dharma Prakash Agrawal, World Scientific Publishing Company; 2 edition (2011)
- 6) Principles of Distributed Database Systems; 2nd Edited By M. Tamer Ozsu and Patrick Valduriez, Person Education Asia.
- 7) Database System Concepts, 5th edition, Avi Silberschatz , Henry F. Korth , S. Sudarshan: McGraw-Hill (2010)
- 8) Database Systems: Concepts, Design and Applications, 2nd edition, Shio Kumar Singh, Pearson Publishing, (2011).
- 9) Multi-dimensional aggregation for temporal data. M. Böhlen, J. Gamper, and C.S. Jensen. In Proc. of EDBT-2006, pp. 257-275, (2006).
- 10) A First course in Artificial Intelligence, Deepak Khemani, Tata McGraw Hill Education (India) private limited (2013)
- 11) Artificial Intelligence: A Modern Approach, 3e, Stuart Jonathan Russell, Peter Norvig, Prentice Hall Publications (2010).
- 12) Artificial Intelligence Illuminated, Ben Coppin, Jones and Bartlett Publishers Inc (2004)
- 13) Operating Systems: Design and Implementation, Third Edition, Andrew S. Tanenbaum, Albert S. Woodhull, Prentice Hall, 2006.
- 14) Compilers: Principles, Techniques and Tools 2nd edition, Alfred V. Aho , Monica S. Lam , Ravi Sethi , Jeffrey D. Ullman , Pearson (2011)
- 15) Programming Amazon EC2, Jurg van Vliet, Flavia Paganelli, O'Reilly Media, 2011.
- 16) Security in Computing 4th edition, Charles P. Pfleeger, Charles P. Pfleeger, Shari Lawrence Pfleeger, Prentice Hall; 4th edition (2006)

- 17) Business Intelligence (2nd Edition), Efraim Turban, Ramesh Sharda, Dursun Delen, David King, Pearson (2013)
- 18) Business Intelligence for Dummies, Swain Scheps, Wiley Publications (2008).
- 19) Introduction to Machine Learning (Second Edition): Ethem Alpaydm, The MIT Press (2010).
- 20) Pattern Recognition and Machine Learning: Christopher M. Bishop, Springer (2006)
- 21) Digital Image Processing, R.Gonzalez, R.Woods, Pearson Education.