MIT Academy of Engineering, Alandi (D)
An Autonomous Institute affiliated to SPPU, Pune

MITAoE Ph. D Entrance Test

Paper 1A: Research Methodology

Examination Scheme
Total Marks: 50
(Multiple Choice Questions- 2 marks each)

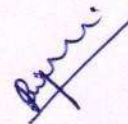| |
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| **Unit 1: Foundation of Research** |
| Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method - understanding the language of research - Concept, Construct, definition, Variable. Research Process. |
| **Unit 2: Problem Identification and 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. 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. . |
| **Unit 3: Data Collection and analysis** |
| Execution of the research - Observation and Collection of data - Methods of data collection, hypothesis-testing - Generalization and Interpretation. Data Preparation - Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis - Cross tabulations and Chi-square test including testing hypothesis of association. Statistics and its significance in research.. |
| **Unit 4: Measurement** |
| Qualitative - Quantitative Research - Concept of measurement, causality, generalization, replication. Merging the two approaches. Problem in measurement in research - Validity and Reliability. Levels of measurement - Nominal, Ordinal, Interval, Ratio. 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. |
| **Unit 5: Scientific Writing and Information sources** |

Layout of a Research Paper, Journals in Computer Science, Impact factor of journals, When and where to publish?, Selecting a journal, conference. Information sources: Types of publications, Indexing and abstracting services, Online library, Search engines, Citation indexes, Citations analysis, Online searching methods, Initiatives for knowledge management. Use of tools / techniques for Research: Reference Management Software like Zotero/mendeley, Software for paper formatting like LaTeX/MSOffice, software for detection of Plagiarism. Reporting and Thesis writing: Structure and components of scientific reports, Types of report, Technical reports and thesis, Illustrations and tables, Bibliography and footnotes, Oral presentation preparation. References: How to cite and list correctly, Common documentation styles, Citation of sources in the text, Reference management softwares.

Unit 6 Mental Ability and Research Ethics

Analogy, Classification, Series, Coding-Decoding, Direction Sense, Reasoning: Representation Through Venn Diagrams, Mathematical Operations, Arithmetical Reasoning, Inserting the Missing Character, Number, Ranking and Time Sequence Test, Eligibility Test, Number and symbols ordering, Comprehension questions, Statement and assumptions, Statement and conclusions, Statement and actions. Ethical issues- Ethical issues related to publishing, ethical committees, Commercialization, Copyright, royalty, Intellectual property rights and patent law, Trade related aspects of intellectual property Rights, Reproduction of published material, Plagiarism: Plagiarism and Self-Plagiarism, citation and acknowledgement, Reproducibility and accountability.

B.O.S. Chairman
School of Computer Engineering

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School of Computer Engineering

MITAoE Ph. D. Entrance Test

Paper 2: Computer Engineering

Examination Scheme
Total Marks: 100
(Multiple Choice Questions- 2 marks each)

| Unit1: Theory of Computing |
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| Finite Automata and Regular Expressions, Properties of Regular Sets, Context Free Grammars, Push down Automata, Properties of Context Free Languages, pumping lemma, Turing Machines, Undecidability, Chomsky Hierarchy. Growth of Functions, Time and Space Complexity, Searching and Sorting Techniques, Hash Tables, Heaps and Disjoint Sets, Divide-and-Conquer, Greedy Algorithms, Backtracking, Dynamic Programming, Probabilistic Analysis and Randomized Algorithms, Shortest Paths, Maximum Flow, Multithreaded Algorithms, Linear Programming, String Matching, NP-Completeness. |

Unit II: Operating Systems
Operating-System Structures, System calls, Processes, Threads, inter-process communication, CPU Scheduling, concurrency and synchronization, Deadlocks, Memory management, virtual memory, File systems, Inodes, Structure of Regular File, Conversion of path name to Inode, Inode assignment to new file, Process creation, Signals, Termination, Driver Interfaces, Disk Interfaces, Terminal Interfaces, Streams Multiprocessor Systems, Distributed System Structures, Distributed File Systems, Distributed Coordination, Distributed Unix Systems, Special-Purpose Systems: Real-Time Systems, Multimedia Systems.

Unit III: Computer Networks
Basics of layering: OSI and TCP/IP Protocol Stacks; Basics of packet, circuit and virtual circuit-switching; Data link layer: framing, error detection, Medium Access Control, Ethernet bridging; Routing protocols: shortest path, flooding, distance vector and link state routing; fragmentation and IP addressing, IPv4, IPv6, CIDR notation, IP protocols: ARP, DHCP, ICMP, Network Address Translation (NAT); Transport layer: flow control and congestion control, UDP, TCP, sockets; Application layer protocols: DNS, SMTP, HTTP, FTP, Software Defined Networking, Email, Basics of Wi-Fi. Network security: authentication, basics of public key and private key cryptography, digital signatures and certificates, firewalls.

Unit IV: Information Systems and Information Retrieval
Overview of Database Systems, Introduction to Database Design, The Relational Model, Relational Algebra and Calculus, SQL: Queries, Constraints, Triggers, Database Application Development, Internet Applications, Overview of Storage and Indexing, Storing Data: Disks and Files, Tree-Structured Indexing, Hash-Based Indexing, Overview of Query Evaluation, External Sorting, Evaluating Relational Operators, A Typical Relational Query Optimizer, Overview of Transaction Management, advanced transaction processing, Concurrency Control, Crash Recovery, Schema Refinement and Normalization, File organization, indexing (e.g., B and B+ trees).Physical Database
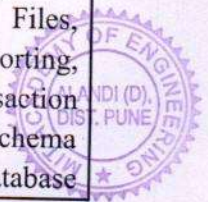
Design and Tuning, Security and Authorization, Parallel and Distributed Databases, Object-Database Systems, Deductive Databases, Active Database, OLTP,OLAP, Data Warehousing and Decision Support, Interpretation of model, Data Mining, Information Retrieval and XML Data, Spatial Data Management, Unstructured Databases -MongoDB.

Unit V: Computer Architecture

Computer Architecture: Fundamentals of Quantitative Design and Analysis, Memory Hierarchy Design, Instruction-Level Parallelism and Its Exploitation, Data-Level Parallelism in Vector, SIMD, and GPU Architectures, Thread-Level Parallelism, Warehouse-Scale Computers to Exploit Request-Level and Data-Level Parallelism, Computer Abstractions and Technology, Instructions: Language of the Computer, Instruction set of 80386 Performance, Control Unit and Types, The Processor: Datapath and Control, Enhancing Performance with Pipelining, Large and Fast: Exploiting Memory Hierarchy, Segmentation and Paging in 80386,Storage, Networks, and Other Peripherals, Multiprocessors and Clusters. Multicore Architecture.

Unit VI: Programming and Data Structure

Programming and Data Structure in C: Recursion. Arrays, Stacks, Queues, Linked lists, Trees: Binary Search Trees, Threaded Binary Trees, AVL Trees, B Trees, B+ Trees, Heaps, Graphs and Graph Traversal Techniques, Asymptotic worst case time and space complexity, Sorting Algorithms, Algorithm Design Techniques, Divide and Conquer algorithms, Directories and Contiguous allocation, File maintenance.

Unit VII: Mathematics of Computation

Discrete Mathematics: Propositional and first order logic. Sets, relations, functions, partial orders and lattices. Groups. Graphs: connectivity, matching, coloring. Combinatorics: counting, recurrence relations, generating functions. Linear Algebra: Matrices, determinants, system of linear equations, eigenvalues and eigenvectors, LU decomposition. Calculus: Limits, continuity and differentiability. Maxima and minima. Mean value theorem. Integration. Probability: Random variables. Uniform, normal, exponential, poisson and binomial distributions. Mean, median, mode and standard deviation. Sample space, Classical definition of probability and Axiomatic approach of probability, Addition theorem on probability, Conditional probability, Multiplication theorem on probability Conditional probability and Bayes theorem.

Unit VIII: Artificial Intelligence

Artificial Intelligence, Intelligent Agents, Solving Problems by Searching, Beyond Classical Search, Adversarial Search, Constraint Satisfaction Problems, First- Order Logic, Inference in First-Order Logic, Classical Planning, Planning and Acting in the Real World, Knowledge Representation, Quantifying Uncertainty, Probabilistic Reasoning, Probabilistic Reasoning over Time, Making Simple Decisions, Making Complex Decisions, Learning from Examples, Knowledge in Learning, Learning Probabilistic Models, Reinforcement Learning, Natural Language Processing, Natural Language for Communication, Perception, Robotics, Philosophical Foundations, AI: The Present and Future. Fundamentals of AI, Decision tree, agents, Logical agent ,Baysian theorem and network, ANN(Artificial Neural Networks): Mc Culloch model, perceptron model etc, Application of Drone, robotics, automatic car driving.

Unit IX: Programming Languages and Translators

Compilers and Interpreters, The science of building a compiler, Applications of Compiler Technology, Programming Language basics Compilation Phases, Linear Analysis, Hierarchical Analysis, Lexical analysis, Parsing-top down and bottom-up parsing, syntax-directed translation Intermediate code Generation, code optimization in the context of C programming language.

Unit IX: Computer Graphics

Graphics primitives and Scan conversion, Introduction to OpenGL, Modern Graphics Hardware, Transformation Matrices (2D, 3D Linear transformations, Translation, homogeneous coordinate transformations, Inverses of transformation matrices, Scaling rotation and translation), A 2D and 3D Transformation Library for Graphics, Viewing (Viewing transformations, projective transformations, Perspective projection, Properties of the perspective transform), Ray Tracing, polygon, windowing and clipping, Light, Shading algorithms, Colour Models, curves and fractals, blending function, B-spline and Bezier curve, triadic and coach curve, Textures and Texture Mapping, Animations languages, tools and gaming.

B.O.S. Chairman
School of Computer Engineering