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Ph.D. Entrance Test 2020

Syllabus of Paper- II

Subject: **Computer Science and IT**

Sr. No.	Name of The Unit	Detailing
01	Unit-I: Research Metrology for Computer Science and Technology	**Research Metrology for Computer Science and Technology:** **Introduction:** Research problems, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation, data collection, analysis, research design, interpretation, Necessary instrumentations. **Literature studies:** approaches, analysis; Plagiarism, Research ethics, Classification, analysis, Statistical treatment of collected data. Arithmetic mean, geometric mean, standard deviation, errors, propagation of errors, statistical distribution laws. Quantitative techniques. **Technical writing:** report and Paper writing, Developing a Research Proposal, assessment criteria by a review committee. Citation, Index - Impact Factor, H-index etc. **IPR:** Patents, Designs, Trade and Copyright. Process of Patenting, International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT. **Scope of Patent Rights:** Licensing and transfer of technology. Patent information and databases. Geographical Indications. Ownership of Patents, Author & ownership of Copyright, Administration of Patent System. New developments in IPR; IPR of Computer Software and technology. IPR as Protection Strategy.
02	Unit-II: CSA, DMS, DS,TOC	**Computer System Architecture :** **Digital Logic Circuits and Components, Data Representation:** **Register Transfer and Micro operations:** Register Transfer Language, Bus and Memory Transfers, Arithmetic, Logic and Shift Microoperations. **Basic Computer Organization and Design:** Stored Program Organization and Instruction Codes, Computer Registers, Computer Instructions, Timing and Control, Instruction Cycle, Memory-Reference Instructions, I/O, Interrupt. **Programming the Basic Computer:** Machine Language, Assembly Language, Assembler, Program Loops, Subroutines, Input-Output Programming. **Microprogrammed Control:** Control Memory, Address Sequencing, Design of Control Unit. **Central Processing Unit:** General Register Organization, Stack Organization, Instruction Formats, Addressing Modes, RISC Computer, CISC Computer. **Pipeline and Vector Processing:** Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline, Vector Processing Array Processors.

Input-Output Organization: Peripheral Devices, Input-Output Interface, Asynchronous Data Transfer, Modes of Transfer, Priority Interrupt, DMA, Serial Communication.
Memory Hierarchy and management ,
Multiprocessors: Characteristics of Multiprocessors, Interconnection Structures, Interprocessor Arbitration, Interprocessor Communication and Synchronization, Cache Coherence, Multicore Processors.

Discrete Structures and Optimization:

Mathematical Logic: Propositional and Predicate Logic, Propositional Equivalences, Normal Forms, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference.
Sets and Relations: Set Operations, Representation and Properties of Relations, Equivalence Relations, Partially Ordering.
Counting, Mathematical Induction and Discrete Probability: Basics of Counting, Pigeonhole Principle, Permutations and Combinations, Inclusion-Exclusion Principle, Mathematical Induction, Probability, Bayes' Theorem.
Group Theory: Groups, Subgroups, Semi Groups, Product and Quotients of Algebraic Structures, Isomorphism, Homomorphism, Automorphism, Rings, Integral Domains, Fields, Applications of Group Theory.
 Boolean algebra and Graph Theory;
Optimization: Linear Programming - Mathematical Model, Graphical Solution, Simplex and Dual Simplex Method, Sensitive Analysis; Integer Programming, Transportation and Assignment Models, PERT-CPM: Diagram Representation, Critical Path Calculations.

DATA STRUCTURE:

Data Structures: Arrays and their Applications; Sparse Matrix, Stacks, Queues, Priority Queues, Linked Lists, Trees, Forest, Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree, B Tree, B+ Tree, B* Tree, Data Structure for Sets, Graphs, Sorting and Searching Algorithms; Hashing.
Performance Analysis of Algorithms and Recurrences: Time and Space Complexities; Asymptotic Notation, Recurrence Relations.
Design Techniques: Divide and Conquer; Dynamic Programming, Greedy Algorithms, Backtracking, Branch and Bound.
Graph Algorithms: Breadth-First Search, Depth-First Search, Shortest Paths, Maximum Flow, Minimum Spanning Trees.

Theory of Computation:

Theory of Computation: Formal Language, Non-Computational Problems, Diagonal Argument, Russels's Paradox.
Regular Language Models: Deterministic Finite Automaton (DFA), Non-Deterministic Finite Automaton (NDFA), Equivalence of DFA and NDFA, Regular Languages, Regular Grammars, Regular Expressions, Properties of Regular Language, Pumping Lemma, Non-Regular Languages, Lexical Analysis.
Context Free Language: Pushdown Automaton (PDA), Non-Deterministic Pushdown Automaton (NPDA), Context Free Grammar, Chomsky Normal Form,

		Greibach Normal Form, Ambiguity, Parse Tree Representation of Derivation Trees, Equivalence of PDA's and Context Free Grammars; Properties of Context Free Language. **Turing Machines (TM):** Standard Turing Machine and its Variations; Universal Turing Machines, Models of Computation and Church-Turing Thesis;; Context-Sensitive Languages,.
03	Unit-III: OS, DCCN,DBMS	**Operating System :** **System Software:** Machine, Assembly and High-Level Languages; Compilers and Interpreters; Loading, Linking and Relocation; Macros, Debuggers. **Basics of Operating Systems:** Operating System Structure, Operations and Services; System Calls, Operating-System Design and Implementation; System Boot. **Process Management and Threads:** CPU Scheduling**:** Scheduling Criteria and Algorithms; Thread Scheduling, Multiple-Processor Scheduling, Real-Time CPU Scheduling. **Deadlocks:** Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Avoidance and Detection; Recovery from Deadlock. **Memory and storage Management**: Mass-Storage Structure, Disk Structure, Scheduling and Management, RAID Structure. **File and Input/output Systems:** **Security:** Protection, Access Matrix, Access Control, Revocation of Access Rights, Program Threats, System and Network Threats; Cryptography as a Security Tool, User Authentication, Implementing Security Defenses. **Virtual Machines:** Types of Virtual Machines and Implementations; Virtualization. **Basics of Linux Operating Systems** , **Windows Operating Systems:** **Distributed Systems:** Types of Network based Operating Systems, Network Structure, Communication Structure and Protocols; Robustness, Design Issues, Distributed File Systems. **Data Communication and Computer Networks :** **Data Communication**: Components of a Data Communication System, Simplex, Half-Duplex and Duplex Modes of Communication; Analog and Digital Signals; Noiseless and Noisy Channels; Bandwidth, Throughput and Latency; Digital and Analog Transmission. **Computer Networks**: Network Topologies, Local Area Networks, Metropolitan Area Networks, Wide Area Network, Wireless Networks, Internet. **Network Models**: Layered Architecture, OSI Reference Model and its Protocols; TCP/IP Protocol Suite, Physical, Logical, Port and Specific Addresses; Switching Techniques. **Functions of OSI and TCP/IP Layers**, **World Wide Web (WWW): Basics of www**, Electronic Mail Architecture, SMTP, POP and IMAP; TELNET and FTP. **Network Security**: Malwares, Cryptography and Steganography; Secret-Key Algorithms, Public-Key Algorithms, Digital Signature, Virtual Private Networks, Firewalls. **Mobile Technology**: GSM and CDMA; Services and Architecture of GSM and Mobile Computing;

		Database Management Systems : **Database System Concepts and Architecture:** Data Models, Schemas, and Instances; Three-Schema Architecture and Data Independence; Database Languages and Interfaces; Centralized and Client/Server Architectures for DBMS. **Data Modeling:** Entity-Relationship Diagram, Relational Model - Constraints, Languages, Design, and Programming, Relational Database Schemas, Update Operations and Dealing with Constraint Violations; Relational Algebra and Relational Calculus; Codd Rules. **SQL:** Data Definition and Data Types; **Normalization for Relational Databases:** Functional Dependencies and Normalization; Algorithms for Query Processing and Optimization; Transaction Processing, Concurrency Control Techniques, Database Recovery Techniques, Object and Object-Relational Databases; Database Security and Authorization. **Enhanced Data Models:** Temporal Database Concepts, Multimedia Databases, Deductive Databases, XML and Internet Databases; Mobile Databases, Geographic Information Systems, Genome Data Management, Distributed Databases and Client-Server Architectures.
04	Inter-IV : CD, PL,CG,s/w egg	**Compiler Design:** **Syntax Analysis:** Associativity, Precedence, Grammar Transformations, Top Down Parsing, Recursive Descent Predictive Parsing, LL(1) Parsing, Bottom up Parsing, LR Parser, LALR(1) Parser. **Semantic Analysis:** Attribute Grammar, Syntax Directed Definitions, Inherited and Synthesized Attributes; Dependency Graph, Evaluation Order, S-attributed and L-attributed Definitions; Type-Checking. **Run Time System:** Storage Organization, Activation Tree, Activation Record, Stack Allocation of Activation Records, Parameter Passing Mechanisms, Symbol Table. **Intermediate Code Generation:** Intermediate Representations, Translation of Declarations, Assignments, Control Flow, Boolean Expressions and Procedure Calls. **Code Generation and Code Optimization:** Control-flow, Data-flow Analysis, Local Optimization, Global Optimization, Loop Optimization, Peep-Hole Optimization, and Instruction Scheduling.
		Programing Language: **Language Design and Translation Issues:** Programming Language Concepts, Paradigms and Models, Programming Environments, Virtual Computers and Binding Times, Programming Language Syntax, Stages in Translation, Formal Transition Models. **Elementary Data Types:** Properties of Types and Objects; Scalar and Composite Data Types. **Programming in C:** Tokens, Identifiers, Data Types, Sequence Control, Subprogram Control, Arrays, Structures, Union, String, Pointers, Functions, File Handling, Command Line Arguments, Preprocessors.

Object Oriented Programming: Class, Object, Instantiation, Inheritance, Encapsulation, Abstract Class, and Polymorphism.

Programming in C++: Tokens, Identifiers, Variables and Constants; Data types, Operators, Control statements, Functions Parameter Passing, Virtual Functions, Class and Objects; Constructors and Destructors; Overloading, Inheritance, Templates, Exception and Event Handling; Streams and Files; Multifile Programs.

Computer Graphics:

Computer Graphics: Video-Display Devices, Raster-Scan and Random-Scan Systems; Graphics Monitors, Input Devices, Points and Lines; Line Drawing Algorithms, Mid-Point Circle and Ellipse Algorithms; Scan Line Polygon Fill Algorithm, Boundary-Fill and Flood-Fill.

2-D Geometrical Transforms and Viewing: Translation, Scaling, Rotation, Reflection and Shear Transformations; Matrix Representations and Homogeneous Coordinates; Composite Transforms, Transformations Between Coordinate Systems, Viewing Pipeline, Window to View-Port Coordinate Transformation, Viewing Functions, Line and Polygon Clipping Algorithms.

3-D Object Representation, Geometric Transformations and Viewing: Polygon Surfaces, Quadric Surfaces, Spline Representation, Bezier and B-Spline Curves; Bezier and B-Spline Surfaces; Illumination Models, Polygon Rendering Methods, Viewing Pipeline and Coordinates; General Projection Transforms and Cipping.

Software Engineering:

Software Process Models: Software Process, Generic Process Model – Framework Activity, Process Lifecycle, Prescriptive Process Models, Project Management, Component Based Development, Aspect-Oriented Software Development, Formal Methods, Agile Process Models – Extreme Programming (XP), Adptive Software Development, Scrum, Dynamic System Development Model, Feature Driven Development, Crystal, Web Engineering**.**

Software Requirements: Functional and Non-Functional Requirements; Eliciting Requirements, Developing Use Cases, Requirement Analysis and Modelling; Requirements Review, Software Requirement and Specification (SRS) Document.

Software Design: Abstraction, Architecture, Patterns, Separation of Concerns, Modularity, Information Hiding, Functional Independence, Cohesion and Coupling; Object-Oriented Design, Data Design, Architectural Design, User Interface Design, Component Level Design.

Software Quality: McCall's Quality Factors, ISO 9126 Quality Factors, Quality Control, Quality Assurance, Risk Management, Risk Mitigation, Monitoring and Management (RMMM); Software Reliability.

Estimation and Scheduling of Software Projects: Software Sizing, LOC and FP based Estimations; Estimating Cost and Effort; Estimation Models, Constructive Cost Model (COCOMO), Project Scheduling and Staffing; Time-line Charts.

Software Testing: Verification and Validation; Error, Fault, Bug and Failure; Unit and Integration Tesing; White-box and Black-box Testing; Basis Path Testing, Control Structure Testing, Deriving Test Cases, Alpha and Beta Testing;

		Software Configuration Management: Change Control and Version Control; Software Reuse, Software Re-engineering, Reverse Engineering.
05	**Unit-V: : Artificial Intelligence, Image Processing, Data mining**	

Artificial Intelligence (AI):

Approaches to AI: Turing Test and Rational Agent Approaches; State Space Representation of Problems, Heuristic Search Techniques, Game Playing, Min-Max Search, Fundamentals of search: problem, solution, state space, breadth-first, depth-first, heuristics, A*, local search and optimization procedures.

Knowledge Representation and **Planning: Natural Language Processing**: Grammar and Language; Parsing Techniques, Semantic Analysis and Pragmatics. Multi Agent Systems and Agent ,

Fuzzy Sets: Notion of Fuzziness, Membership Functions, Fuzzification and Defuzzification; Operations on Fuzzy Sets, Fuzzy Functions and Linguistic Variables; Fuzzy Relations, Fuzzy Rules and Fuzzy Inference; Fuzzy Control System and Fuzzy Rule Based Systems.
Genetic Algorithms (GA): Encoding Strategies, Genetic Operators, Fitness Functions and GA Cycle; Problem Solving using GA.

Artificial Neural Networks (ANN): Supervised, Unsupervised and Reinforcement Learning; Single Perceptron, Multi-Layer Perceptron, Self-Organizing Maps, Hopfield Network.

Image Processing:
Digital Image Fundamentals, Image transforms, Image enhancement, Image restoration, Image compression, Image segmentation, representation and description, recognition and interpretation.

Data Mining :
Introduction to Data Mining, Definitions, Origins of Data Mining, Data Mining Tasks, Classification, Clustering, Association Rule Discovery, Sequential Pattern Discovery, Regression, Challenges of Data Mining, Data Mining-Data, Types of data sets, Data Quality, Data Preprocessing, Aggregation, Sampling, Dimensionality Reduction, Feature subset selection, Feature creation, Discretization and Linearization, Attribute Transformation, Density. OLAP , Data Mining Classification, Decision Trees, and Model Evaluation: Classification Techniques, Data Mining Cluster Analysis and algorithms, Applications of Cluster Analysis, Types of Clusters, Clustering Algorithms, Data Mining Anomaly Detection.

Reference Books:

Unit 01:

Research Methodology for Computer Science and Technology:

- Research Methodology (Second Revised Edition) – C.R.Kothari; New Age Publishers.

- Thesis and Assignment Writing – J Anderson, B.H. Dursten and M. Poole,Wiley Eastern.

- Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
- Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
- Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
- Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd.
- Mayall, "Industrial Design", McGraw Hill.
- Niebel, "Product Design", McGraw Hill.
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age".
- T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand.

Unit 02:

Computer System Architecture:

- Computer Architecture: A Quantitative Approach, J. Hennessy, D. Patterson, Pub. Morgan Kaufmann
- Computer Organization and Design, J. Hennessy, D. Patterson, Elsevier India Private Limited

Discrete Structures and Optimization:

- Discrete Mathematics – Seymour Lipschutz
- Discrete Mathematical Structure – Bernard Kolman, Robert C. Busby
- Discrete Math by Tremblay Manohar
- Logic in Computer Science: Modelling and Reasoning about Systems, by Michael Huth ,
- Mark Ryan Cambridge Univeristy Press
- Elements of Numerical Analysis, Peter Henrici, John Wiley & Sons.
- Numerical Linear Algebra, Leslie Fox, Oxford University Press.

Data Structures:

1. Fundamentals of Data Structures, Sartaj Sahni, University Press

2. Data Structures through C, Yashwant Kanetkar, BPB Publications

3. Introduction to Algorithms: Coreman, Leiserson, Revest and Stein, MIT Press

Theory of Computation:

1. Introduction to Automata Theory, Languages and Computation –John E. Hopcroft and Ullman

2. An Introduction to Formal Languages and Automata –Peter Linz

Unit 03:

Operating Systems:

- Operating System Concepts, Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, John Wiley Publication.
- The Design of UNIX Operating System, M. Bach, Pearson Education.

Data Communication and Computer Networks:

- Computer Networks - Andrew S. Tanenbaum, Pearson Education
- Data and Computer Communications -William Stallings

Database Management Systems:

- Database Management Systems, Raghu Ramakrishnan and Johannes Gehrke, McGraw-Hill Higher Education

Unit 04:

Compiler Design:

1. Compilers: Principles, Techniques and Tools –Aho, Lam, Sethi and Ullman

Programming Languages:

1. Principles of Programming Languages Dowek, Gilles

2. Essentials of Programming Languages, Friedman, Wand and Haynes, 2nd or 3rd ed., MIT Press**.**

3. C++ programming language, Bjarne Stroustrup, Addison-Weslwy

Computer Graphics:

1. Introduction to Computer Graphics –Hearn and Baker, Rogers

Software Engineering:

1. Software Engineering: A Practitioners Approach, Pressman, Mc Graw Hill

Unit 05:

Artificial Intelligence:

1. Artificial Intelligence (2nd ed) by Elaine Rich and Kevin Knight, McGraw Hill (1991). ISBN 0-07-100894-2

2. Artificial Intelligence (3rd ed) by P H Winston, Addison-Wesley (1992), ISBN 0-201- 53377-4

3. Artificial Intelligence – a modern approach by Russell and Norvig. Prentice Hall Int 1995 ISBN 0-13-360124-2

4. Artificial Intelligence: a modern approach, S. Russell and P. Norvig, Prentice Hall, ISBN0-13-080302-2

5. Qiangfu ZHAO and Tatsuo Higuchi, Artificial Intelligence: from fundamentals to intelligent searches, Kyoritsu, 2017, ISBN:978-4-320-12419-6 (in Japanese).

Image Processing:

1. Digital Image Processing (4th Edition) 4th Edition by Rafael C. Gonzalez and Richard E. Woods.

2. Fundamental of Digital Image Processing by Anil K Jain , PHI**.**

Data Mining:

- Han, J. and Kamber, M., Data Mining: Concepts and Techniques, 2nd Edition, Morgan Kaufmann.

Name & Signatures of Syllabus Committee:

Sd/-	sd/-	sd/-
Professor Karbhari V Kale	**Professor R R Deshmukh**	**Professor Sachin Deshmukh**
(Chairman)	**(Member)**	**(Member)**

Date: 10/06/2020

Place: Aurangabad.