Ph. D Entrance Examination

COMPUTER SCIENCE & ENGINEERING: PAPER-II

1. **COMPUTER ARCHITECTURE & ORGANIZATION**: Combinational Circuit: adder, subtractor, decoder, MUX etc. Sequential Circuit: Flip-flops, Registers, Counters, Machine Instructions and Addressing Modes, ALU & Data path, Memory interface, I/O Interface, Instruction pipeline, Cache, Main and secondary storage.
2. **COMPUTER NETWORKS**: ISO/OSI stack, LAN technologies, Flow and error control techniques, IPV4, IPV6, TCP/UDP, Routing algorithms, Congestion control, Application layer protocols, Basic concepts of Switches, Bridges, Gateway & Routers, Basic concepts of Network security: Public and private key cryptography, Firewall, Digital signature etc.
3. **OPERATING SYSTEM:** Process, Thread, Inter process Communication, CPU Scheduling, Concurrency control, synchronization, Deadlock, Memory management and Virtual Memory, File system, I/O System Protection and Security.
4. **DATA STRUCTURES:** Overview of Programming in C/C++, Recursion, Parameter Passing, Scope, Binding, Array , Stacks, Queues, Link list, Searching & Sorting Techniques ,Lists and their Applications, Trees: Binary Tree, Properties & Representation, ADT Binary Tree, Binary search Trees, AVL Trees & Applications, Graphs: Representations & Properties, Directed and Undirected graphs, Graph search methods, Path finding Algorithms, Asymptotic notations ,Greedy, Dynamic Approach, Branch and Bound techniques.
5. **THEORY OF COMPUTATION AND COMPILER DESIGN**: Regular Language and Finite Automata, Context free Grammar, Context sensitive Grammar, push down automata, Turing Machine, Undecidabilty, Lexical Analyzer, Parsing Syntax, Direct translation, Runtime environment, Immediate and Target code generation, Code optimization.
6. **DATABASE MANAGEMENT SYSTEM**: Basic concept, ER model, Relationship Model, Relational algebra, Tuple Calculus, Data Base design, Integrity constraint, Normal Forms, Query languages (SQL), File structure, Concurrency Control and Transactions.
7. **SOFTWARE ENGINEERING AND WEB DEVELOPMENT**: Information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding testing, implementation, maintenance. HTML, XML, Scripting and Basic Concept of Client and server side programming. PROBABILITY
8. **THEORY AND DISCRETE MATHEMATICS**: Conditional Probability, Mean, Median, Mode and Standard Deviation, Exponential, Sets, Relations, Functions, Group, Partial Order, Boolean algebra, Propositional and Predicate Logic.
9. **ADVANCE COMPUTING**: Artificial intelligence, Heuristic and blind search, Knowledge base system, Fuzzy logic, fuzzy membership function, Neural network, ANN, Learning rules. Single layer and multilayer neural network, Back Propagation network, Genetic algorithm, Fundamentals, basic concepts, working principle, encoding and fitness function.

Syllabus for Department of Computer Applications

The syllabus is designed to cover fundamental and advanced topics in **Computer Applications** with an emphasis on research-oriented fields. It focuses on contemporary technologies, theoretical concepts, and methodologies.

Unit 1: Mathematical Foundations and Computational Techniques
Linear Algebra: Matrices, eigenvalues, eigenvectors, singular value decomposition. **Probability and Statistics**: Random variables, hypothesis testing, regression analysis. **Optimization**: Linear programming, nonlinear optimization, dynamic programming. **Graph Theory**: Shortest path, minimum spanning trees, graph algorithms in computation.

Unit 2: Advanced Data Structures and Algorithms
Data Structures: Trees, heaps, hash tables, graph representations. **Algorithm Design**: Divide and conquer, dynamic programming, greedy algorithms. **Complexity Analysis**: NP-completeness, approximation algorithms. **Emerging Topics**: Parallel and distributed algorithms.

Unit 3: Database Systems and Data Analytics
Database Management Systems: SQL, NoSQL, database normalization, and indexing. **Big Data**: Hadoop, Spark, and MapReduce concepts. **Data Warehousing and Mining**: OLAP, association rules, clustering, and classification. **Visualization**: Data preprocessing, exploratory data analysis (EDA).

Unit 4: Artificial Intelligence and Machine Learning
AI Concepts: Search algorithms, reasoning, and knowledge representation. **Machine Learning Algorithms**: Linear regression, decision trees, SVM, clustering. **Deep Learning**: Neural networks, CNNs, RNNs, transformers. **Applications**: AI in healthcare, education, and natural language processing.

Unit 5: Software Engineering and DevOps
Software Development Life Cycle (SDLC): Agile methodologies, requirements engineering. **Testing and Quality Assurance**: Unit, integration, system testing, and automation tools. **DevOps Practices**: CI/CD pipelines, containerization (Docker, Kubernetes). **Cloud-Based Development**: Deployment on AWS, Azure, and GCP.

Unit 6: Cybersecurity and Blockchain
Cryptography: Symmetric and asymmetric encryption, hashing, digital signatures. **Network Security**: Firewalls, IDS/IPS, secure communication protocols. **Blockchain Fundamentals**: Smart contracts, consensus mechanisms, cryptocurrency. **Cybersecurity in Practice**: Vulnerability assessment, penetration testing, ethical hacking.

Unit 7: Internet of Things (IoT) and Cloud Computing
IoT Architecture: Sensors, actuators, and IoT communication protocols. **Cloud Computing Fundamentals**: Virtualization, cloud services (IaaS, PaaS, SaaS). **Edge and Fog Computing**: Real-time analytics and applications. **Applications**: Smart cities, industrial automation, IoT-based healthcare.

Unit 8: Emerging Technologies

Quantum Computing: Quantum bits, quantum gates, quantum algorithms. **Augmented and Virtual Reality (AR/VR)**: Tools, applications, and development platforms. **Natural Language Processing (NLP)**: Text mining, sentiment analysis, transformers. **Blockchain for Emerging Applications**: Supply chain, healthcare, and e-governance.

Unit 9: Research Methodology and Tools

Research Problem Identification: Defining problems and objectives. **Literature Review**: Sources, critical analysis, and gap identification. **Data Collection and Analysis**: Qualitative and quantitative methods, statistical tools. **Scientific Writing and Ethics**: Writing research papers, plagiarism, and citations. **Tools**: LaTeX, MATLAB, R, Python for research applications.

Department of Mechanical Engineering (ME)

This syllabus focuses on core areas and advanced topics in Mechanical Engineering, ensuring a strong foundation for research pursuits.

Unit 1: Advanced Solid Mechanics
Stress-strain relationship and elasticity, Failure theories: Maximum stress, strain energy, and distortion energy theories, Plasticity: Yield criteria and hardening models, Fracture mechanics: Crack propagation and stress intensity factor, Fatigue and creep in materials.

Unit 2: Fluid Mechanics and Computational Fluid Dynamics (CFD)
Governing equations: Continuity, momentum, and energy equations, Boundary layer theory and turbulent flow modeling, Numerical techniques: Finite Difference Method (FDM), Finite Volume Method (FVM), Applications: Aerodynamics, microfluidics, and thermal management systems, CFD software tools: ANSYS Fluent, OpenFOAM.

Unit 3: Heat Transfer and Thermal Systems
Modes of heat transfer: Conduction, convection, and radiation, Heat exchangers: Types, design, and analysis, Boiling and condensation phenomena, Thermal insulation and energy-efficient systems. Advanced cooling techniques for electronics and industrial systems.

Unit 4: Advanced Manufacturing Processes
Non-traditional manufacturing: EDM, ECM, laser machining. Additive manufacturing: SLA, SLS, FDM, and metal 3D printing. Micro and nano-manufacturing techniques. Industry 4.0: Digital manufacturing and smart factories. Sustainable manufacturing practices.

Unit 5: Materials Science and Engineering
Advanced materials: Composites, smart materials, and high-temperature alloys. Nanomaterials: Synthesis, properties, and applications. Material characterization techniques: SEM, XRD, TEM. Phase transformations and microstructural evolution. Mechanical properties of advanced materials.

Unit 6: Robotics and Automation
Kinematics and dynamics of robotic manipulators. Sensors and actuators in robotics. Autonomous systems and path planning. Control systems: PID, adaptive, and fuzzy control. Applications in manufacturing and service industries.

Unit 7: Renewable Energy and Sustainability
Solar thermal and photovoltaic systems. Wind and hydropower systems: Design and optimization. Energy storage technologies: Batteries, supercapacitors, and thermal storage. Waste-to-energy systems and biofuels. Lifecycle analysis and carbon footprint assessment.

Unit 8: Design and Optimization
Advanced concepts in machine design: Reliability and fatigue design. Finite Element Analysis (FEA) in structural design. Optimization techniques: Genetic algorithms, simulated annealing,

and neural networks. Multi-objective optimization and design of experiments (DOE). Applications in automotive, aerospace, and biomedical engineering.

Unit 9: Research Methodology

Research problem identification and formulation. Experimental design and data analysis. Statistical tools: Regression, ANOVA, and hypothesis testing. Technical writing, paper publication, and presentation. Ethics in research and intellectual property rights.