

**MAHARSHI DAYANAND UNIVERSITY ROHTAK**

**Syllabus for Ph.D entrance examination**

**(Electronics & Communication Engineering  
Common with Electronic Science)**

**UNIT-I**

Introduction to Semiconductor, energy bands in solids, concept of effective mass, density of states, Fermi levels, PN Junction, Diode equation and diode equivalent circuit, Breakdown in diodes, Zener diode, Tunnel diode, Metal semiconductor junction – Ohmic and Schottky contacts, Characteristics and equivalent circuits of JFET, MOSFET. Low dimensional semiconductor devices – quantum wells, quantum wires, quantum dots. High Electron Mobility Transistor (HEMT), Solar cells – I-V characteristics, fill factor and efficiency, LED, LCD and flexible display devices.

Emerging materials for future Devices: Graphene, Carbon Nano tubes (CNT), ZnO, SiC etc.

**UNIT-II**

IC fabrication – crystal growth, epitaxy, oxidation, lithography, doping, etching, isolation methods, metallization, bonding, Thin film deposition and characterization Techniques: XRD, TEM, SEM, EDX. Thin-film active and passive devices, MOS technology and VLSI, scaling of MOS devices, NMOS and CMOS structures and fabrication, Characteristics of MOS transistors and threshold voltage, NMOS and CMOS inverters, Charge-Coupled Device (CCD) – structure, charge storage and transfer, Basics of VLSI design, stick diagrams, Layout design rules.

**UNIT-III**

Superposition, Thevenin, Norton and Maximum Power Transfer Theorems, Network elements, Network graphs, Nodal and Mesh analysis, Laplace Transform, Fourier Transform and Z-transform, Time and frequency domain response, Passive filters, Two-port Network Parameters : Z, Y, ABCD and h parameters, Transfer functions, Signal representation, State variable method of circuit analysis, AC circuit analysis, Transient analysis, Zero and Poles, Bode Plots.

Continuous time signals, Fourier Series and Fourier transform representations, Sampling theorem and applications, Discrete time signal, Discrete Fourier transform (DFT), Fast Fourier transform (FFT), Basic concepts of digital signal processing, digital filters – IIR, FIR.

**UNIT –IV**

Rectifiers, Voltage regulated ICs and regulated power supply, Biasing of Bipolar junction transistors and FETs, operating point and stability, Amplifiers, Classification of amplifiers, Concept of feedback, Hartley, Colpitt's and Phase Shift oscillators, Operational amplifiers (OPAMP) - characteristics, computational applications, comparators, Schmitt trigger, Instrumentation amplifiers, wave shaping circuits, Phase locked loops, Active filters, Multivibrators, Voltage to frequency convertors (V/F), frequency to voltage convertors (F/V).

parameters, Transfer function analysis, Transient analysis, Continuous time signal, Discrete time signal



## UNIT-V

Logic Families, Logic Gates, Boolean algebra and minimization techniques, Combinational circuits, Programmable Logic Devices (PLD), CPLD, flip-flops, memories, Sequential Circuits: Counters – Ring, Ripple, Synchronous, Asynchronous, Shift registers, multiplexers and demultiplexers, A/D and D/A converters, Analysis and Design of fundamental mode state machines: State variables, State table and State diagram, Sequential PLD, FPGA, Analysis and Design of digital circuits using HDL.

## UNIT-VI

Introduction of Microprocessor 8086: Architecture, Addressing modes, instruction set, interrupts, Programming, Memory and I/O interfacing. Introduction of Microcontrollers – 8051 for embedded systems, Architecture and register set of Microcontroller 8051, Addressing modes, Instruction set of 8051 – Data transfer instructions, Arithmetic instructions, Logic instructions, bit level and byte level control transfer instructions, 8051 assembly programming – stack operations, subroutines, interrupts, 8051 programming as timer/counter, 8051 serial communication, 8051 interfacing RS232, LED/LCD display, Keyboard, Stepper motor.

## UNIT-VII

Electrostatics - vector calculus, Gauss's Law, Laplace and Poisson's equations, Magnetostatics – Biot Savart's law, Ampere's law and electromagnetic induction, Maxwell's equations and wave equations, Plane wave propagation in free space, dielectrics and conductors, Poynting theorem, Reflection and refraction, polarization, interference, coherence and diffraction, Transmission lines and waveguides – line equations, impedance, reflections and voltage standing wave ratio, rectangular waveguides. Antennas – retarded potential and Hertzian dipole, half wave antenna, antenna patterns, radiation intensity, gain, effective area and Frii's free space receiver power equation.

Microwave Sources and Devices -Reflex Klystron, Magnetron, TWT, Gunn diode, IMPATT diode, Crystal Detector and PIN diode.

Radar – block diagram of Radar, frequencies and power used, Radar range equation.

## UNIT-VIII

Analog modulation and demodulation - AM, FM and PM, Principle of super heterodyne receiver, Random signals, noise, noise temperature and noise figure, Basic concepts of information theory, Error detection and correction, Digital modulation and demodulation – PCM, ASK, FSK, PSK, BPSK, QPSK and QAM, Time and Frequency-Division Multiplexing, Multiple Access techniques, Data Communications – Modems, Codes, Principles of Mobile and Satellite Communication, Optical communication, Optical sources - LED, spontaneous and stimulated emission, semiconductor Lasers, Detectors – PIN photodiodes, Avalanche photodiodes (APD), Optical fibers – attenuation and dispersion characteristics, Bandwidth, Wavelength division multiplexing. Fundamentals of Internet of Things (IoT) for communication.



## UNIT-IX

Power devices – characteristics of SCR, DIAC, TRIAC, power transistors, Protection of thyristors against over voltage and over current. SCR triggering -  $dv/dt$  and  $di/dt$ , triggering with single pulse and train of pulses, A.C. and D.C. motors - construction and speed control. Switched Mode Power Supply (SMPS). Uninterrupted Power Supply (UPS).

Open loop and closed loop control system, Block Diagram reduction techniques, transfer function and signal flow diagram, Stability criterion: Routh-Hurwitz and Nyquist plot, On-off controller, Proportional (P), Proportional-Integral (PI), Proportional-Derivative (PD), PID controllers.

## UNIT – X

Transducers – Resistance, Inductance, Capacitance, Piezoelectric, Thermoelectric, Hall effect, Photoelectric, Measurement of displacement, velocity, acceleration, force, torque, strain, temperature, pressure, flow, humidity, thickness, pH. Measuring Equipment – Measurement of R, L and C, Bridge and Potentiometers, voltage, current, power, energy, frequency/time, phase, Digital Multimeters, CRO, Digital Storage Oscilloscope, Spectrum Analyzer., Biomedical Instruments – ECG, EEG, Blood Pressure Measurements, MEMS and its applications Sensors for IoT applications.





**Syllabus for Ph.D entrance examination**  
**(Electrical Engineering)**

**Section 1:**

**Engineering Mathematics**

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigenvalues, Eigenvectors.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, Median, Mode, Standard Deviation, Random variables, Discrete and Continuous distributions, Poisson distribution, Normal distribution, Binomial distribution, Correlation analysis, Regression analysis.

Numerical Methods: Solutions of nonlinear algebraic equations, Single and Multi-step methods for differential equations. Transform Theory: Fourier Transform, Laplace Transform, z-Transform.

**Electrical Engineering**

**Section 2: Electric Circuits**

Network graph, KCL, KVL, Node and Mesh analysis, Transient response of dc and ac networks, Sinusoidal steady-state analysis, Resonance, Passive filters, Ideal current and voltage sources, Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem, Two-port networks, Three phase circuits, Power and power factor in ac circuits.

**Section 3: Electromagnetic Fields**

Coulomb's Law, Electric Field Intensity, Electric Flux Density, Gauss's Law, Divergence, Electric field and potential due to point, line, plane and spherical charge distributions, Effect of dielectric medium, Capacitance of simple configurations, Biot-Savart's law, Ampere's law, Curl, Faraday's law, Lorentz force, Inductance, Magnetomotive force, Reluctance, Magnetic circuits, Self and Mutual inductance of simple configurations.

**Section 4: Electrical Machines**

Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three phase transformers: connections, parallel operation; Auto-transformer, Electromechanical energy conversion principles, DC machines: separately excited, series and shunt, motoring and generating mode of operation and their characteristics, starting and speed control of dc motors; Three phase induction motors: principle of operation, types, performance, torque-speed characteristics, no-load and blocked rotor tests, equivalent circuit, starting and speed control; Operating principle of single phase induction motors; Synchronous machines: cylindrical and salient pole machines, performance, regulation and parallel operation of generators, starting of synchronous motor, characteristics; Types of losses and efficiency calculations of electric machines.



## Section 5: Power Systems

Power generation concepts, ac and dc transmission concepts, Models and performance of transmission lines and cables, Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per-unit quantities, Bus admittance matrix, Gauss-Seidel and Newton-Raphson load flow methods, Voltage and Frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis, Principles of over-current, differential and distance protection; Circuit breakers, System stability concepts, Equal area criterion.

## Section 6: Control Systems

Mathematical modeling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and Steady-state analysis of linear time invariant systems, Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Stability analysis, Lag, Lead and Lead-Lag compensators; P, PI and PID controllers; State space model,

## Section 7: Electrical and Electronic Measurements

Bridges and Potentiometers, Measurement of voltage, current, power, energy and power factor; Instrument transformers, Digital voltmeters and multimeters, Phase, Time and Frequency measurement; Oscilloscopes, Error analysis.

## Section 8: Analog and Digital Electronics

Characteristics of diodes, BJT, MOSFET; Simple diode circuits: clipping, clamping, rectifiers; Amplifiers: Biasing, Equivalent circuit and Frequency response; Oscillators and Feedback amplifiers; Operational amplifiers: Characteristics and applications; Simple active filters, VCOs and Timers, Combinational and Sequential logic circuits, Multiplexer, Demultiplexer, Schmitt trigger, Sample and hold circuits, A/D and D/A converters, 8085 Microprocessor: Architecture, Programming and Interfacing.

## Section 9: Power Electronics

Characteristics of semiconductor power devices: Diode, Thyristor, Triac, GTO, MOSFET, IGBT; DC to DC conversion: Buck, Boost and Buck-Boost converters; Single and three phase configuration of uncontrolled rectifiers, Line commutated thyristor based converters, Bidirectional ac to dc voltage source converters, Issues of line current harmonics, Power factor, Distortion factor of ac to dc converters, Single phase and three phase inverters, Sinusoidal pulse width modulation.





# SYLLABUS FOR ENTRANCE EXAMINATION (Ph.D. CIVIL ENGINEERING)

## Structural Engineering

**Engineering Mechanics:** equilibrium equations; Internal forces in structures; Friction and its applications; Kinematics of point mass and rigid body; Centre of mass  
**Structural Analysis:** Statically determinate and indeterminate structures by force/energy methods; Analysis of trusses, arches, beams, cables and frames; Displacement methods; Influence lines; **Construction Materials and Management:** Construction Materials, material properties and behaviour; mix design, short-term and long-term properties. Construction Management: Types of construction Tendering and construction contracts; Rate analysis, Cost estimation; **Concrete Structures:** Working stress, Limit state and Ultimate load design concepts; Design of beams, slabs, columns; Bond and development length; **Steel Structures:** Working stress and Limit state design concepts; beams and beam- columns, column bases; Connections - simple and eccentric.

## Geotechnical Engineering

**Soil Mechanics:** Three-phase system and phase relationships, index properties; soil classification system; Permeability, Darcy's law; Seepage through soils, uplift pressure, piping; Principle of effective stress, capillarity, seepage force and quicksand condition; Compaction in laboratory and field conditions; One- dimensional consolidation, time rate of consolidation; Mohr's circle, stress paths, effective and total shear strength parameters, characteristics of clays and sand. **Foundation Engineering:** Sub-surface investigations - plate load test, standard penetration and cone penetration tests; Earth pressure theories Stress distribution in soils, pressure bulbs; Shallow foundations - Terzaghi's , effect of water table; Combined footing and raft foundation; Contact pressure; Settlement analysis in sands and clays; Deep foundations , load capacity of piles in sands and clays, pile load test, negative skin friction.

## Water Resources Engineering

**Fluid Mechanics:** Properties of fluids, fluid statics; types of flow; Flow in pipes Concept of boundary layer and its growth. **Hydraulics:** Forces on immersed bodies; Flow measurement in channels and pipes; Dimensional analysis and hydraulic similitude; Channel Hydraulics - Energy-depth relationships, specific energy, slope profile, uniform flow and gradually varied flow

**Hydrology:** precipitation, evaporation, evapo-transpiration, unit hydrographs, hydrograph analysis, flood estimation and routing, surface run-off models, ground water hydrology , Application of Darcy's law.

**Irrigation:** Duty, delta, estimation of evapo-transpiration; Design of lined and unlined canals, head works, Types of irrigation systems, irrigation methods; Water logging and drainage; Canal regulatory works, cross-drainage structures, outlets and escapes.



## **Environmental Engineering**

**Water and Waste Water:** Quality standards,. Drinking water standards, basic unit operations and unit processes for surface water treatment, distribution of water. Sewage and sewerage treatment, quantity and characteristics of wastewater. effluent discharge standards. Domestic wastewater treatment. **Air Pollution, Noise Pollution**

## **Transportation Engineering**

**Transportation Infrastructure:** Highway alignment and engineering surveys; Geometric design of highways - cross-sectional elements, sight distances, horizontal and vertical alignments; **Highway Pavements:** Highway materials - desirable properties and quality control tests; Design of bituminous paving mixes; Design factors for flexible and rigid pavements; Design of flexible pavement using IRC: 37-2012; Design of rigid pavements. **Traffic Engineering:** Traffic studies on flow, speed, travel time - delay and O-D study, PCU, peak hour factor, parking study, accident study and analysis, statistical analysis of traffic data; Microscopic and macroscopic parameters of traffic flow, fundamental relationships; Control devices, signal design by Webster's method; Types of intersections and channelization; Highway capacity and level of service of rural highways and urban roads.

## **Geomatics Engineering**

Principles of surveying; Errors and their adjustment; Maps - scale, coordinate system; Distance and angle measurement - Levelling and trigonometric levelling; Traversing and triangulation survey; Total station; Horizontal and vertical curves. Photogrammetry - scale, flying height; Remote sensing - Basics of Geographical information system (GIS) and Geographical Positioning system (GPS).





**Syllabus for Ph.D entrance examination**

**Subject : Computer Science & Engineering Common With  
Computer Science And Applications**

**Unit - 1 : 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.

**Graph Theory:** Simple Graph, Multigraph, Weighted Graph, Paths and Circuits, Shortest Paths in Weighted Graphs, Eulerian Paths and Circuits, Hamiltonian Paths and Circuits, Planner graph, Graph Coloring, Bipartite Graphs, Trees and Rooted Trees, Prefix Codes, Tree Traversals, Spanning Trees and Cut-Sets.

**Boolean Algebra:** Boolean Functions and its Representation, Simplifications of Boolean Functions.

**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, Resource Levelling, Cost Consideration in Project Scheduling.

**Unit - 2 : Computer System Architecture**

**Digital Logic Circuits and Components:** Digital Computers, Logic Gates, Boolean Algebra, Map Simplifications, Combinational Circuits, Flip-Flops, Sequential Circuits, Integrated Circuits, Decoders, Multiplexers, Registers and Counters, Memory Unit.

**Data Representation:** Data Types, Number Systems and Conversion, Complements, Fixed Point Representation, Floating Point Representation, Error Detection Codes, Computer Arithmetic - Addition, Subtraction, Multiplication and Division Algorithms.

**Register Transfer and Microoperations:** 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, Input-Output, Interrupt.

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**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:** Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Virtual Memory, Memory Management Hardware.

**Multiprocessors:** Characteristics of Multiprocessors, Interconnection Structures, Interprocessor Arbitration, Interprocessor Communication and Synchronization, Cache Coherence, Multicore Processors.

### **Unit - 3 : Programming Languages and Computer Graphics**

**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, 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.

**Web Programming:** HTML, DHTML, XML, Scripting, Java, Servlets, Applets.

**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, Viewing

Coordinate Reference Frame, 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 Clipping.

## **Unit – 4 : 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; Constraints, Queries, Insert, Delete, and Update Statements; Views, Stored Procedures and Functions; Database Triggers, SQL Injection.

**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.

**Data Warehousing and Data Mining:** Data Modeling for Data Warehouses, Concept Hierarchy, OLAP and OLTP; Association Rules, Classification, Clustering, Regression, Support Vector Machine, K-Nearest Neighbour, Hidden Markov Model, Summarization, Dependency Modeling, Link Analysis, Sequencing Analysis, Social Network Analysis.

**Big Data Systems:** Big Data Characteristics, Types of Big Data, Big Data Architecture, Introduction to Map-Reduce and Hadoop; Distributed File System, HDFS.

**NOSQL:** NOSQL and Query Optimization; Different NOSQL Products, Querying and Managing NOSQL; Indexing and Ordering Data Sets; NOSQL in Cloud.

## **Unit – 5 : System Software and 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:** Process Scheduling and Operations; Interprocess Communication, Communication in Client-Server Systems, Process Synchronization, Critical-Section Problem, Peterson's Solution, Semaphores, Synchronization.

**Threads:** Multicore Programming, Multithreading Models, Thread Libraries, Implicit Threading, Threading Issues.



**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 Management:** Contiguous Memory Allocation, Swapping, Paging, Segmentation, Demand Paging, Page Replacement, Allocation of Frames, Thrashing, Memory-Mapped Files.

**Storage Management:** Mass-Storage Structure, Disk Structure, Scheduling and Management, RAID Structure.

**File and Input/Output Systems:** Access Methods, Directory and Disk Structure: File-System Mounting, File Sharing, File-System Structure and Implementation; Directory Implementation, Allocation Methods, Free-Space Management, Efficiency and Performance; Recovery, I/O Hardware, Application I/O Interface, Kernel I/O Subsystem, Transforming I/O Requests to Hardware Operations.

**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.

**Linux Operating Systems:** Design Principles, Kernel Modules, Process Management, Scheduling, Memory Management, File Systems, Input and Output; Interprocess Communication, Network Structure.

**Windows Operating Systems:** Design Principles, System Components, Terminal Services and Fast User Switching; File System, Networking.

**Distributed Systems:** Types of Network based Operating Systems, Network Structure, Communication Structure and Protocols; Robustness, Design Issues, Distributed File Systems.

## **Unit – 6 : Software Engineering**

**Software Process Models:** Software Process, Generic Process Model – Framework Activity, Task Set and Process Patterns; Process Lifecycle, Prescriptive Process Models, Project Management, Component Based Development, Aspect-Oriented Software Development, Formal Methods, Agile Process Models – Extreme Programming (XP), Adaptive 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.

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**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 Testing; White-box and Black-box Testing; Basis Path Testing, Control Structure Testing, Deriving Test Cases, Alpha and Beta Testing; Regression Testing, Performance Testing, Stress Testing.

**Software Configuration Management:** Change Control and Version Control; Software Reuse, Software Re-engineering, Reverse Engineering.

## **Unit – 7 : Data Structures and Algorithms**

**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.

**Lower Bound Theory:** Comparison Trees, Lower Bounds through Reductions.

**Graph Algorithms:** Breadth-First Search, Depth-First Search, Shortest Paths, Maximum Flow, Minimum Spanning Trees.

**Complexity Theory:** P and NP Class Problems; NP-completeness and Reducibility.

**Selected Topics:** Number Theoretic Algorithms, Polynomial Arithmetic, Fast Fourier Transform, String Matching Algorithms.

**Advanced Algorithms:** Parallel Algorithms for Sorting, Searching and Merging, Approximation Algorithms, Randomized Algorithms.

## **Unit – 8 : Theory of Computation and Compilers**

**Theory of Computation:** Formal Language, Non-Computational Problems, Diagonal Argument, Russell'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; Recursive and Recursively-Enumerable Languages; Context-Sensitive Languages, Unrestricted Grammars, Chomsky Hierarchy of Languages, Construction of TM for Simple Problems.

**Unsolvable Problems and Computational Complexity:** Unsolvable Problem, Halting Problem, Post Correspondence Problem, Unsolvable Problems for Context-Free Languages, Measuring and Classifying Complexity, Tractable and Intractable Problems.

**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, Instruction Scheduling.

## **Unit – 9 : 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; Data Encoding and Modulation Techniques; Broadband and Baseband Transmission; Multiplexing, Transmission Media, Transmission Errors, Error Handling Mechanisms.

**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:** Framing, Error Detection and Correction; Flow and Error Control; Sliding Window Protocol, HDLC, Multiple Access – CSMA/CD, CSMA/CA, Reservation, Polling, Token Passing, FDMA, CDMA, TDMA, Network Devices, Backbone Networks, Virtual LANs.

IPv4 Structure and Address Space; Classful and Classless Addressing; Datagram, Fragmentation and Checksum; IPv6 Packet Format, Mapping Logical to Physical Address (ARP), Direct and Indirect Network Layer Delivery; Routing Algorithms, TCP, UDP and SCTP Protocols; Flow Control, Error Control and Congestion Control in TCP and SCTP.



**World Wide Web (WWW):** Uniform Resource Locator (URL), Domain Name Service (DNS), Resolution - Mapping Names to Addresses and Addresses to Names; 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; Middleware and Gateway for Mobile Computing; Mobile IP and Mobile Communication Protocol; Communication Satellites, Wireless Networks and Topologies; Cellular Topology, Mobile Adhoc Networks, Wireless Transmission and Wireless LANs; Wireless Geolocation Systems, GPRS and SMS.

**Cloud Computing and IoT:** SaaS, PaaS, IaaS, Public and Private Cloud; Virtualization, Virtual Server, Cloud Storage, Database Storage, Resource Management, Service Level Agreement, Basics of IoT.

## **Unit – 10 : 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, Alpha Beta Cutoff Procedures.

**Knowledge Representation:** Logic, Semantic Networks, Frames, Rules, Scripts, Conceptual Dependency and Ontologies; Expert Systems, Handling Uncertainty in Knowledge.

**Planning:** Components of a Planning System, Linear and Non Linear Planning; Goal Stack Planning, Hierarchical Planning, STRIPS, Partial Order Planning.

**Natural Language Processing:** Grammar and Language; Parsing Techniques, Semantic Analysis and Pragmatics.

**Multi Agent Systems:** Agents and Objects; Agents and Expert Systems; Generic Structure of Multiagent System, Semantic Web, Agent Communication, Knowledge Sharing using Ontologies, Agent Development Tools.

**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.





## Syllabus for Entrance Test for admission in Ph.D Mechanical Engineering

**APPLIED MECHANICS, STRENGTH OF MATERIALS AND DESIGN** :Engineering Mechanics: Free body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion, including impulse and momentum (linear and angular) and energy formulations; impact. Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of columns; strain energy methods; thermal stresses. Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of slider-crank mechanism; gear trains; flywheels.

**FLUID MECHANICS AND THERMAL SCIENCES** Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc. Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods. Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; Carnot cycle, irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion.

**PRODUCTION ENGINEERING and MANUFACTURING TECHNOLOGY** Metal Casting: Design of patterns, moulds and cores; solidification and cooling; riser and gating design, design considerations. Forming: Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy. Joining: Physics of welding, brazing and soldering; adhesive bonding; design considerations in welding. Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, principles of design of jigs and fixtures, Non-conventional machining. Welding processes friction stir processing, friction stir welding, TIG welding, MIG welding, SAW welding and all advanced welding processes

**INDUSTRIAL ENGINEERING** :Production Planning and Control: Forecasting models, aggregate production planning, scheduling, materials requirement planning. Inventory Control: Deterministic and probabilistic models; safety stock inventory control systems. Operations Research: Linear programming, simplex and graphical method, transportation model, assignment model, network flow models, simple queuing models, PERT and CPM. Supply Chain Management.

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