Asst Executive Engineer (AEE)

(Civil/Mechanical/Electrical)

Syllabus

Civil Engineering Syllabus.

Paper I

1. **SOLID MECHANICS:-** Elastic constants, plane stress, plane strain, Mohr's circle, combined stress; Elastic theories of failure; Simple bending, Shear; Torsion of circular and rectangular sections and simple members. Bending Moment and Shear Force in statically determinate beams.

2. **STRUCTURAL ANALYSIS:-** Analysis of determinate structures - different methods including graphical methods. Analysis of indeterminate skeletal frames - moment distribution, slope deflection, stiffness and force methods, energy methods, Muller-Breslau principle and application. Plastic analysis of indeterminate beams and simple frames - shape factors. Basic concepts of matrix method of structural analysis

3. **DESIGN OF CONCRETE STRUCTURES:-** Limit state design for bending, shear, axial compression and combined forces. Codal provisions for slabs, beams, walls and footings.
Principles of prestressed concrete design, materials, methods of prestressing, losses. Design of simple members.

4. **DESIGN OF STEEL STRUCTURES (Based on Limit State Method):-** Analysis and design of tension and compression members, Column bases, Connections- simple and eccentric beam-column connections. Plate girders and trusses.

5. **BUILDING MATERIALS and BUILDING CONSTRUCTION:-**

(a) **Building Materials:-** *Cement:* Components, different types, setting times, strength. *Cement Mortar:* Ingredients, proportions, water demand, mortars for plastering and masonry.
Concrete: Importance of W/C Ratio, Strength, ingredients including admixtures, workability, testing for strength, non-destructive testing, mix design methods. *Bricks:* Types, Indian Standard classification, absorption, saturation factor, strength in masonry.

(b) **Building Construction:-** Types of Foundations, Brick masonry, Stone masonry, Floorings, Causes and prevention of cracks in buildings, Damp proofing, Special maintenance of buildings.

6. **ESTIMATION, CONSTRUCTION PLANNING AND MANAGEMENT:-** Preliminary estimate, Detailed estimate, Specifications and cost analysis. Bar chart, Linked bar chart, Work-breakdown structures, Activity- on – arrow diagrams, critical path, probabilistic activity durations, Event- based networks, PERT networks; Time- cost study, Resource allocation.

Paper II

1. **WATER RESOURCES AND HYDRAULIC ENGINEERING:-**

(a) **Irrigation Engineering:-** Consumptive use of water, irrigation systems, water demand assessment; Storages and their yields, ground water and well hydraulics; Waterlogging, drainage design; Design of rigid boundary canals, Lacey's and Tractive force concepts in canal design, lining of canals; Sediment transport in canals; Forces acting on gravity dams and their design, Design of headworks, distribution works, falls, Cross-drainage works, outlets; River training

(b) **Hydrology:-** Hydrological cycle, precipitation and related data analyses, Probable maximum precipitation, unit hydrograph and synthetic unit hydrographs; Evaporation and transpiration; Floods and their management, Design Flood, Streams and their gauging; Routing of floods; Capacity of Reservoirs.

(c) **Fluid Mechanics**:- Fluid Properties, Pressure, Thrust, Buoyancy; Flow Kinematics; Integration of flow equations; Flow measurement; Relative motion; Moment of momentum; Viscosity, Boundary layer and Control, Dimensional Analysis,Flow development, losses in pipe flows, Pipe networks, Flow measuring equipment and structures.

(d) **Open Channel Flow**:- Momentum and Energy principles in Open channel flow, Types of flow, Flow sections and properties; Normal flow, Gradually varied flow,Hydraulic jump.

2. ENVIRONMENTAL ENGINEERING

(a) **Water Supply Engineering**:- Sources of supply, design of intakes, Estimation of demand; Water quality standards; Primary and secondary treatment, detailing and maintenance of treatment units; Conveyance of treatment units; distribution systems of treated water, leakages and control; Institutional and industrial water supply.

(b) **Waste Water Engineering**:- Urban rain water disposal;Quantity and characteristics of waste water, Collection of waste water, Primary, Secondary and tertiary treatment of waste water, Sludge disposal, effluent discharge standards, Institutional and industrial sewage management.

(c) **Solid Waste Management**:- Characteristics, Generation, Collection and Transportation, Engineered systems of solid waste management (reuse, recycle, recovery, treatment and disposal). Design and Management of landfills.

(d) **Airand Noise Pollution**:- *Air pollution*: sources and impacts, air pollution controls, standards and limits. *Noise pollution*- impacts of noise, permissible limits, measurements and control of noise pollution.

3. GEOTECHNICAL ENGINEERING:-

(a) **Soil Mechanics**:- Fundamental definitions and interrelationships; Properties and Classification of soils, Permeability and seepage, Effective stress principles, Shear strength, Consolidation, Compaction, stress distribution in soils.

(b) **Foundation Engineering**:- Types of foundations, Foundation design requirements, Shallow foundations - bearing capacity, settlement analysis in sands and clays, Deep foundations- pile types, dynamic and static formulae, load carrying capacity of piles in sands and clays, group action, negative skinfriction , Earth pressure theories, effect of water table, layered soils, Stability of slopes, Sub-surface investigations- scope, drilling bore holes, sampling, penetration tests, plate load tests, geophysical tests.

4. TRANSPORTATION ENGINEERING:-

(a) **Highway Engineering**:- Geometric design of highways, Testing and specifications of paving materials, design of flexible and rigid pavements

(b) **Traffic Engineering**:- Traffic characteristics, theory of traffic flow, intersection design, traffic signs and signal design, highway capacity.

5. SURVEYING:- Principles and classification of surveys, mapping concepts, Coordinate systems, Measurement of distance and directions, Levelling, Theodolite traversing, Contours, Plane table surveying, Errors and adjustments, Curves, Total station, Concept of Global Positioning System; Photogrammetry and Remote Sensing concepts.

Distribution of Marks for Civil Engineering

Paper – I

Number of multiple choice questions:

1. Solid Mechanics – 40
2. Structural Analysis – 40
3. Design of concrete structure – 30
4. Design of steel structure – 20
5. Building Material and Building Construction – 30
6. Estimation, Construction Planning and Management – 20

Total number of questions – 180. Duration of Examination – 3 hours.
Each question carries one mark. **Negative marking system with deduction of 0.25 mark for every wrong answer.**

Paper – II

Number of multiple choice questions:

1. Water Resources and Hydraulic Engineering – 50
2. Environmental Engineering – 30
3. Geotechnical Engineering – 50
4. Transportation Engineering – 30
5. Surveying – 20

Total number of questions – 180. Duration of Examination – 3 hours.
Each question carries one mark. **Negative marking system with deduction of 0.25 mark for every wrong answer.**

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Mechanical Engineering Syllabus.
Paper-I

1. Theory of Machines:- Kinematic chain, Mechanisms and inversions, Motor Vehicle steering gears, Hookes' Joint, Toothed gears, Tooth profiles, Interference, Gear Trains, Compound gears, Differential, Cam profiles, Displacement, velocity and acceleration of cam followers, Flywheel and Turning moment diagram.

Governors, Stability, Sensitivity, Isochronism and hunting, Governor effort and power, Controlling force and effect of friction, Balancing of revolving masses.

Balancing of single and multicylinder engines, Friction and lubrication, Hydrodynamic theory of lubrication, Linear free and forced vibration of single and two degree freedom mechanical systems with or without damping, Critical speeds and whirling of shafts, Vibration of beams, Torsional vibration.

2. Machine Design:- Design of Joints: Cotters, Keys, splines, welded joints, threaded joints, threaded fastners, joints formed by interference fits, Design of friction drives: coupling and clutches, belt and chain drives, power screws.

Design of power transmission systems: gears and gear drives shaft and axle, wire ropes, Design of bearings: hydrodynamic bearings and rolling element bearings.

3. Mechanics of Solids:- Stress and strain for materials in tension, compression and shear, Relation between elastic constants for an isotropic, linear elastic and homogeneous materials, Uniaxial Loading, Thermal stresses, Stress-strain diagrams for ductile and brittle materials, Stress and strain in two dimensions, Principal planes, Mohr's circle, Strain rosette. Bending moment and shear force diagrams. Composite beams. Bending stresses, Shear stress distribution. Slope and deflection in beams. Torsion of circular shafts. Helical springs. Combined stresses. Theories of failure. Thick and thin walled pressure vessels, shrink-fit. Struts and columns. Energy principles. Strain energy due to bending, twisting and axial load. Castigliano's theorem. Reciprocal Theorem. Slope and deflection by energy methods.

4. Engineering Materials:- Basic concepts on structure of solids, Crystalline materials, Defects in crystalline materials, Alloys and binary phase diagrams, structure and properties of common engineering materials. Iron-carbon equilibrium diagram, TTT-diagram. Heat treatment of steels, Plastics, Ceramics and composite Materials, Common applications of various materials.

5. Manufacturing Science:- Basic principles of forging, drawing, extrusion and rolling, Pattern, Gating and risering system, casting defects, special casting process, welding: Gas welding, arc welding, resistance welding, thermit welding. Cutting tool materials, Tool geometry and nomenclature ASA, ORS and NRS, types of chips, cutting variables, Chip reduction coefficient, Merchant's force diagram, velocity relationship and Kronenberg's relationship. Ernest & Merchant angle relationship, Lee-shafer relationship-cutting fluid, Tool wear, Taylor's tool life equation, Drilling, Milling and boring, Gear Manufacturing, Economics of metal machining, Jigs and fixtures. Fits and Tolerances, NC, CNC, ECM, EDM, AJM, USM, LBM, Plasma machining, High energy rate forming.

6. Manufacturing Management:- Production Planning and Control, Forecasting-Moving average, exponential smoothing, Operations scheduling; assembly line balancing. Product development. Breakeven analysis, Capacity planning. PERT and CPM. Control Operations: Inventory control-ABC analysis. EOQ model. Materials requirement planning. Job design, Job standards, work measurement, Quality management-Quality control. Operations Research: Linear programming Graphical and Simplex methods. Transportation and assignment models. Single server queuing model. Value Engineering: Value analysis for cost/value. Total quality management and forecasting techniques. Project management.

Paper-II

1. **Thermodynamic Cycles:-** Basic concepts. Open and closed systems, Applications of laws of Thermodynamics, (Zeroeth, First and Second Laws), Gas equations, Clapeyron equation, Availability, Irreversibility and Tds relations, reciprocating air compressors.

2. **I.C. Engines, Fuels and Combustion:-** Spark ignition and compression ignition engines, Two stroke and Four stroke engines, mechanical, thermal and volumetric efficiency, Heat balance. Combustion process in S.I. and C.I. engines, preignition detonation in S.I. engine, Diesel knock in C.I. engine, Choice of engine fuels, Octane and Cetane ratings. Alternate fuels, Carburetion and Fuel injection, Engine emissions and control. Solid, liquid and gaseous fuels, stoichometric air requirements and excess air factor, fuel gas analysis, higher and lower calorific values and their measurements.

3. **Heat Transfer, Refrigeration and Air Conditioning:-** One and two dimensional heat conduction, Heat transfer from extended surfaces, Heat transfer by forced and free convection. Heat exchangers. Overall heat transfer coefficient, Fundamentals of diffusive and convective mass transfer, Radiation laws, heat exchange between black and non black surfaces, Network Analysis. Heat pump, refrigeration cycles (Air refrigeration, vapour compression and absorption refrigeration) and systems, Condensers, evaporators and expansion devices and controls. Properties and choice of refrigerant, Refrigeration Systems and components, psychometrics, comfort indices, cooling load calculations, solar refrigeration.

4. **Fluid Mechanics:-** Properties and classification of fluids, Manometry, Forces on immersed surfaces, Center of pressure, Buoyancy, Elements of stability of floating bodies, Kinematics and dynamics: Continuity, Momentum and Energy Equations, Irrotational flow and incompressible, Inviscid flow, Velocity potential, Pressure field and forces on immersed bodies, Bernoulli's equation, Fully developed flow through pipes, Pressure drop calculations, Measurement of flow rate and Pressure drop, Elements of boundary layer theory, Integral approach, Laminar and turbulent flows, Separations, Flow over weirs and notches, Open channel flow, Hydraulic jump, Dimensionless numbers, Dimensional analysis, Similitude and modelling, One-dimensional isentropic flow, Flow through convergent-divergent ducts. Adiabatic and Isentropic flow, fanno lines, Rayleigh lines.

5. **Fluid Machineries and Power Plants:-** Theory and design of axial flow turbines and compressors, Reciprocating and centrifugal pumps, Impulse and Reaction turbines, Specific speed, Classification, Energy transfer, Flow through turbo-machine blades, cascades, centrifugal compressor. Dimensional analysis and modelling. Steam generators, Fire-tube and water tube boilers, Flow of steam through nozzles and diffusers, wetness and condensation, various types of steam and gas turbines, Selection of site for steam, hydro, nuclear and stand-by power plants, Selection base and peak load power plants, Modern High pressure, High duty boilers, Draft and dust removal equipment, Fuel and cooling water systems, heat balance, station and plant heat rates, operation and maintenance of various power plants, preventive maintenance, economics of power generation.

Distribution of Marks for Mechanical Engineering

Paper-I

Number of multiple choice questions to be prepared:

1. Theory of Machines: 30
2. Machine Design: 30
3. Mechanics of Solids: 30
4. Engineering Materials: 30
5. Manufacturing Science: 30
6. Manufacturing Management: 30

Total number of questions: 180, Time: 3 Hours, Each question carries one mark. **Negative marking system with deduction of 0.25 mark for every wrong answer.**

Paper-II

Number of multiple choice questions to be prepared:

1. Thermodynamics Cycles:		10
2. I.C. Engines, Fuels and Combustion:		30
3. Heat Transfer, Refrigeration and Air Conditioning: (10+10+10)		60
4. Fluid Mechanics:		40
5. Fluid Machineries and Power Plants:		40

Total number of questions: 180, Time: 3 Hours, Each question carries one mark. **Negative marking system with deduction of 0.25 mark for every wrong answer.**

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Syllabus for the Recruitment to the post of Assistant Executive Engineer (Electrical) in Group-A.

Electrical Engineering Paper-1

1. Electrical Machines:
Single phase transformer – equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers – connections, parallel operation; auto-transformer & three winding transformer; principles of energy conversion; Windings of rotating Machines; DC Generators & Motors- Characteristics, starting and speed control, Armature Reaction and Commutation; Three phase Induction Motors – performance characteristics, starting and speed control; single phase Induction Motors; Synchronous Generators – performance, regulation, parallel operation; Synchronous Motors – starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

2. Electrical Circuits:
Network Graph, KCL, KVL, Node/Cut Sets, Mesh/Tie Sets Analysis, Sinusoidal Steady State Analysis; Transient Response of DC and AC Networks; Resonance in Electrical Circuits; Concepts of Ideal voltage and Current Sources; Network Theorems; Driving Point Impedance and Admittance and Transfer Functions of Two Port Network; Elementary concepts filters; three phase circuits; Fourier Series and Laplace Transform Methods for serving Electrical Networks; Two elements Network Synthesis.

3. Control Systems:
Mathematical Modelling of Physical Systems; Block Diagram and Signal flow graphs and their reduction; Time domain and frequency domain analysis of linear dynamical systems; Error for different types of inputs and stability criteria for feedback systems; Stability analysis using Routh-Hurwitz array, Nyquist Plot and Bode Plot, Root Locus and Nichols Chart and the Estimation of Gain and Phase margin; Basic Concepts of Compensator Design; State variable Matrix and its uses in System Modelling and Design; Sample data system and performance of such a system with the samples in the error channel; stability of sampled data system elements of non-linear control analysis; Control System Components – Electromechanical, Hydraulic, Pneumatic components.

4. Measurement & Instrumentation:
Bridges and potentiometer, PMMC, Moving Iron, Dynamometer and Induction Type Instruments; Measurement of Voltage, Current, Power; Energy and Power factor; Instrument Transformers; Digital Voltmeter and Multimeter; Phase, Time and Frequency Measurements; Q-Meter, Oscilloscope, Potentiometric Recorders, Error Analysis; transducers and their applications to the measurement of non-electrical quantities like; temperature, pressure, flow-rate, displacement, acceleration, noise level etc., Data Acquisition system; A/D and D/A converters.

5. Electromagnetic Theory:
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 distribution,Effects 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.

Electrical Engineering Paper-II

1. Power Systems:
Electric Power Generation – Thermal, Hydro, Nuclear – Economics and operating Factors; Transmission line parameters; Steady state performance of overhead Transmission line and Cables and Surge propagation; Distribution System; Insulators, Bundle Conductors, Corona and Radio Interference Effects; Per Unit quantities; Bus Admittance and Impedance matrices; Load Flows; Voltage Control and Power factor corrections; Economic Operation; Symmetrical Components; Analysis of symmetrical and Unsymmetrical faults; principle of over current, differential and distance protection; concept of solid state relays and digital protection; Circuit Breakers; Concept of Stability – swing Curves and Equal Area criterion; Basic concept of HDVC transmission and FACTS Devices.

2. Power Electronics & Electric Drivers:
Semiconductor Power Devices – Diodes, Transistors, Thyristors, Triacs, GTOs, MOSFETs and IGBTs – Static Characteristics and principle of operations; Triggering DC-DC Converters– Single Buck Phase Converters, and Three Phase half controlled and full controlled Bridge Rectifier's, Boost Converter, Buck-Boost Converter, Single phase and three phase Inverters, Pulse Width Modulation Techniques; basic Concept of adjustable DC and AC Drivers.

3. Engineering Mathematics:
Matrix theory, Eigen values & Eigen vectors, system of linear equations, Numerical methods for solution of non-linear algebraic equations and differential equations, integral calculus, partial derivatives, maxima, and minima, Line, Surface and Volume Integrals, Fourier series, linear, non-linear and partial differential equations, initial and boundary value problems, complex variables, Taylor's and Laurent's series, residue theorem, probability and statistics fundamentals, Sampling theorem, random variables, Normal and poisson distributions, correlation and regression analysis.

4. Analog and Digital Electronic Circuits:
Semiconductor Device Physics, P-N junctions and transistors- circuit models and parameters; FET, Zener, Tunnel, Schottky, Photo Diodes and their applications; Rectifier circuits; voltage regulators and multipliers; switching behaviour of diodes and transistors; small signal amplifiers-biasing circuits, frequency response and improvement; multistage amplifiers and feedback amplifiers; DC amplifiers; Wave shaping circuits; Multivibrators and Flip Flops and their applications; Digital logic gate families, Universal Gates; Combination circuits for arithmetic and logic operations; Sequential logic circuits; Counter and registers; RAM and ROMs.

5. Signal and Systems:
Representation of continuous and discrete-time signals, shifting and scaling operations, Linear Time Invariant and Casual systems, Fourier Series representation of continuous periodic signals, Sampling theorem, Applications of fourier Transform, Laplace Transform and z-Transform.

A. Electrical Engineering Paper-I

1. Electrical Machines	40
2. Electrical Circuits	40
3. Control Systems	40
4. Measurement & Instrumentation	30
5. Electromagnetic Theory	30
Total No. of Questions	180

B. Electrical Engineering Paper-II

1. Power Systems	40
2. Power Electronic & Electric Drivers	40
3. Engineering Mathematics	40
4. Analog & Digital Electronic Circuits	30
5. Signal and Systems	30
Total No. of Questions	180

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