**Civil Engineering Portion**

**Module 1 (12 Marks)**
**Buildings:** Types of buildings, site selection, components of a residential building and their functions. Load bearing and framed structures; Brick and rubble masonry; Roofs and floors; Basic infrastructure services; Green buildings

**Building rules and regulations:** Relevance of NBC, KBR & CRZ norms; **Building area:** Plinth area, built up area, floor area, carpet area and floor area ratio for a building as per KBR.

**Surveying:** objectives and principles. Linear, and angular and methods, Survey stations and Survey lines- ranging, Bearing of survey lines;

**Levelling:** Principles and methods of leveling; Principle of Electromagnetic distance measurement (EDM), Principle of Total station

**Construction material:** Conventional construction materials: types, properties and uses of building materials: bricks, stones, cement, sand and timber, Modern construction materials; **Cement concrete:** Constituent materials, types of cement and concrete, short-term and long-term properties of concrete; **Steel:** Structural Steel – Composition, material properties and behaviour; Steel sections and steel reinforcements, types and uses.

**Construction Management:** Types of construction projects; Tendering and construction contracts; Project planning and network analysis – PERT and CPM; Cost estimation

**Transportation Infrastructure:** Geometric design of highways – cross-sectional elements, sight distances, horizontal and vertical alignment, Highway materials – desirable properties

**Environmental Engineering:** Unit processes and operations for Water and Waste Water Treatment - primary and secondary treatments

**Module 2 (13 Marks)**

**Statics:** basic principles of statics, composition and resolution of forces-resultant and equilibrium equations; Friction; analysis of connected bodies; couple; General coplanar force system & forces in space - resultant and equilibrium equations.
Centroid of composite areas, moment of inertia, Polar moment of inertia, mass moment of inertia

**Dynamics:** rectilinear translation, equations of kinematics, kinetics, Motion on horizontal and inclined surfaces, motion of connected bodies. Impulse momentum equation and work energy equation; Curvilinear translation - equations of kinematics –projectile motion, kinetics, Moment of momentum and work energy equation.; Rotation – kinematics of rotation; Plane motion of rigid body; Simple harmonic motion –undamped free vibration of spring mass system-effect of damping

**Solid Mechanics:** Different types of supports, loads; Beams-Reactions at supports; Bending moment and shear force in statically determinate beams; Simple stress and strain relationships; Simple bending theory, Flexural and shear stresses, Uniform torsion; combined and direct bending stresses

**Soil Mechanics:** Three-phase system and phase relationships, Index properties; Permeability – one dimensional flow, Compaction of soils; One- dimensional consolidation, Pile load test, Bearing capacity of soil, functions of foundations, types – shallow and deep.

**Fluid Mechanics and Hydraulics:** Properties of fluids, Fluid statics, Laminar and turbulent flow, Forces on immersed bodies, Flow in pipes; Flow measurement in channels and pipes, Water logging and drainage; Hydrologic cycle

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**Electrical Engineering**

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Module 1: [5 Marks]

**Electrical Machines:**

DC Machines – Basics of Separately excited DC motor, Shunt and Series motors – Torque and power, back EMF, mechanical and electrical characteristics, Shunt DC generator and characteristics – EMF equation – external and internal characteristics.

Three phase induction motor: Principles and characteristics – Types – performance – standard tests – equivalent circuits - Starting and speed control. Operating principle of single-phase induction motors;

Synchronous machines: cylindrical and salient pole machines, performance and characteristics, regulation and parallel operation of generators, starting of synchronous motors; Types of losses and efficiency calculations of electric machines.

Single-phase transformers - Principles and construction – equivalent circuit – phasor diagrams – open circuit and short circuit tests - voltage regulation – efficiency, all-day efficiency – Autotransformer
Three-phase transformers: connections, vector groups, parallel operation;

## Module 2: [5 Marks]

**Power Systems** – Generation, ac and dc transmission concepts, Models and performance of transmission lines and cables, Economic Load Dispatch, Series and shunt compensation, Electric field distribution and insulators, Distribution systems, Per-unit quantities, Voltage and Frequency control, Power factor correction, Symmetrical components, Symmetrical and unsymmetrical fault analysis, Principles of over-current, differential, directional and distance protection; Circuit breakers, System stability concepts, Equal area criterion.

## Module 3: [5 Marks]

**Control Systems:** Mathematical modelling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and Steady-state analysis of linear time invariant systems, Stability analysis using Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Lag, Lead and Lead-Lag compensators; P, PI and PID controllers.

**Electrical and Electronic Measurements**: Bridges and Potentiometers, Measurement of voltage, current, power, energy and power factor; Instrument transformers, Digital voltmeters and multi-meters, Phase, Time and Frequency measurement; Oscilloscopes, Error analysis. Digital energy meter.

## Module 4: [5 Marks]

Electrical System Design:  Wiring systems, Earthing and protection equipment – MCB, RCCB

Load Survey- common power ratings of domestic gadgets- connected load diversity factor-selection of number of sub circuits (lighting and power)- selection of MCB distribution boards to provide over load, short circuit and earth leakage protection. – Electrical System design for domestic and industrial installations – Pre-commissioning tests - Insulation resistance measurement, continuity test, polarity test and earth resistance measurement as applicable to domestic installations. Industrial installations – classifications- Design of electrical distribution systems with main switch board, sub switch boards and distribution boards with ACBs, MCCBs and MCBs as the case may be, for feeding power (mainly motors) and lighting loads of small and medium industries. Selection of armoured power cables (AYFY, A2XFY, YWY) – calculation of ampacity, voltage drop, short circuit withstand capacity etc.

Design of MSB & SSB including Motor Control Centre (MCC) for motor controls - selection of bus bars and switchgears. Selection of 11kV indoor and outdoor transformer substations - selection of switchgears and protective devices – Short circuit calculations and earthing design for the HV and LV sides of an 11 kV substation.

**Module 5: [5 Marks]**

**Power Electronics:** – Power semiconductor devices - Thyristor, MOSFET, IGBT - Static V-I characteristics and firing/gating circuits; DC to DC conversion: Buck, Boost and Buck-Boost Converters; Single and three-phase configuration of fully-controlled and semi-controlled rectifiers; Line harmonics of controlled rectifiers - Power factor and Distortion Factor of ac to dc converters; Single-phase and three-phase voltage and current source inverters, 120 degree and 180 degree conduction modes - sinusoidal pulse width modulation.

## Mechanical Engineering

**Module 1 : Theory of Machines and Machine Design; (5 marks)**

Concept of simple machine, Four bar linkage and link motion, Flywheels and fluctuation of energy, Power transmission by belts – V-belts and Flat belts, Clutches – Plate and Conical clutch, Gears – Type of gears, gear profile and gear ratio calculation, Governors – Principles and classification, Riveted joint, Cams, Bearings, Friction in collars and pivots.

**Module 2 : Engineering Mechanics and Strength of Materials; (5 marks)**

Equilibrium of Forces, Law of motion, Friction, Concepts of stress and strain, Elastic limit and elastic constants, Bending moments and shear force diagram, Stress in composite bars, Torsion of circular shafts, Bucking of columns – Euler's and Rankin's theories, Thin walled pressure vessels. Thermal Engineering.

## Module 3 : Thermal Engineering Properties of Pure Substances; (5 marks)

P-V & P-T diagrams of pure substance like H2O, Introduction of steam table with respect tosteam generation process; definition of saturation, wet & superheated status. Definition of dryness fraction of steam, degree of superheat of steam. H-s chart of steam (Mollier's .Chart).

1 st Law of Thermodynamics : Definition of stored energy & internal energy, 1st Law of Thermodynamics of cyclic process, Non Flow Energy Equation, Flow Energy & Definition of Enthalpy, Conditions for Steady State Steady Flow; Steady State Steady Flow Energy Equation.

2 nd Law of Thermodynamics : Definition of Sink, Source Reservoir of Heat, Heat Engine, Heat Pump & Refrigerator; Thermal Efficiency of Heat Engines & co-efficient of performance of Refrigerators, Kelvin – Planck & Clausius Statements of 2nd Law of Thermodynamics, Absolute or Thermodynamic Scale of temperature, Clausius Integral, Entropy, Entropy change calculation of ideal gas processes. Carnot Cycle & Carnot Efficiency, PMM-2; definition & its impossibility.

Air standard Cycles for IC engines : Otto cycle; plot on P-V, T-S Planes; Thermal Efficiency,Diesel Cycle; Plot on P-V, T-S planes; Thermal efficiency. IC Engine Performance, IC Engine Combustion, IC Engine Cooling & Lubrication.

Rankine cycle of steam : Simple Rankine cycle plot on P-V, T-S, h-s planes, Rankine cycle efficiency with & without pump work.

Boilers: Classification; Specification; Fittings & Accessories : Fire Tube & Water Tube Boilers. Air Compressors & their cycles: Refrigeration cycles; Principle of a Refrigeraton Plant; Nozzles & Steam Turbines

## Module 4 : Fluid Mechanics & Machinery Properties & Classification of Fluid; (5 marks)

Ideal & real fluids: Newton's law of viscosity, Newtonian and Non-Newtonian fluids, compressible and incompressible fluids.

<u>Fluid Statics :</u> Pressure at a point. Measurement of Fluid Pressure : Manometers, U-tube, Inclined tube.

<u>Fluid Kinematics :</u> Stream line, laminar & turbulent flow, external & internal flow, continuity equation.

<u>Dynamics of ideal fluids :</u> Bernoulli's equation, Total head; Velocity head; Pressure head; Application of Bernoulli's equitation.

<u>Measurement of Flow rate Basic Principles :</u> Venturimeter, Pilot tube, Orifice meter. Hydraulic Turbines : Classifications, Principles.

<u>Centrifugal Pumps :</u> Classifications, Principles, Performance.


## Module 5 : Production Engineering; (5 marks)

<u>Classification of Steels :</u> mild steal & alloy steel, Heat treatment of steel,

<u>Welding :</u> Arc Welding, Gas Welding, Resistance Welding, Special Welding Techniques i.e. TIG, MIG, etc. (Brazing & Soldering), Welding Defects & Testing; NDT,

<u>Foundry & Casting:</u> methods, defects, different casting processes, Forging, Extrusion, etc,

<u>Metal cutting principles:</u> cutting tools, Basic Principles of machining with (i) Lathe (ii) Milling (iii) Drilling (iv) Shaping (v) Grinding, Machines, tools & manufacturing processes.


## Electronics & Communication Engineering - Syllabus

### Module-1 – 6 marks

*Solid state devices*
Fermi-Dirac Distribution function, carrier concentration at equilibrium, parameters associated with generation, recombination and transport mechanism, Drift and diffusion currents and current density in extrinsic semiconductors, Current components and current equation in a pn junction diode and bipolar junction transistor, Basic MOS physics, scaling of MOSFETs, short channel effects
*Network theory*
Mesh / Node analysis, Network Theorems, steady state response of the linear time invariant networks,
Transient response of RLC networks, Network functions, Network Parameters, Analysis of single port and two port networks
*Analog circuits*
Analog circuits using diodes, first order RC circuit, Amplifiers using BJT and MOSFET, Oscillators and regulated power supply circuits

**Module-2 – 4 marks**

*Logic circuit design*
Digital logic and Boolean algebra, combinational logic using AND/OR/NOT gates/Multiplexers, Logic families, Implementation of sequential logic circuits, Verilog models.
*VLSI design*
Methodologies in ASIC and FPGA design, VLSI Logic circuits with MOSFET logic families, memory elements, Design of arithmetic circuits, MOSFET fabrication techniques

**Module-3 - 5 marks**

*Electromagnetics*
Basic mathematical concepts related to electromagnetic vector fields, Maxwell's equation, electromagnetic wave propagation and wave polarization, characteristics of transmission lines, solving with Smith chart, propagation of EM waves in Wave guides
*Microwave and antennas*
Basic concept of antennas and its parameters, far filed pattern of Short dipole and Half wave dipole antenna, Design of broad band antennas, arrays and its radiation patterns, cavity resonators and microwave sources, microwave hybrid circuits and microwave semiconductor devices

**Module-4 - 5 marks**

*Signals and systems*
Properties of signals and systems, Representation of signals with the help of series and transforms, orthogonality of signals and convolution integral, LTI response to input signals, discretise continuous time signals
*Digital Signal Processing*
Properties and relations of DFT, DFT based filtering methods, DFT and IDFT using DIT and DIF radix-2 FFT algorithms, linear phase FIR filters and IIR filters, FIR and IIR filter structures, multi-rate DSP operations decimation and interpolation, architecture of DSP processor

**Module-5 - 5 marks**

*Analog and Digital communication*
analog communication systems, concepts of random processes to LTI systems, waveform coding techniques in digital transmission, Gram-Schmitt procedure to develop digital receivers, equalizer design to counteract inter-symbol interference (ISI), digital modulation techniques in signal transmission
*Information theory and coding*
Measures of information – entropy, conditional entropy, mutual information, Shannon's source coding theorem for data compression, concept of channel capacity, linear block codes for error detection and

correction, algebraic codes for error correction, encoding and decoding of convolutional and LDPC codes


**NOTE: - It may be noted that apart from the topics detailed above, questions from other topics prescribed for the educational qualification of the post may also appear in the question paper. There is no undertaking that all the topics above may be covered in the question paper.**