ANNEXURE – II

NOTIFICATION NO.09/2018

SCHEME AND SYLLABUS FOR RECRUITMENT TO THE POSTS OF ASSISTANT EXECUTIVE ENGINEERS IN VARIOUS ENGINEERING SERVICE

SCHEME FOR SCREENING TEST

WRITTEN EXAMINATION (OBJECTIVE TYPE)

BACHELOR'S DEGREE STANDARD

| S.No | Paper | Subject/Branch | Marks | No.of Questions | Total | Duration of time |
|---|---|---|---|---|---|---|
| 1 | Part-A | General Studies & Mental Ability | 50 Marks | 50 Questions | 150 Questions and 150 Marks | 150 Minutes |
| | Part-B | Civil & Mechanical Engineering (Common) (or) Electrical Engineering | 100 Marks | 100 Questions | | |

**NB:** The candidate has to appear for Papers of his / her subject of study at Engg. Degree. i.e B.E / B. Tech (concerned Subject)

1. NEGATIVE MARKS: As per G.O. Ms. No.235 Finance (HR-I, Plg & Policy) Dept., Dt.06/12/2016, for each wrong answer will be penalized with 1/3rd of the marks prescribed for the question.

SYLLABUS FOR SCREENING TEST TO THE POST OF ASSISTANT EXECUTIVE ENGINEERS IN CIVIL , MECHANICAL AND ELECTRICAL ENGINEERING

PART - A

50 QUESTIONS 50 MARKS

GENERAL STUDIES AND MENTAL ABILITY

1. Events of national and international importance.
2. Current affairs- international, national and regional.
3. General Science and it applications to the day to day life Contemporary developments in Science & Technology and information Technology
4. Social- economic and political history of modern India with emphasis on Andhra Pradesh.
5. Indian polity and governance: constitutional issues, public policy, reforms and e-governance initiatives with specific reference to Andhra Pradesh.
6. Economic development in India since independence with emphasis on Andhra Pradesh.
7. Physical geography of Indian sub-continent and Andhra Pradesh.
8. Disaster management: vulnerability profile, prevention and mitigation strategies, Application of Remote Sensing and GIS in the assessment of Disaster.
9. Sustainable Development and Environmental Protection
10. Logical reasoning, analytical ability and data interpretation.
11. Data Analysis:
    a) Tabulation of data
    b) Visual representation of data
    c) Basic data analysis (Summary Statistics such as mean, median, mode, variance and coefficient of variation) and Interpretation
12. Bifurcation of Andhra Pradesh and its Administrative, Economic, Social, Cultural, Political, and Legal implications/problems.

SYLLABUS FOR SCREENING TEST TO THE POST OF ASSISTANT EXECUTIVE ENGINEERS IN CIVIL AND MECHANICAL ENGINEERING

PART - B

100 QUESTIONS 100 MARKS

**1. Strength of Material:**

Forces, moments, Equilibrium; Applying the Equation of Equilibrium, Planar Trusses; Friction;
Simple Stresses & Strains: Elasticity and plasticity, Types of stresses & strains, Generalized Hooke's law – Stress–strain diagram for mild steel – Working stress –Factor of safety – Lateral strain, Poisson's ratio & volumetric strain – Elastic modulii & the relationship between them – Bars of varying section – composite bars –Temperature stresses. Strain energy – Resilience – Gradual, sudden, impact and shock loadings. Shear Force (S.F) and Bending Moment (B.M): Definition of beam –Types of beams – Concept of shear force and bending moment – S.F and B.M for cantilever, simply supported and overhanging beams subjected to point loads, U.D.L., uniformly varying loads and combination of these loads – Point of contra flexure –Relation between S.F., B.M and rate of loading at a section of a beam.
Flexural Stresses: Theory of simple bending - Assumptions – bending equation: Neutral axis – bending stresses – section modulus of different sections – Design of simple beam sections. Shear Stresses: Derivation of formula –Shear stress distribution across various beam sections
Principal Stresses and Strains: Stresses on an inclined section of a bar under axial loading – Compound stresses – Normal and tangential stresses on an inclined plane for biaxial stresses – Two perpendicular normal stresses accompanied by a state of simple shear –Mohr's circle of stresses –Principal stresses and strains – Analytical and graphical solutions. Different theories of Failure: Various theories of failure. Columns and struts – Euler's column theory – types of end conditions; critical load on the column - derivations – Rankin's formula for columns. Lifting machines, definitions, Law of machine, study of important lifting machines; virtual work principal.
Torsion of Circular Shafts: Theory of pure torsion – Torsion Equations: Assumptions made in the theory of pure torsion – Torsional moment of resistance – Polar section modulus – Power transmitted by shafts – Combined bending and torsion and end thrust. Springs-Helical and leaf springs.
Thin & Thick Cylinders and Spherical shells: Thin seamless shells – formula for longitudinal and circumferential stresses and max shear stresses – hoop, longitudinal and volumetric strains – changes in diameter, and volume of thin shells.

**2. Fluid Mechanic and Machinery**

Fluid statics: Dimensions and units: physical properties of fluids-specific gravity, viscosity, and surface tension -vapour pressure and their influence on fluid motion-atmospheric, Pascal's law, gauge and vacuum pressures – Measurement of pressure-Piezometer, U-tube and differential manometers..Hydrostatics, Fluid forces on planes and curved surfaces, submerged and floating bodies, Buoyancy and stability. Fluid kinematics: description of flow pattern and types of fluid flows – Velocity and acceleration: convective, temporal, tangential and normal accelerations, control volume-basic principles of fluid flow, continuity equation for 3-D, 2-D, 1-D flow. Rotational and irrotational motion, Velocity potential, stream function, flow net.
Fluid dynamics: Surface and body forces – Euler's and Bernoulli's equations for flow along a stream line and its applications, momentum equation and its applications. Flow measurement devices – Gross measurement: Venturimeter, Orificemeter, Turbine flow meters, Rotameters; Pressure measurement: Pitot tubes, hot wire/film anemometer, their measurement principles and sources of errors; calibration.

Closed conduit flow: Reynolds experiment - Major and Minor losses in pipes-pipes in series and pipes in parallel-total energy line-hydraulic gradient line, water hammer. Boundary Layer Concepts: Definition, thicknesses, characteristics along thin plate, laminar and turbulent boundary layers boundary layer in transition, separation of boundary layer, submerged objects – Drag and lift.

Basics of turbo machinery: Hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, velocity diagrams, work done and efficiency, Hydraulic Turbines: Classification of turbines, Heads and efficiencies, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine - working proportions, work done, efficiencies , hydraulic design – Draft tube theory-functions and efficiency. Performance of hydraulic turbines: Geometric similarity, Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation. Centrifugal pumps: Classification, working, work done – barometric head-loss and efficiencies, specific speed - Performance characteristic curves, NPSH. Selection of pumps and economic evaluation of pumping.

Hydraulic Directional Control – Check Valves, Shuttle Valves, two- three- and four-Way Directional Control Valves, Directional Control Valve Actuation. Hydraulic Pressure Control – Pressure Relief Valves, Unloading Valves, Pressure Reducing Valves, Sequence Valves,

Counterbalance Valves, Pressure Compensated Pumps.

Hydro Projects And Plant: Classification – Typical layouts – plant auxiliaries – plant operation, pumped storage plants. Hydro Electric Power Plant: Water power – Hydrological cycle / flow measurement – drainage area characteristics – Hydrographs – Storage and Pondage – Classification of dams and spill ways.

SYLLABUS FOR SCREENING TEST TO THE POST OF ASSISTANT EXECUTIVE ENGINEERS IN ELECTRICAL ENGINEERING BRANCH

PART - B

100 QUESTIONS 100 MARKS

**1. Electric Circuits**: Active and passive network elements – dependent and independent sources – response of passive elements to arbitrary excitations – energy stored in inductance and capacitance – Kirchoff's loss – formation of mesh and Nodel Integro differential equations – their solutions by classical and Laplace transformation methods – Transient and steady state response of RL, RC elements to impulse, step, ramp and sinusoidal inputs – single phase AC circuits – methods of solutions – poly phase circuits – analysis of balanced and unbalanced circuits – measurements of three phase power.

**2. Electrical Measurements and Instruments**: Absolute and secondary instrument types – Principle of operation of different type of instrument – extension of instrument ranges – measurement of voltage, current, power and energy – localization of cable faults – Murray loop and Varley loop tests – Cathode ray Oscilloscope.

**3. Illumination:** Solid angle, luminous flux, luminous intensity – Illumination and candle power – laws of Illumination – flood lighting, street lighting – electric lamps.

**4. DC Generators and Motors**: Types of DC generators – EMF equation – constructional details – characteristics of shunt, series and compound generators – Armature reaction – types of DC motors – Torque developed in a DC motor – speed controls of DC motors and starters.

**5**. **Transformers**: Constructional details – Principle of operati9on – vector diagrams on no load and load – regulation and efficiency – equivalent circuits and tests for the determination of parameters of equivalent circuits – types of three phase transformers and their applications – Scott connection of transformers.

**6. 3-Phase Induction Motors**: Principle of operation – Cage and Slip ring motors – torque slip characteristics – methods of speed control.

**7. 3-Phase Alternators**: Principle of operation and constructional details – types of Alternators – synchronous impedance – voltage regulation – short circuit ratio and its importance – Phasor diagrams of round rotor and salient pole machines – synchronization – behaviour of an alternator connected to infinite bus – effect of varying excitation current and mechanical torque – power angle curves – control of active and reactive powers.

**8. 3-Phase Synchronous Motors**: Principle of operation – torque developed and methods of starting – V and Inverted V curves – effects of variations of excitation – synchronous condensers.

**9. Single phase induction Motors**: Types of single phase motors – Types of Single phase induction motors – characteristics and methods of starting – shaded pole induction motor.

**10. Transmission & Distribution:** Line constants – Inductance and Capacitance calculations – Representation of over head Lines – Short, Medium and Long lines – ABCD constants – Mechanical Design – Sag, Tension Calculations, Tuned Power Lines.

**11. Over Head Line Insulators:** Types of Insulators – Potential distributions over a string of suspension insulators – string efficiency – Methods of improving string efficiency.

**12. Underground Cables:** Insulation of cables – Grading of cables – Capacitance Measurement in cables – Testing of Cables – Power frequency withstand tests.

**13. Fault Calculations:** Balanced Fault calculations on systems – Symmetrical components – Types of faults – Analysis of unbalanced faults.

**14. Generating Stations:** Location and types, types of hydroelectric power stations, layout of a hydro-power plant, types of turbines used – Pumped storage installations – Layout of thermal electric power stations, types of turbines used, condensers, cooling towers, boiler feed pump; energy flow diagram of steam power plant. Nuclear power generation; Nuclear fission – types

of nuclear power reactors – Principle of a fast breeder reactor.

**15. Protection:** Characteristic of Relays – Over current, directional and distance protection of lines. Protection of Alternators against stator faults, rotor faults, loss of excitation, unbalanced loading, overloading, failure of prime-mover. Over speeding and over voltage. Protection of transformers against winding faults, overloads and external short circuits.

**16. Circuit Breakers:** Air-blast, oil, minimum oil, vacuum – Sulphur hexafluoride and d.c. circuit breakers – Relative merits and demerits.

**17. Economic Aspects:** Generation costs and their classification, load curve, load utilization and plant capacity factors. Load sharing between base load and peak-load stations. Load forecasting. Economical distribution of load between unit within a plant and between plants. Modeling of fuel costs for thermal generation. Optimal operation of an all thermal generating system and of a hydro-thermal system. Consideration of transmission losses.

**18. Utilization of Electrical Energy:** Industrial drives – Motors for various drives –Estimating and Rating – Testing of D.C. and A.C. motors – Neutral Earthing.

SCHEME FOR THE MAIN EXAMINATION

WRITTEN EXAMINATION (OBJECTIVE TYPE)

BACHELOR'S DEGREE STANDARD

<table>
<tr><td><u>PAPER 1</u> :<br>General Studies & Mental Ability</td><td>150 Marks</td><td>150 Questions</td><td>150 Minutes</td></tr>
<tr><td><u>PAPER 2 :</u><br>Civil & Mechanical Engineering (Common)<br>OR<br>Electrical Engineering</td><td>150 Marks</td><td>150 Questions</td><td>150 Minutes</td></tr>
<tr><td><u>PAPER 3</u>:<br>Civil Engineering<br>(For Post Code No.1,2,4 & 8)</td><td rowspan="4">150Marks</td><td rowspan="4">150 Questions</td><td rowspan="4">150 Minutes</td></tr>
<tr><td>Mechanical Engineering<br>(For Post Code No. 5 only)</td></tr>
<tr><td>Civil & Mechanical Engineering (Common)<br>(For Post Code No. 6 &7)</td></tr>
<tr><td>Electrical Engineering<br>(For Post Code No. 3 only)</td></tr>
<tr><td>Total</td><td colspan="3">450 Marks</td></tr>
</table>

NB: 1. The candidate has to appear for Papers of his / her subject of study at Engg. Degree. i.e. B.E / B. Tech (concerned Subject)

2. In respect of Paper-3, (Post Code No. 6 & 7) the Examination will be conducted in different session.

3. NEGATIVE MARKS: As per G.O. Ms. No.235 Finance (HR-I, Plg & Policy) Dept., Dt.06/12/2016, for each wrong answer will be penalized with 1/3$^{rd}$ of the marks prescribed for the question.

PAPER - I
GENERAL STUDIES & MENTAL ABILITY

1. Events of national and international importance.
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6. Economic development in India since independence.
7. Physical geography of India sub-continent.
8. Disaster management: vulnerability profile, prevention and mitigation strategies, Application of Remote Sensing and GIS in the assessment of Disaster.
9. Sustainable Development and Environmental Protection
10. Logical reasoning, analytical ability and data interpretation.
11. Data Analysis:
    a) Tabulation of data
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    c) Basic data analysis (Summary Statistics such as mean and variance coefficient of variation etc.,) and Interpretation
12. Bifurcation of Andhra Pradesh and its Administrative, Economic, Social, Cultural, Political, and legal implications/problems.

PAPER-2
COMMON TO CIVIL AND MECHANICAL ENGINEERING
(For Post Codes 1, 2, 4, 5, 6, 7, 8)

**1. Strength of Material:**

Forces, moments, Equilibrium; Applying the Equation of Equilibrium, Planar Trusses; Friction.
Simple Stresses & Strains: Elasticity and plasticity, Types of stresses & strains, Generalized Hooke's law–stress –strain diagram for mild steel – Working stress – Factor of safety –Lateral strain, Poisson's ratio & volumetric strain – Elastic modulii & the relationship between them – Bars of varying section – composite bars – Temperature stresses. Strain energy –Resilience – Gradual, sudden, impact and shock loadings.
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Fluid statics: Dimensions and units: physical properties of fluids-specific gravity, viscosity, and surface tension - Vapour pressure and their influence on fluid motion - atmospheric, Pascal's law, gauge and vacuum pressures – measurement of pressure - Piezometer, U-tube and differential manometers. Hydrostatics, Fluid forces on planes and curved surfaces, submerged and floating bodies, Buoyancy and stability. Fluid kinematics: description of flow pattern and types of fluid flows – Velocity and acceleration: convective, temporal, tangential and normal accelerations, control volume - basic principles of fluid flow, continuity equation for 3-D, 2-D,

1-D flow. Rotational and irrotational motion, Velocity potential, stream function, flow net.

Fluid dynamics: Surface and body forces –Euler's and Bernoulli's equations for flow along a stream line and its applications, momentum equation and its applications. Flow measurement devices – Gross measurement: Venturimeter, Orificemeter, Turbine flow meters, Rotameters; Pressure measurement: Pitot tubes, Hot wire/film anemometer, their measurement principles and sources of errors; calibration.

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PAPER-2
ELECTRICAL ENGINEERING
(For Post Code No. 3 only)

**1. Electric Circuits**: Active and passive network elements – dependent and independent sources – response of passive elements to arbitrary excitations – energy stored in inductance and capacitance – Kirchoff's loss – formation of mesh and Nodel Integro differential equations – their solutions by classical and Laplace transformation methods – Transient and steady state response of RL, RC elements to impulse, step, ramp and sinusoidal inputs – single phase AC circuits – methods of solutions – poly phase circuits – analysis of balanced and unbalanced circuits – measurements of three phase power.
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**9**. **Single phase induction Motors**: Types of single phase motors – Types of Single phase induction motors – characteristics and methods of starting – shaded pole induction motor.

PAPER – 3
CIVIL ENGINEERING
(For Post Code No. 1, 2, 4 & 8)

**1. BUILDING MATERIALS:** Timber: Different types and species of structural timber, density – moisture relationship, strength in different directions, defects, preservations, and plywood.
Bricks: Types, Indian standard classification, absorption, saturation factor, strength in masonry, influence of mortar strength on masonry strength.
Cement: Compounds of 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, mix design methods, non-destructive testing.

**2. STRUCTURAL ANALYSIS:** General theorems: theorems relating to elastic structures, principles of virtual work, strain energy in elastic structures, complementary energy, Castigliano's theorem, Betti's and Maxwell's reciprocal theorems.
Analysis of determinate structures – Deflection of determinate beams by double integration Macaulay's moment area and conjugate beam methods, Analysis of indeterminate skeletal frames-Moment distribution, Slope deflection, Kani's, Stiffness and force methods, Energy methods, Plastic analysis of indeterminate beams and simple portal frames..

**3. DESIGN OF STEEL STRUCTURES:** Principles of limit state method. Plastic sections, Design of bolted and welded connections, Design of tension, compression members and beams, axially and eccentrically loaded joints, Simple connection of bracket plates to columns, beam to beam and beam to column connections, design of framed, un-stiffened and stiffened seat connections. Design of industrial roofs. Principles of ultimate load design. Design of simple members.

**4. DESIGN OF CONCRETE AND MASONRY STRUCTURES:** Limit state design for bending, Shear, Axial compression and combined forces. Codal provision for slabs, Beams, Columns and footings. Principles of pre-stressed concrete design, Materials, Methods of pre-stressing, losses. Design of simple members and determinate structures. Design of brick masonry as per IS codes.

**5. CONSTRUCTION PLANNING AND MANAGEMENT:** Bar chart, Linked bar chart, Work break down structures, Activity – on – arrow diagrams. Critical path, Probabilistic activity durations, Event based networks. PERT network: Time-cost study, Crashing, Resource allocation.
**6. HYDRAUICS, AND WATER RESOURCE ENGINEERING:** Open Channel flow : types of flows - Type of channels – Velocity distribution – Energy and momentum correction factors, uniform flow and calculation of uniform flow, most economical section, Specific energy, critical flow conditions, critical depth computation, Non-Uniform flow: Assumptions and Equation for Gradually varied flow, types of channel bottom slopes, classification of surface profiles. Rapidly varied flow, hydraulic jump, energy dissipation. Hydraulic Similitude: Dimensional analysis-Rayleigh's method and Buckingham's pi theorem- –Geometric, kinematic and dynamic similarities - dimensionless numbers – model and prototype relations. Distorted and non-distorted models.

Hydrological cycle and its components, Precipitation and related data analysis, Evaporation and transpiration; S-hydrograph, Unit hydrographs. Floods and their management, Probable maximum Flood; Streams and their gauging; Routing of floods; Capacity of reservoirs.
Multipurpose uses of water; Soil-Plant-Water relationships, Irrigation systems, Water demand assessment; Storages and their yields, Ground water yield and well Hydraulics; Water logging, drainage design. Design of rigid boundary canals, Lacey's and tractive force concepts in canal design, Lining of Canals, Sediment transport in canals, Non-overflow and overflow section of gravity dams and their design, Energy dissipaters, tail water rating; Design of head works, Distribution works, Falls, Cross-drainage works, Outlets, River training.

**7. ENVIRONMENTAL ENGINEERING:** Water Supplying Engineering: Sources of supply, Yields, Design of intakes and conductors, Estimation of demand. Water quality standards, Control of water borne diseases. Primary and secondary treatment. Conveyance and distribution systems of treated water, Leakages and control. Rural water supply. Institutional and industrial water supply.
Waste Water engineering: Urban rain water disposal, Systems of sewage collection and disposal. Design of sewers and sewerage systems, Pumping. Characteristics of sewage and its treatment. Disposal of products of sewage treatment. Plumbing systems. Rural and semi-urban sanitation.
Solid Waste Management: Sources and effects of air pollution, Monitoring of air pollution, Noise pollution, Standards, Ecological chain and balance. Environmental impact assessment.

**8. SOIL MECHANICS AND FOUNDATION ENGINEERING:** Properties and classification of soil, Compaction, Permeability and Seepage, Flow nets, Compressibility and consolidation. Stress distribution in soils, Shearing resistance, Stresses and failure. Soil testing in laboratories and in-situ, Earth pressure theories, Soil exploration. Types of foundations, Selection criteria, bearing capacity, Settlement, laboratory and field tests, Design of shallow foundations. Types of piles and their design and layout. Foundations on expansive soils.

**9. SURVEYING AND TRANSPORT ENGINEERING:** Classification of surveys, Scales, Accuracy, Measurement of distances, Direct and indirect methods, Optical and electronic devices, Measurement of directions, Prismatic compass, Local attraction, Theodolites, Types, Measurement of elevations, Spirit and trigonometric leveling, Contours, Digital elevation modeling concept, Establishment of control by triangulations and traversing, Measurement and adjustment of observations, Computation of coordinates, Field astronomy, Concept of global positioning system, Map preparation by plane tabling and by photogrammetry, Remote sensing concepts, Map substitutes.
Planning of Highway systems, Alignment and geometric design, Horizontal and vertical curves, Grade separation, Highway Materials and construction methods for different surfaces and maintenance. Principles of pavement design, Drainage. Traffic surveys, Intersections, Signaling, Mass transit systems, Accessibility, Networking.

Paper-3
MECHANICAL ENGINEERNG
(For Post Code No. 5 only)

1. **Thermodynamics**
Definition of system & control volume, properties and state of a substance, units of mass, length, time, force, energy and work; Equality of temperature, Zeroth Law; Properties of Pure Substances – Pure substance; phase change and phase equilibrium; properties tables and diagrams; Ideal gas law, deviation from ideal law and compressibility factor; Work & Energy – Definition of work and energy; First Law of Thermodynamics; internal energy, enthalpy and specific heat of gases, liquids and solids; energy analysis of closed system; mass and energy analysis of control volumes; Second law of Thermodynamics – Thermal efficiency and coefficient of performance; Kelvin-Planck and Clausius statements and their equivalence; reversibility and its departure; Carnot cycle; thermodynamic temperature scale; Entropy – Clausius inequality; entropy change for pure substance; entropy generation and principle of entropy increase; entropy change for reversible process; entropy change for ideal gases; Energy – Work potential of energy; reversible work and irreversibility; Second Law efficiency; Energy change of a system; Energy transfer by heat, work and mass; Energy balance for closed system and control volumes; Power & Refrigeration Cycles – Air standard power cycles: Otto Cycle, Diesel Cycle, Stirling & Ericsson Cycle; Brayton Cycle and its variants; Second law analysis of gas power cycles; Rankine Cycle and its variants; Vapour Compression Cycle; Second law analysis of vapour power cycles.
2. **Heat Transfer**
Steady state conduction in one and two-dimensional systems – one dimensional unsteady state conduction; analytical and numerical methods. Extended surface heat transfer (Fins). Convection: Basic equations, Dimensional analysis, Boundary layers; Forced convections: External and internal flows, correlations, Natural convection and Mixed convection. Design of heat exchangers: LMTD and NTU methods. Radiation heat transfer: Basic laws, properties of surfaces, view factors, network method and enclosure analysis for gray – diffuse enclosures containing transparent media, engineering treatment of gas radiation; boiling and condensation.

3. **Refrigeration and Air Conditioning**
Refrigerating machines, heat pump, vapour compression system, second law efficiency of vapour compression cycle, refrigerants – selection of a refrigerant; thermodynamic, chemical and physical requirements, substitutes of CFC refrigerants; Multi-stage systems, components of a refrigerator – Compressor, condensers, expansion devices, evaporators; Gas cycle refrigeration; Vapour absorption.
system; Properties of moist air and psychometric chart; Psychrometry of air-conditioning processes; solar radiation, heat transfer through buildings and load calculations; Component design of air-conditioning units.

4. **Turbomachines**
Dimensional analysis – incompressible and compressible fluid analysis, performance characteristics for low and high speed machines, cavitation; 2D Cascades – cascade geometry, flow characteristics, forces, performance, turbine cascades; Axial flow turbines – mean line analysis, velocity vector diagram, thermodynamic analysis, multi-staging and losses per stage of axial turbines, effect of reaction on efficiency, turbine blade cooling; axial compressor – mean line analysis, velocity diagram, thermodynamic analysis, multistage analysis, high Mach number compressors, stall and surge phenomenon; Centrifugal Pumps,

fans and compressors – their definitions and differences, Thermodynamic analysis, diffuser performance, slip factor, Performance analysis, chocking in a compressor; Hydraulic Turbines – Pelton, Francis and Kaplan turbines, cavitation.

5. **Theory of Machines**

Basic Kinematic concepts: Introduction to mechanisms, Links, Kinematic pairs, Kinematic chains, Mechanism and Inversions, Kennedy's theorem, Velocity and acceleration in mechanism, Relative velocity methods, Instantaneous center of rotation, Acceleration diagram, Acceleration center. Cams: Synthesis of translating flat-face, translating roller and oscillating roller follower cams. Gears: terminology, fundamental law of gearing, involute profile, Interference and undercutting, minimum number of teeth, contact ratio, bevel, helical, spiral and worm gears, Gear Trains – simple, compound and epicyclic gear trains; sliding gear boxes and synchronous gear boxes.

Dynamics of machines: Dynamics of Rigid Bodies in Plane Motion; Dynamic Force Analysis of Machines. Balancing of inertia forces: Balancing of rotors, balancing of inline internal combustion engines. Friction Devices: Introduction to friction, Belt, chain and rope drive, Transmission of Power through friction clutch.

6. **Machine Design**

Design consideration – limits, fits, tolerances, and standardization, a brief introduction to strength of materials, modes of failure, failure theories, design of shafts under static and fatigue loadings, design of springs – helical, compression, tension, torsional and leaf springs, design of joints – threaded fasteners, preloaded bolt joints, welded and glued joints, design and analysis of sliding and rolling contact bearings, analysis and applications of power screws and couplings, analysis of clutches and brakes, design of belt and chain drives, design of spur and helical gears.

7. **Machine Drawing and Solid Modelling**

Principle of drawing. Introduction to machine drawing, production drawing, assembly drawing. Different sectional views. Fits, limits, tolerances and surface finish. Introduction to computer aided design, fundamentals of computer graphics; geometric modelling of synthetic curves: Hermite, Bezier, B-spline, NURBS. Parametric representation of surfaces: plane, ruled, revolution; Part modelling techniques: wireframe, surface and solid modelling, data representation and exchange formats, geometry and topology. Three-dimensional transformations and projections. Solid modelling of different machine elements. Example, threads, bolts and nuts, welded and riveted joints, shafts, keys, cotter and pin joints; couplings and clutches, springs, belts and pulleys; bearings, gears. Assembly of different components of IC engine.

8. **Engineering Materials**

Concepts of metallurgy and materials science, types of materials (metals, ceramics, polymers, hybrids), material properties (structural and functional), application orientated material design, some case studies: biomaterials, automotive, aerospace, etc. Structure of metals, Determination of structure and chemical composition, concepts of alloys, phase and phase diagrams. Imperfections in crystals-point defects, dislocations and voids, theory of dislocations, strengthening mechanisms, diffusion in solids, heat treatments and phase transformations, mechanical response and microstructure-property relationship.

9. **Manufacturing Science**

Introduction to Manufacturing and its evolution, Net and near-net shape manufacturing; Metal Casting: Solidification of Alloys and its mechanism, Gating System Design and Estimation of Solidification time, Riser Design and Riser Placement, Process Variations, Defects and Product Design; Metal Forming: Mechanism of plastic deformation, fundamentals of plasticity, Introduction to Force equilibrium method, State of Stress and boundary conditions in Upsetting/forging, Rolling, Wire and tube drawing, Extrusion and Deep Drawing, Defects, Load estimation for one plane strain and one axisymmetric bulk deformation processes, Analysis of Deep Drawing and Bending, Introduction to High velocity forming processes; Powder Processing (Metals and Ceramics), Polymer Part Manufacturing, Introduction and properties of polymer melts and Visco-elasticity, Processing of Thermoplastics (Extrusion, Injection Molding, Blow Molding, Rotational Molding) and Thermosets (compression and transfer molding), Tool and product design principles; Rapid Manufacturing: Need for Rapid Prototyping/Rapid Tooling/Rapid Manufacturing, Introduction to Processes for Prototyping, Tooling and Manufacturing; Joining and Welding: Introduction, Solid State and Fusion Joining, Brazing and Soldering, Mechanical and Adhesive Joining, Metal and nonmetal joining; Metrology: Tolerancing (Dimensional and Geometric) principles and their measurements (Geometrical tolerances using point data), Interferometry – principles, flatness testing using optical flat, optical interferometers.

Conventional Removal and Finishing Processes: Importance of Material Removal and allied processes, classification; Chip Formation; Types of Chips; Tool Specification: Coordinate and Orthogonal Systems; Mechanics of Metal Cutting: Merchant's Circle Diagram, Stress, Strain and Strain Rate, determination of Shear Plane Angle; Tool Wear and Tool Life; Variables affecting Tool Life; Practical Machining Operations: Turning, drilling, milling; Finishing Operations: Grinding (MRR estimation, Wheel Specifications, Wheel Wear) and other processes; Economics of machining: Minimum Production Cost Criterion, Maximum Production Rate and Maximum Profit Rate Criteria; Unconventional Removal and Finishing

Processes: Abrasive Jet Machining, Ultrasonic Machining; Electro Discharge Machining; Abrasive Jet Machining; Electron Beam Machining; Laser Beam Machining, Finishing processes (AFM and other variants); Miniaturization and its importance, Micro-Manufacturing Processes (Additive, formative and Removal), Scaling laws with emphasis on micro-Manufacturing.

**10. Computer Integrated Manufacturing**

Current developments in CAD- feature based modeling, design by feature, function, feature linkages, application of feature based models, parametric modeling; Computer Aided Manufacturing: fundamentals of part programming, path generation, post processing and verification; Group Technology, Computer aided process planning (CAPP), computer aided inspection and reverse engineering, manufacturing process simulation, virtual and distributed manufacturing, computer integrated manufacturing.

**11. Industrial Engineering**

Basics of probability and statistics, Linear Programming and applications, Queuing theory and its applications, forecasting approaches, Monte Carlo simulation procedure. Inventory models discussion (deterministic and probabilistic Models), News vendor model, Inventory Planning and Control, Decision support system tools, Economic Order Quantity (EOQ). Product Design: Design for Manufacture and Assembly (DFMA), Concurrent engineering Work systems design: Work study and classifications, Method study – work measurement, work sampling, Cost Estimation, Calculation of Machining Times, Cost Depreciation, Productivity, Productivity Measurement, Time study, Recording Techniques for Work Study, Information Collection Techniques, Job Evaluation, Ranking system, Incentive Schemes, Individual Group-Company-wide Bonus Schemes, Behavioural aspects of Incentives Plant layout, Ergonomics, CRAFT, Cellular Manufacturing, Scheduling, Assembly Line Balancing, Future directions in Production. Quality management and control: Quality Improvement, Cost of Quality, Statistical Process Control, Central Tendency and Dispersion, Control Charts, Acceptance Sampling, New Quality Concepts, Taguchi Methods, Design of Experiments (DoE), Robust Design, Ishikawa Diagram, ISO certification, Kaizen, Zero Defects Program, Total Quality Management (TQM), Six Sigma; Maintenance Management: Preventive and breakdown maintenance approaches, reliability, Work study for Maintenance, Total Productive Maintenance (TPM), Spare Parts Management, Characteristics and classification of Spare parts; Supply Chain design, scheduling, layout design: Materials Requirement Planning (MRP), MRP-II, Enterprise Resource Planning (ERP), Logistic, Distribution and Supply chain Management, Applications of News vendor model in supply chain.

**12. Modelling and Simulation**

Introduction to modelling and simulation, introduction to symbolic and numerical computations, degrees of freedom, modelling in dependent and independent coordinates, Lagrange equations, state space formulation, Newton-Raphson method, explicit integrator, implicit integrator, dynamics of constrained mechanical systems as differential algebraic equations, Baumgaurte stabilization, Gauss principle, and inverse problems.

## Paper-3
## COMMON TO CIVIL AND MECHANICAL ENGINEERING
## (For Post Code No. 6 & 7)

**1. ENGINEERING DRAWING:**

Conic Sections including the Rectangular Hyperbola. Cycloid, Epicycloid and Hypocycloid, Involute. Scales – Plain, Diagonal and Vernier Scales. Principles of Orthographic Projections – Conventions – Projections of Points and Lines Projections of Plane regular geometric figures, Projections of Regular Solids – Auxiliary Views. Sections or Sectional views of Right Regular Solids – Prism, Cylinder, Pyramid, Cone – Auxiliary views – Sections of Sphere. Development of Surfaces of Right Regular Solids – Prism, Cylinder, Pyramid and Cone Principles of Isometric Projection – Isometric Scale – Isometric Views – Conventions – Isometric Views of Lines, Plane Figures, Simple and Compound Solids – Isometric Projection of objects having non- isometric lines. Isometric Projection of Spherical Parts. Conversion of Isometric Views to Orthographic Views and Vice-versa – Conventions Auto- CAD: Basic principles.

**2. Environmental science:**

Definition, Scope and Importance – Need for Public Awareness. Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation– Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems - Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. - Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. - Energy resources: Growing energy needs, renewable and non-renewable energy sources use of alternate energy sources. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

**3. ECOSYSTEMS:** Concept of an ecosystem. - Structure and function of an ecosystem. - Producers, consumers and decomposers. - Energy flow in the ecosystem - Ecological succession. - Food chains, food webs and ecological pyramids. - Introduction, types and characteristic features, Structure and function of Forest, Grassland, Desert and Aquatic ecosystems.

**4. BIODIVERSITY AND ITS CONSERVATION:** Introduction - Definition: genetic, species and ecosystem diversity. - Bio-geographical classification of India - Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values - . Biodiversity at global, national and local levels. India as a mega-diversity nation - Hot-sports of biodiversity - Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. - Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.
Definition, Cause, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards.

**5. SOLID WASTE MANAGEMENT:** Causes, effects and control measures of urban and industrial wastes. - Role of an individual in prevention of pollution.

**6. DISASTER MANAGEMENT:** floods, earthquake, cyclone and landslides.

**7. SOCIAL ISSUES AND THE ENVIRONMENT:** From Unsustainable to Sustainable development - Urban problems related to energy – Water conservation, rain water harvesting, watershed management - Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, Open zoneone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act - Issues involved in enforcement of environmental legislation. Public awareness.

**8. HUMAN POPULATION AND THE ENVIRONMENT:** Population growth, variation among nations. Population explosion - Family Welfare Programme. Environment and human health. Human Rights. Value Education. HIV/AIDS. Women and Child Welfare. Role of information Technology in Environment and human health.

**9. PRINCIPLES OF ELECTRICAL AND ELECTRONIC ENGINEERING:**

**i. Electrical Circuits -** R-L-C Parameters, Voltage and Current Independent and Dependent Sources, Source Transformation – V–I relationship for Passive elements, Kirchoff's Laws, Network reduction techniques – series, parallel, series- parallel, star–to-delta, delta-to-star transformation,

**ii. Single Phase AC Circuits -** R.M.S. and Average values, Form Factor, steady state analysis of series, Parallel and Series parallel Combinations of R, L and C with Sinusoidal excitation, concept of reactance, Impedance, Susceptance and Admittance – phase and phase difference, Concept of Power Factor, j-notation.

**iii. P-N Junction Diode** - Diode equation, Energy Band diagram, Volt- Ampere characteristic, Temperature dependence, Static and dynamic resistances, Equivalent circuit, Diffusion and Transition Capacitances.

**iv. Bipolar Junction Transistor (BJT) -** Construction, Principle of Operation, Symbol, Amplifying Action, Common Emitter, Common Base and Common Collector configurations. Concepts of Feedback amplifiers and Oscillators

**v. Special Purpose Devices -** Breakdown Mechanisms in Semi Conductor Diodes, Zener diode characteristics, Use of Zener diode as simple regulator.

**vi. Rectifiers and Linear ICs**: PN junction diode applications as Half ware, full ware and Bridge Rectifiers, characteristics of Op-Amp, Application of Op – Amps (Inverting, Non – Inverting, Differentiator and Integrator)

**10. COMPUTER FUNDAMENTALS:**
Basics of computer and its operation: Functional Components and their inter-connections, concept of Booting, Use of Operating System for directory listing, hierarchical directory structure, renaming, deleting files/folders, Memory and types of memory, working with USB flash drives, copying files, concepts of path and pathname, switching between tasks, installation/removal of applications.

PAPER-3
ELECTRICAL ENGINEERING
(For Post Code No. 3 only)

**1. Transmission & Distribution:** Line constants – Inductance and Capacitance calculations – Representation of over head Lines – Short, Medium and Long lines – ABCD constants – Mechanical Design – Sag, Tension Calculations, Tuned Power Lines.
**2. Over Head Line Insulators:** Types of Insulators – Potential distributions over a string of suspension insulators – string efficiency – Methods of improving string efficiency.
**3. Underground Cables:** Insulation of cables – Grading of cables – Capacitance Measurement in cables – Testing of Cables – Power frequency withstand tests.
**4. Fault Calculations:** Balanced Fault calculations on systems – Symmetrical components – Types of faults – Analysis of unbalanced faults.
**5. Generating Stations:** Location and types, types of hydroelectric power stations, layout of a hydro-power plant, types of turbines used – Pumped storage installations – Layout of thermal electric power stations, types of turbines used, condensers, cooling towers, boiler feed pump; energy flow diagram of steam power plant. Nuclear power generation; nuclear fission – types of nuclear power reactors – Principle of a fast breeder reactor.
**6. Protection:** Characteristic of Relays – Over current, directional and distance protection of lines. Protection of Alternators against stator faults, rotor faults, loss of excitation, unbalanced loading, overloading, failure of prime-mover. Over speeding and over voltage. Protection of transformers against winding faults, overloads and external short circuits.
**7. Circuit Breakers:** Air-blast, oil, minimum oil, vacuum – sulphur hexafluoride and d.c. circuit breakers – Relative merits and demerits.
**8. Economic Aspects:** Generation costs and their classification, load curve, load utilization and plant capacity factors. Load sharing between base load and peak-load stations. Load forecasting. Economical distribution of load between unit within a plant and between plants. Modeling of fuel costs for thermal generation. Optimal operation of an all thermal generating system and of a hydro-thermal system. Consideration of transmission losses.
**9. Utilization of Electrical Energy:** Industrial drives – Motors for various drives – Estimating and Rating – Testing of D.C. and A.C. motors – Neutral Earthing.