SCHEME OF EXAMINATION

WRITTEN EXAMINATION (OBJECTIVE TYPE) BACHELOR'S DEGREE STANDARD

PAPER 1 : i) General Studies(QP1)	150 Marks	150 Questions	150 Minutes
PAPER 2 : Concerned Subject Civil & Mechanical &Agricultural Engineering (Common)(QP2)	150 Marks	150 Questions	150 Minutes
PAPER 3: Civil (QP3) OR Mechanical(QP4) OR Civil & Mechanical Engineering (Common)(QP5) OR Mechanical &Agriculture Engineering (Common)(QP6)	150 Marks	150 Questions	150 Minutes
Total:	**450 Marks**		

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)

PAPER -I
GENERAL STUDIES

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 emphases on Indian national movement.
5. Indian polity and governance: constitutional issues, public policy, reforms and e-governance initiatives.
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
    b) Visual representation of data
    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, including

    a). Loss of capital city, challenges in building new capital and it's financial implications.
    b). Division and rebuilding of common Institutions.
    c). Division of employees, their relocation and nativity issues.
    d). Effect of bifurcation on commerce and entrepreneurs.
    e). Implications to financial resources of state government.
    f). Task of post-bifurcation infrastructure development and opportunities for investments.
    g). Socioeconomic, cultural and demographic impact of bifurcation.
    h). Impact of bifurcation on river water sharing and consequential issues.
    i). AP REORGANISATION ACT, 2014 on AP and the arbitrariness of certain provisions.

PAPER-2: COMMON TO CIVIL, MECHANICAL AND AGRICULTURAL ENGINEERING

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: Venturi meter, Orifice meter , turbine flow meters, rotameters; Point measurement: pitot tubes, hot wire/film anemometer, their measurement principles and sources of errors; calibration.

Closed conduit flow: Reynold's 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-losses 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 Electric Power Plant: Water power – Hydrological cycle / flow measurement – drainage area characteristics – Hydrographs – storage and Pondage – classification of dams and spill ways. **Hydro Projects And Plant:** Classification – Typical layouts – plant auxiliaries – plant operation, pumped storage plants.

Paper3: **COMMON TO CIVIL AND MECHANICAL ENGINEERING**

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

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.

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, characteristic features, structure and function of Forest, Grassland, Desert and Aquatic ecosystems.

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.

SOLID WASTE MANAGEMENT: Causes, effects and control measures of urban and industrial wastes. - Role of an individual in prevention of pollution. Disaster management: floods, earthquake, cyclone and landslides.

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, ozone 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.

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.

Principles of Electrical and Electronic Engineering

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,

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.

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

Bipolar Junction Transistor (BJT) - Construction, Principle of Operation, Symbol, Amplifying Action, Common Emitter, Common Base and Common Collector configurations.

Transistor Configurations - BJT modeling, Hybrid model, Determination of h-parameters from transistor characteristics, Analysis of CE, CB and CC configurations using h-parameters, Comparison of CE, CB and CC configurations.

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

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, formatting floppy, copying files, concepts of path and pathname, switching between tasks, installation/removal of applications;

PAPER 3: COMMON TO MECHANICAL AND AGRICULTURAL ENGINEERING

Environmental science

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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

Principles of Electrical and Electronic engineering

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Manufacturing Technology

Introduction to various carpentry tools, types of wood and their characteristics and operations in wood working; Introduction to tools and measuring instruments for fitting; introduction to Smithy tools operations; introduction to tools and operations in sheet metal work ; Introduction to welding, types of welding.

Casting processes. Classification, constructional details of center lathe, Main accessories and attachments. Main operations and tools used on center lathes. Types of shapers, Constructional details of standard shaper. Work holding devices, shaper tools and main operations. Types of drilling machines. Constructional details of pillar and radial drilling machines. Work holding and tool holding devices. Twist drills, Types and classification. Constructional details and principles of operation of column and knee type universal milling machines. Main operations on milling machine.

Cutting tools including CNC tools and finishing tools. Advanced manufacturing techniques like powder metallurgy, Heat Treatment of steels including pack carburizing, shot pining process, chemical vapor deposition (CVD) etc. Limits, Fits & Tolerances, Jigs & Fixtures, Microstructure Analysis. Industrial lay-out planning, Quality management.

Heat and Mass Transfer

Introductory concepts, modes of heat transfer, thermal conductivity of materials, measurement. General differential equation of conduction. One dimensional steady state conduction through plane and composite walls, tubes and spheres with and without heat generation. Insulation materials, critical thickness of insulation. Fins, Free and forced convection. Newton's law of cooling, heat transfer coefficient in convection. Useful non dimensional numbers and empirical relationships for free and forced convection. Equation of laminar boundary layer on flat plate and in a tube. Laminar forced convection on a flat plate and in a tube. Combined free and forced convection. Introduction. Absorptivity, reflectivity and transmissivity of radiation. Black body and monochromatic radiation, Planck's law, Stefan-Boltzman law, Kirchoff's law, grey bodies and emissive power, solid angle, intensity of radiation. Radiation exchange between black surfaces, geometric configuration factor. Heat transfer analysis involving conduction, convection and radiation by networks. Types of heat exchangers, fouling factor, log mean temperature difference, heat exchanger performance, transfer units. Heat exchanger analysis restricted to parallel and counter flow heat exchangers. Steady state molecular diffusion in fluids at rest and in laminar flow, Flick's law, mass transfer coefficients. Reynold's analogy.

Thermodynamics and Heat Engines

Thermodynamics properties, closed and open system, flow and non-flow processes, gas laws, laws of thermodynamics, internal energy. Application of first law in heating and expansion of gases in non-flow processes. First law applied to steady flow processes. Carnot cycle, Carnot theorem. Entropy, physical concept of entropy, change of entropy of gases in thermodynamics process. Generation of steam,. Classification of steam boilers, Lancashire, locomotive and Babcock-Wilcox boilers. Boiler mountings and accessories., Air Standard efficiency, other engine efficiencies and terms. Otto, diesel and dual cycles. Calculation of efficiency, mean effective pressure and their comparison. Measurement of IP, BP and heat balance calculations (not involving combustion). Engine efficiencies and performance.

Sources of farm power -conventional & non-conventional energy sources. Classification of IC engines. Study of engine components their construction, operating principles and functions. Engine systems and their construction details and adjustments; valves & valve mechanism. Fuel & air supply, cooling, lubricating, electrical and ignition systems. IC engine fuels - their properties detonation and knocking in IC engines, study of properties of coolants, anti freeze and anti-corrosion materials, lubricant types & study of their properties. Engine governing systems.

Theory of Machines

Elements, links, pairs, kinematics chain, and mechanisms. Classification of pairs and mechanisms. Lower and higher pairs. Four bar chain, slider crank chain and their inversions. Determination of velocity and acceleration using graphical (relative velocity and acceleration) method. Instantaneous centers. Types of gears. Law of gearing, velocity of sliding between two teeth in mesh. Involute and cycloidal profile for gear teeth. Spur gear, nomenclature, interference and undercutting. Introduction to helical , spiral, bevel and worm gear. Simple, compound, reverted, and epicyclic trains. Determining velocity ratio by tabular method. Turning moment diagrams, co-efficient of fluctuation of speed and energy, weight of flywheel, flywheel applications. Belt drives, types of drives, belt materials. Length of belt, power transmitted, velocity ratio, belt size for flat and V belts. Effect of centrifugal tension, creep and slip on power transmission, Chain drives. Types of friction, laws of dry friction. Friction of pivots and collars. Single disc, multiple disc, and cone clutches. Rolling friction, anti friction bearings. Types of governors. constructional details and analysis of Watt, Porter, Proell governors. Effect of friction, controlling force curves. Sensitiveness, stability, hunting, isochronism, power and effort of a governor. Static and dynamic balancing. Balancing of rotating masses in one and different planes. Partial primary balancing of reciprocating masses.

Mechanical measurements and Instrumentation

Measurement and its significance-methods of measurement , instruments, classification of instruments, elements of a generalized measurement system, errors in measurement and their uncertainity; Detector transducer elements-introduction, primary and secondary transducer, classification, signal conditioning and data presentation elements, static performance characteristics of instruments; Measurement of pressure, introduction, types of pressure measuring devices, ranges and their application; Measurement of strain, introduction, strain gauge, resistance strain gauge theory, strain gauge circuits, strain gauges arrangements for the measurement of axial force, bending force , torque and pressure; Measurement of temperature, introduction, classification of temperature measuring devices, methods of measuring temperature; Measurement of sound, introduction, measurement of sound using microphones; Study of miscellaneous instruments, Tachometer, stroboscope, proving ring, LVDT.

Industrial Engineering and Management

Organization, administration and management; Definition, types, quality of good industrial management, advantages of good organization, purchase organization; Stores, store keeping, inventory control, economic order quantity; Site selection of a factory, general location of a factory, factory layout; plant lay out , principles, methods , flow pattern, advantages of scientific plant layout; production planning and control, continuous, mass , intermittent production; scales forecasting techniques ; Process planning, definition, procedure , economic batch quantity; Elements cost ; Scheduling , factors affecting scheduling, procedure, techniques; Dispatching procedure, operations route sheet, progress control, orders control, methods to take corrective action, routing and scheduling, operation and route sheet; Standardisation, procedure, advantages, simplification, specialisation, interchangeability; Inspection and quality control, kinds of inspection, sampling inspection, advantages, sampling plans, characteristics of

single sampling plan , double sampling plan, multiple sampling plans; Control charts, types, characteristics, plotting of X,R,P,C charts; Work study, method study, work measurement study, definitions, advantages, method study procedure, work measurement procedure; Indian factory act 1948- Health, safety, welfare provisions in factory act.

Refrigeration and Air Conditioning

Principles of refrigeration, - units, terminology, production of low temperatures, air refrigerators working on reverse carnot cycle and bell coleman cycle. Vapor refrigeration-mechanism, P-V,P-S,P-H diagrams, vapor compression cycles, dry and wet compression, super cooling and sub cooling. Vapour absorption refrigeration system. Common refrigerants and their properties. Design calculations for refrigeration system. Cold storage plants.

Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric process. Air conditioning – principles –Type and functions of air conditioning, physiological principles in air conditioning, air distribution and duct design methods, fundamentals of design of complete air conditioning systems – humidifiers and dehumidifiers – cooling load calculations, types of air conditioners – applications.

Renewable Energy Resources

Classification of energy sources; introduction to renewable energy sources; characterization of biomass; types, construction, working principle, uses and safety/environmental aspects of different renewable energy devices like gasifiers, biogas plants, solar passive heating devices, photovoltaic cells and arrays; Brief introduction to wind energy, hydroelectric energy, ocean energy, briquetting and baling of biomass, biomass combustion, biodiesel preparation and energy conservation in agriculture.

PAPER – 3 : OPTIONAL FOR CIVIL ENGINEERING

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 maculay'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 bems, axially and eccentrically loaded joints, Simple connection of bracket plates to columns, beam to beam and beam to column connections, design of framed, unstiffened 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 theirgauging; 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 OPTIONAL FOR MECHANICAL ENGINEERNG

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; Exergy – Work potential of energy; reversible work and irreversibility; Second Law efficiency; Exergy change of a system; Exergy transfer by heat, work and mass; Exergy balance for closed system and control volumes; Power & Refrigeration Cylces – 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, multistaging 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, MicroManufacturing Processes (Additive, formative and Removal), Scaling laws with emphasis on microManufacturing.

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