



# **Gujarat Public Service Commission**

**Advt.25/2022-23**

Scheme and Syllabus for the Competitive  
Examination of Executive Engineer  
(Mechanical) and Deputy Executive Engineer  
(Mechanical) under Gujarat Water Supply and  
Sewerage Board

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## Scheme of Examination:-

Note: The medium of the examination shall be English. The medium of Part I General Studies of Paper-1 shall be in Gujarati and English. Gujarati and English Papers in Main Examination shall be in respective Language only. In case of question of interpretation of syllabus, the interpretation of English shall be final.

### 1. Preliminary Examination

Paper No.	Nature of Exam	Name of the paper	Time	Total Allotted Marks
1.	Objective	Part-I General Studies, Part-II Mechanical Engineering Aptitude	2 Hours	100 100
2.		Mechanical Engineering	3 Hours	300
			Total Marks	500

(The Preliminary Examination is a screening test only and marks obtained in the preliminary test shall not be counted for final selection.)

### 2. Main Examination

(For only those candidates who are declared qualified in Preliminary Examination)

Paper No.	Nature of Exam	Name of Paper	Time	Total Allotted Marks
1.	All Papers are Descriptive	Gujarati	2 Hours	100
2.		English	2 Hours	100
3.		Mechanical Engineering -1	3 Hours	200
4.		Mechanical Engineering-2	3 Hours	200
5.		Mechanical Engineering-3	3 Hours	200
Total Marks of written Examination				800
Interview (Only for the candidates who are declared qualified in Main Written Examination)				100
Total Marks to be considered for Final Selection				900

**Syllabus of Preliminary Examination for  
the Competitive Examination of Executive  
Engineer (Mechanical) and Deputy  
Executive Engineer (Mechanical) under  
Gujarat Water Supply and Sewerage Board**

# **Paper 1: General Studies and Mechanical Engineering**

## **Aptitude (Preliminary Examination – Objective)**

**Total Marks-200**

**No. of Questions-200**

**Time-2 Hours**

### **Part-I General Studies**

**Marks-100**

**Medium: English/Gujarati**

1. Indus valley Civilization: Features, Sites, Society, Cultural History, Art and Religion. Vedic age. Important Dynasties of India and Gujarat – Impact and Contribution, Important Policies, their administration, economy, society, religion, literature, arts and architecture. India's Freedom Movement, Revolutionaries in India and abroad. Achievements and administrative reforms of the rulers of princely states of Saurashtra, Kutchh and Gujarat.
2. Cultural Heritage of India and Gujarat: Art forms, Literature, Litterateurs, Sculpture and Architecture, Important organizations and institutions.
3. Geography of India and Gujarat: Physical, Social and Economic. General issues, legal aspect, policies and treaties on Environment Ecology, Bio-diversity and Climate Change. Forest and Wildlife Conservation in India. Environmental Hazards, Pollution, Carbon Emission, Global warming.
4. Indian Constitution: Evolution, features, Preamble, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Amendments, Significant Provisions and Basic Structure. Panchayati Raj, Public Policy and Governance. Rights Issues (Human rights, Women rights, SC/ST rights, Child rights) etc. Important Policies and Programmes of Central and State Governments. India's Foreign Policy: International Relations, Important Institutions, Agencies and Fora, their structure and mandate.

5. Indian Economy: Emergence and development of planning exercise in India, Performance, Dynamics, Challenges, New Initiatives, Reforms etc. by the State and Central Government. Important Events, Developments and Social Sector Initiatives. NITI Aayog: aims, constitution and functions. Social Audit. Regulatory framework for money and banking: concepts, structure and role.
6. Science and Technology: Relevance of Science & Technology to the day to day life; Institutions and Organization in India promoting integration of Science, Technology and Innovation, their activities and contribution; Contribution of Prominent Indian Scientists. Awareness in the field of Information and Communication Technology (ICT), Space Technology, Technology in Defence, Biotechnology, Nanotechnology etc. Energy policy of India, Nuclear Policy of India.
7. Current Events of Regional, National and International importance.

## ભાગ-૧ સામાન્ય અભ્યાસ

ગુણ-૧૦૦

માધ્યમ: ગુજરાતી/અંગ્રેજી

૧. સિંધુ ખીણની સભ્યતા: લાક્ષણિકતાઓ, સ્થળો, સમાજ, સાંસ્કૃતિક ઇતિહાસ, કળા અને ધર્મ. વેદિક યુગ. ભારત અને ગુજરાતના રાજવંશો-અસરો અને પ્રદાન, મહત્વની નીતિઓ, તેમનું વહીવટી તંત્ર, અર્થતંત્ર, સમાજ, ધર્મ, કલા, સ્થાપત્ય અને સાહિત્ય. ભારતની સ્વતંત્રતા માટેની ચળવળ, ભારત અને વિદેશમાં ભારતીય ક્રાંતિકારીઓ. સૌરાષ્ટ્ર, કચ્છ અને ગુજરાતના દેશી રાજ્યોના શાસકોના સુધારાવાદી પગલાઓ અને સિદ્ધિઓ.
૨. ભારત અને ગુજરાતનો સાંસ્કૃતિક વારસો : કળાસ્વરૂપો, સાહિત્ય, સાહિત્યકારો, શિલ્પ અને સ્થાપત્ય, મહત્વની સંસ્થાઓ અને સંગઠનો.
૩. ભારત અને ગુજરાતની ભૂગોળ : ભૌતિક, સામાજિક અને આર્થિક. પર્યાવરણની જાળવણી, બાયોડાયવર્સિટી (જૈવ વિવિધતા) અને ક્લાઈમેટ ચેંજ માટેના સામાન્ય મુદ્દાઓ, કાયદાકીય પાસાઓ, નીતિઓ અને સંધિઓ. ભારતમાં વન અને વન્યજીવન સંરક્ષણ. પર્યાવરણીય આપત્તિઓ, પ્રદૂષણ, કાર્બન ઉત્સર્જન અને વૈશ્વિક ગરમી (તાપવૃદ્ધિ).
૪. ભારતીય બંધારણ: ઉદ્ભવ અને વિકાસ, લાક્ષણિકતાઓ, આમુખ, મૂળભૂત અધિકારો અને ફરજો, માર્ગદર્શક સિદ્ધાંતો, બંધારણીય સુધારા, મહત્વની જોગવાઈઓ અને અંતર્નિહિત માળખું. પંચાયતી રાજ. જાહેર નીતિ અને શાસન. અધિકાર સંલગ્ન મુદ્દાઓ (માનવ અધિકાર, સ્ત્રીઓના અધિકાર, એસસી-એસટી અધિકારો, બાળકોના અધિકાર) ઈત્યાદી. કેન્દ્ર અને રાજ્ય સરકારની અગત્યની નીતિઓ અને કાર્યક્રમો. ભારતની

વિદેશનિતી: આંતરરાષ્ટ્રીય સંબંધો, મહત્વની સંસ્થાઓ, એજન્સી, વિવિધ સંગઠનો, તેમનું માળખું અને અધિકૃત આદેશ.

૫ ભારતીય અર્થતંત્ર: ભારતમાં આયોજનની કામગીરીનો ઉદભવ અને વિકાસ. કેન્દ્ર અને રાજ્ય સરકારની કામગીરી, ગતિશીલતા, પડકારો, નવી પહેલ, સુધારણા વગેરે. અગત્યની ઘટનાઓ, વિકાસ અને સામાજિક ક્ષેત્રની પહેલ. નીતિ આયોગ: ઉદ્દેશો, બંધારણ અને કાર્યો. સામાજિક ઓડિટ. નાણાં અને બેન્કિંગ માટે નિયમનકારી માળખું: વિભાવનાઓ, માળખું અને ભૂમિકા.

૬. વિજ્ઞાન અને ટેકનોલોજી; વિજ્ઞાન અને ટેકનોલોજીનું સ્વરૂપ અને ક્ષેત્ર, રોજબરોજના જીવનમાં વિજ્ઞાન અને ટેકનોલોજીની પ્રસ્તુતતા, ભારતમાં વિજ્ઞાન, ટેકનોલોજી અને ઇનોવેશન સાથે સંકળાયેલી વિવિધ સંસ્થાઓ, તેમની પ્રવૃત્તિઓ અને યોગદાન, પ્રસિધ્ધ ભારતીય વૈજ્ઞાનિકોનું યોગદાન. ઈન્ફર્મેશન અને કોમ્યુનિકેશન ટેકનોલોજી (આઇસીટી), અંતરીક્ષ/અવકાશ અને સંરક્ષણ સેવાઓમાં ટેકનોલોજી, બાયોટેકનોલોજી અને નેનોટેકનોલોજી વગેરે ક્ષેત્રોમાં જાગૃતિ, ભારતની ઉર્જા નીતિ અને પરમાણુ નીતિ.

૭. પ્રાદેશિક, રાષ્ટ્રીય અને આંતરરાષ્ટ્રીય કક્ષાની મહત્વની સાંપ્રત ઘટનાઓ



## **Part II :Mechanical Engineering Aptitude**

**Marks-100**

**Medium: English**

- Engineering Aptitude covering Logical reasoning and Analytical ability.
- Engineering Mathematics and Numerical Analysis.
- General Principles of Design, Drawing, Importance of Safety.
- Standards and Quality practices in production, construction, maintenance and services.
- Theory of Machines.
- Basics of Electrical Engineering
- Basics of Semiconductor Devices.
- Basics of Energy and Environment: Conservation, environmental pollution and degradation, Climate Change, Environmental impact assessment.
- Basics of Project Management.
- Basics of Material Science and Engineering.
- Information and Communication Technologies (ICT) based tools and their applications in Engineering such as networking, e-governance and technology based education.
- Ethics and values in engineering profession.

**Paper 2: Mechanical Engineering**  
**(Preliminary Examination - Objective)**

**Marks-300**

**No. of Questions-300**

**Medium- English**

**Time-3 Hours**

**1. THERMODYNAMICS:**

- Fundamentals- thermodynamic systems and control Volume; Thermodynamic Properties, Process and state; Exact and Inexact differentials; Work- Thermodynamic definition; Temperature, Definition of thermal equilibrium and Zeroth law; Definition of heat; Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Properties of pure substances, behavior of ideal and real gases; Definitions of saturated states; Identification of states & determination of properties, Mollier's chart.
- First Law for Cyclic & Non-cyclic processes; Concept of total energy E; Various modes of energy, Internal energy and Enthalpy.
- Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale.
- Clausius inequality; Definition of entropy S ; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Principle of increase of entropy; Definition of Isentropic efficiency for compressors, turbines and nozzles- Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis.
- Thermodynamic cycles - Basic Rankine cycle; Basic Brayton cycle; Basic vapor compression cycle and comparison with Carnot cycle.

## 2. HEAT-TRANSFER:

- Introduction to three modes of heat transfer, heat balance equation- Steady one dimensional solution for conduction heat transfer, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer, Heissler charts.
- Heat convection, basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.
- Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Wien's displacement law
- Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and NTU methods,
- Introduction to mass transfer, Similarity between heat and mass transfer.

## 3. Mathematics:

- Multivariable Calculus (Integration), Multiple Integration, Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

- First order ordinary differential equations: Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for  $p$ , equations solvable for  $y$ , equations solvable for  $x$  and Clairaut's type.
- Ordinary differential equations of higher orders: Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.
- Complex Variable – Differentiation: Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.
- Complex Variable – Integration: Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

#### **4. Fluid Mechanics:**

- Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, manometry, buoyancy, forces on submerged bodies, stability of floating bodies, fluid acceleration, fluid statics, momentum and energy, Control volume- application of continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications.
- Exact flow solutions in channels and ducts, Couette and Poiseuille flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach

equation, friction factor, Moody's diagram. Elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings, Types of Pipes.

- Need for dimensional analysis—methods of dimension analysis—Similitude—types of similitude Dimensionless parameters—application of dimensionless parameters—Model analysis.
- Euler's equation – theory of Rotodynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps- Reciprocating pump—working principle.
- Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube-Specific speed, unit quantities, performance curves for turbines – governing of turbines.
- Types of Pumps, Pump viscosity, Centrifugal, NPSH, Pump curves, Progressive cavity, Screw pumps, Rope Pump, Submersible, Vertical turbine, Coupling section, Motor section, Well Section, Hydraulic Principles, General pumping fundamental.
- Spillways-Types of spillway based on most prominent features, Spillway Crest Gates.
- Flood Management: Methods of Flood Control, Flood Alleviation or Flood Mitigation, Structural Mitigation Measures, Non-Structural Mitigation Measures.

## **5. Power Engineering and Power Plant Engineering:**

- Air and gas compressors; vapor and gas power cycles, concepts of regeneration and reheat.
- Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers,

turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems

- Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems.
- Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.
- Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems
- Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants.

## **6. I.C. Engines:**

- Combustion in SI and CI engines, Combustion stages, Combustion chambers and abnormal combustion. Fuel supply systems in SI and CI engines, carburetors, Port fuel injection, direct injection and Common rail injection. Ignition system, Lubrication system and Cooling system. Testing of IC engines. Engine emissions and control. Advanced IC Engine concepts Air-standard Otto, Diesel and dual cycles.
- Engine Management, Engine System, Engine Mapping, Open Loop Engine Control Systems, Closed loop Engine Control System, Additional Engine Management System, lean burn engine control. Complete Vehicle Control System, Artificial intelligence and Engine management. Maintenance and

fault diagnostics of engine management system, Engine diagnostics, Troubles and Tune-up, Engine service. Vehicle performance-performance parameters.

- Heavy Earth Movers, Types of Excavators, Dumpers, Draggers, Cranes.

#### **7. Refrigeration and air-conditioning:**

- Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes.

#### **8. Strength of Materials:**

- Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses-elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle, Poisson's Ratio.
- Beams and types transverse loading on beams- shear force and bend moment diagrams- Types of beam supports, simply supported and overhanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.
- Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems.
- Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at ends, stresses and deflection of helical springs.
- Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure.

- Euler's Theory of columns, Energy methods, Thermal Stress, Strain Gauge and rosettes, Testing of Materials with Universal testing Machine, Testing of Hardness and Impact Strength.

#### **9. Engineering Mechanics:**

- Free-body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations, collisions.

#### **10. Kinematics and Theory of Machines:**

- Classification of mechanisms-Basic kinematic concepts and definitions-Degree of freedom, mobility- Grashof's law, Universal Joint-Rocker mechanisms Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope.
- Pumps and Motors, Compressors.

#### **11. Engineering Materials:**

- Structure and properties of engineering materials, phase diagrams, heat treatment, stress-strain diagrams for engineering materials. Young's modulus, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength. Static failure theories: Ductile and brittle failure mechanisms, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fracture mechanics: Introduction to Stress- intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Introduction to non-destructive testing (NDT).



## **12. Manufacturing Processes:**

- Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design. Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy. Principles of welding, brazing, soldering and adhesive bonding, Welding and weld Testing, Classifying Welding process, Fusion versus non-fusion, Pressure versus non-pressure, Energy source of welding, other basis for classification and sub-classification.
- Heat treatment process-Annealing, tempering, normalizing and spheroidising,
- Alloying of steel, properties of stainless steel and tool steels, maraging steels-cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminum and Al-Cu – Mg alloys- Nickel based super alloys and Titanium alloys.
- Unconventional Machining Processes: Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, principles and process parameters, Electrical Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear, dielectric, power and control circuits, wire EDM; Electro-chemical machining (ECM), etchant & maskant, process parameters, MRR and surface finish. Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining.

## **13. Metrology and Inspection:**

- Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.

**14. Computer Integrated Manufacturing:**

- Basic concepts of CAD/CAM and their integration tools. NC/CNC Technology and Part programming, Microprocessors in Automation.

**15. Design of Machine Elements**

- Design considerations - limits, fits and standardization, Review of failure theories for static and dynamic loading (including fatigue failure), Design of shafts under static and fatigue loadings, Analysis and design of sliding and rolling contact bearings, Design of transmission elements: spur, helical, bevel and worm gears; belt and chain drives, Design of springs: helical compression, tension, torsional and leaf springs, Design of joints: threaded fasteners, pre-loaded bolts and welded joints, Analysis and applications of power screws and couplings, Analysis of clutches and brakes

**16. Basic Electronic Engineering**

- Semiconductor Devices and Applications: Introduction to P-N junction Diode and V-I characteristics, Half wave and Full-wave rectifiers, capacitor filter. Zener diode and its characteristics, Zener diode as voltage regulator. Regulated power supply IC based on 78XX and 79XX series, Introduction to BJT, its input-output and transfer characteristics, BJT as a single stage CE amplifier, frequency response and bandwidth.

**17. Operations Research:**

- Linear programming, simplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

**18. Current Trends and Recent Advancements in the field of Mechanical Engineering.**

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Gujarat Water Supply and Sewerage Board**

## પ્રશ્નપત્ર ૧: ગુજરાતી

### (મુખ્ય પરીક્ષા - વર્ણનાત્મક)

ગુણ-૧૦૦

માધ્યમ: ગુજરાતી

સમય-૨ કલાક

<u>અનુક્રમ</u>	<u>અભ્યાસક્રમની વિગત</u>	<u>જ્ઞાનવાચેલ</u>
		<u>ગુણ</u>
૧.	નિબંધ : ત્રણ પૈકી કોઈપણ એક (આશરે ૨૫૦ થી ૩૦૦ શબ્દોમાં) (વર્ણનાત્મક/વિશ્લેષણાત્મક/ ચિંતનાત્મક/સાંપ્રત સમસ્યા પર આધારિત).	૨૦
૨.	વિચાર વિસ્તાર : (બે પૈકી કોઈપણ એક) કાવ્યપંક્તિઓ કે ગદ્યસૂક્તિનો વિચારવિસ્તાર (આશરે ૧૦૦ શબ્દોમાં)	૧૦
૩.	સંક્ષેપીકરણ : આપેલા ગદ્યખંડમાંથી આશરે ૧/૩ ભાગમાં તમારા શબ્દોમાં સંક્ષેપ	૧૦
૪.	ગદ્યસમીક્ષા: આપેલા ગદ્યખંડના આધારે પૂછેલા પ્રશ્નોના જવાબ લખો.	૧૦
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૭.	દ્રશ્ય આલેખન : (ચિત્ર પરથી લખાણ આશરે ૧૫૦ શબ્દોમાં) (આલેખ/ચિત્ર/ફ્લો ચાર્ટ/સરખામણી પત્રક/આંકડાકીય માહિતી વગેરે)	૧૦
૮.	ભાષાંતર : અંગ્રેજીમાંથી ગુજરાતીમાં અનુવાદ	૧૦
૯.	ગુજરાતી વ્યાકરણ સૂચવ્યા મુજબ જવાબ લખો. (આ પ્રશ્નોમાં આંતરિક વિકલ્પો રહેશે નહીં.) ૧) રૂઢિપ્રયોગોના અર્થ અને તેનો વાક્યપ્રયોગ ૨) કહેવતોનો અર્થ	૧૦

- ૩) સમાસનો વિગ્રહ કરી તેની ઓળખ
- ૪) છંદ ઓળખાવો
- ૫) અલંકાર ઓળખાવો
- ૬) શબ્દસમૂહ માટે એક શબ્દ
- ૭) જોડણી શુદ્ધિ
- ૮) લેખન શુદ્ધિ/ભાષા શુદ્ધિ
- ૯) સંધિ - જોડો કે છોડો
- ૧૦) વાક્યરચનાના અંગો/ વાક્યના પ્રકાર/ વાક્ય પરિવર્તન

GPSSC

**PAPER 2: ENGLISH**  
**(MAIN EXAMINATION - DESCRIPTIVE)**

**MARKS - 100**

**Medium: English**

**Time- 2 HOURS**

<b><u>Serial</u></b>	<b><u>TYPE OF QUESTION</u></b>	<b><u>Marks to be</u></b>
<b><u>No.</u></b>		<b><u>allotted</u></b>
01	<b>ESSAY</b> (A minimum of 250 words and a maximum of 300 words): Choose any one topic from a list of five. (Descriptive/ analytical/ philosophical/ based on Current Affairs)	20
02	<b>LETTER WRITING</b> (in about 150 words):  A formal letter expressing one's opinion about an issue. The issues can deal with daily office matters/ a problem that has occurred in the office/ an opinion in response to one sought by a ranked officer/issues pertaining to recent concern etc.	10
03	<b>REPORT WRITING</b> (in about 200 words):  A report on an official function/event/field trip/survey etc.	10
04	<b>WRITING ON VISUAL INFORMATION</b> (in about 150 words) : A report on a graph/image/ flow chart/table of comparison/ simple statistical data etc.	10
05	<b>FORMAL SPEECH</b> (in about 150 words):  A speech (in a formal style) that is to be read out in a formal function. This could be an inauguration speech, an educational seminar/conference, a formal ceremony of importance etc.	10
06	<b>PRECIS WRITING:</b>  A precis in about 100 words for a 300-word passage.	10

07	<b>READING COMPREHENSION:</b>	10
	A reading passage of about 250 words to be given followed by short-answer type questions.	
08	<b>ENGLISH GRAMMAR:</b>	10
	a. Tenses	
	b. Voice	
	c. Narration (Direct-Indirect)	
	d. Transformation of sentences	
	e. Use of Articles and Determiners	
	f. Use of Prepositions	
	g. Use of Phrasal verbs	
	h. Use of idiomatic expressions	
	i. Administrative Glossary	
	j. Synonyms/Antonyms	
09.	<b>TRANSLATION:</b>	10
	Translation of a short passage (of about 150 words) from Gujarati to English.	

**Paper 3: Mechanical Engineering 1**  
**(Main Examination – Descriptive)**

**Marks-200**

**Medium- English**

**Time: 3 hours**

**The structure of the question paper shall be as below:**

No of Questions	Marks Allotted to each Question	Word limit for each Answer	Total Marks
11	10	As per the given space	110
06	15	As per the given space	90

**1. THERMODYNAMICS:**

- Fundamentals- thermodynamic systems and control Volume; Thermodynamic Properties, Process and state; Exact and Inexact differentials; Work- Thermodynamic definition; Temperature, Definition of thermal equilibrium and Zeroth law; Definition of heat; Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Properties of pure substances, behavior of ideal and real gases; Definitions of saturated states; Identification of states & determination of properties, Mollier's chart.
- First Law for Cyclic & Non-cyclic processes; Concept of total energy E; Various modes of energy, Internal energy and Enthalpy.
- Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale.
- Clausius inequality; Definition of entropy S ; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Principle of increase of entropy; Definition of Isentropic efficiency for compressors, turbines and nozzles- Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis.



- Thermodynamic cycles - Basic Rankine cycle; Basic Brayton cycle; Basic vapor compression cycle and comparison with Carnot cycle.

## 2. Applied Thermodynamics

- Introduction to solid, liquid and gaseous fuels– Stoichiometry, exhaust gas analysis- First law analysis of combustion reactions- Heat calculations using enthalpy tables- Adiabatic flame temperature- Chemical equilibrium and equilibrium composition calculations using free energy.
- Vapor power cycles Rankine cycle with superheat, reheat and regeneration,exergy analysis. Super-critical and ultra super-critical Rankine cycle- Gas power cycles, Air standard Otto, Diesel and Dual cycles-Air standard Brayton cycle,effect of reheat, regeneration and intercooling- Combined gas and vapor power cycles- Vapor compression refrigeration cycles, refrigerants and their properties.
- Properties of dry and wet air,use of pschyrometric chart, processes involving heating/cooling and humidification/dehumidification, dew point.
- Basicsof compressible flow. Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow- Flow of steam and refrigerant through nozzle,supersaturation- compressible flow in diffusers, efficiency of nozzle and diffuser.
- Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors.
- Analysis of steam turbines, velocity and pressure compounding of steam turbines.

## 3. Kinematics and Theory of Machines

- Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar

chain and slider crank chains- Limit positions- Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line generators- Universal Joint- Rocker mechanisms.

- Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations- kinematic analysis of simple mechanisms- slider crank mechanism dynamics Coincident points- Coriolis component of acceleration- introduction to linkage synthesis three position graphical synthesis for motion and path generation.
- Classification of cams and followers- Terminology and definitions- Displacement diagrams-Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers.
- Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics.
- Surface contacts- sliding and rolling friction- friction drives- bearings and lubrication friction clutches- belt and rope drives- friction in brakes.

#### **4. Fluid Mechanics:**

- Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, manometry, buoyancy, forces on submerged bodies, stability of floating bodies, fluid acceleration, fluid statics, momentum and energy, Control volume- application of continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications.
- Exact flow solutions in channels and ducts, Couette and Poiseuille flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach

equation, friction factor, Moody's diagram. Elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings, Types of Pipes.

- Need for dimensional analysis—methods of dimension analysis—Similitude—types of similitude Dimensionless parameters—application of dimensionless parameters—Model analysis.
- Euler's equation – theory of Rotodynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps- Reciprocating pump—working principle.
- Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube-Specific speed, unit quantities, performance curves for turbines – governing of turbines.
- Types of Pumps, Pump viscosity, Centrifugal, NPSH, Pump curves, Progressive cavity, Screw pumps, Rope Pump, Submersible, Vertical turbine, Coupling section, Motor section, Well Section, Hydraulic Principles, General pumping fundamental.
- Spillways-Types of spillway based on most prominent features, Spillway Crest Gates.
- Flood Management: Methods of Flood Control, Flood Alleviation or Flood Mitigation, Structural Mitigation Measures, Non-Structural Mitigation Measures.

## **5. I.C. Engines:**

- Combustion in SI and CI engines, Combustion stages, Combustion chambers and abnormal combustion. Fuel supply systems in SI and CI engines, carburetors, Port fuel injection, direct injection and Common rail injection. Ignition system, Lubrication system and Cooling system. Testing of IC

engines. Engine emissions and control. Advanced IC Engine concepts Air-standard Otto, Diesel and dual cycles.

- Engine Management, Engine System, Engine Mapping, Open Loop Engine Control Systems, Closed loop Engine Control System, Additional Engine Management System, lean burn engine control. Complete Vehicle Control System, Artificial intelligence and Engine management. Maintenance and fault diagnostics of engine management system, Engine diagnostics, Troubles and Tune-up, Engine service. Vehicle performance-performance parameters.
- Heavy Earth Movers, Types of Excavators, Dumpers, Draggers, Cranes.

## **6. Engineering Materials:**

- Structure and properties of engineering materials, phase diagrams, heat treatment, stress-strain diagrams for engineering materials. Young's modulus, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell and Vickers and their relation to strength. Static failure theories: Ductile and brittle failure mechanisms, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb; Fracture mechanics: Introduction to Stress- intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Introduction to non-destructive testing (NDT).

## **7. Energy Conservation and Management**

- Introduction to energy & power scenario of world, National Energy consumption data and environmental aspects associated with energy utilization; Energy Auditing- need, types, methodology and barriers, role of energy managers, instruments of energy auditing.
- Components of EB billing, HT and LT supply, transformers, cable sizing; Concept of capacitors, power factor improvement, harmonics; Electric motors- motor efficiency computation, energy efficient motors; Illumination- Lux,

Lumens, types of lighting, efficacy, LED lighting and scope of energy conservation in lighting.

- Thermal systems, Boilers, Furnaces and Thermic Fluid heaters- efficiency computation and energy conservation measures; Steam distribution and usage, steam traps, condensate recovery, flash steam utilization; Insulation & Refractories.
- Energy conservation in major utilities; pumps, fans, blowers, compressed air systems, Refrigeration & Air Conditioning systems, Cooling Towers, DG sets.
- Energy Economics- discount period, payback period, internal rate of return, net present value; Life Cycle costing- ESCO concept.

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**Paper 4: Mechanical Engineering 2**  
**(Main Examination – Descriptive)**

**Marks-200**

**Medium- English**

**Time: 3 hours**

**The structure of the question paper shall be as below:**

No of Questions	Marks Allotted to each Question	Word limit for each Answer	Total Marks
11	10	As per the given space	110
06	15	As per the given space	90

**1. HEAT-TRANSFER:**

- Introduction to three modes of heat transfer, heat balance equation- Steady one dimensional solution for conduction heat transfer, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer, Heissler charts.
- Heat convection, basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection- Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow- Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.
- Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Wien's displacement law
- Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and NTU methods,

- Introduction mass transfer, Similarity between heat and mass transfer.

## **2. Refrigeration and air-conditioning:**

- Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes.

## **3. Strength of Materials:**

- Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses-elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle, Poisson's Ratio.
- Beams and types transverse loading on beams- shear force and bend moment diagrams- Types of beam supports, simply supported and overhanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.
- Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems.
- Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at ends, stresses and deflection of helical springs.
- Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure.
- Euler's Theory of columns, Energy methods, Thermal Stress, Strain Gauge and rosettes, Testing of Materials with Universal testing Machine, Testing of Hardness and Impact Strength.

#### **4. Engineering Mechanics:**

- Free-body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations, collisions.

#### **5. Design of Machine Elements**

- Design considerations - limits, fits and standardization, Review of failure theories for static and dynamic loading (including fatigue failure), Design of shafts under static and fatigue loadings, Analysis and design of sliding and rolling contact bearings, Design of transmission elements: spur, helical, bevel and worm gears; belt and chain drives, Design of springs: helical compression, tension, torsional and leaf springs, Design of joints: threaded fasteners, pre-loaded bolts and welded joints, Analysis and applications of power screws and couplings, Analysis of clutches and brakes

#### **6. Basic Electronic Engineering**

- Semiconductor Devices and Applications: Introduction to P-N junction Diode and V-I characteristics, Half wave and Full-wave rectifiers, capacitor filter. Zener diode and its characteristics, Zener diode as voltage regulator. Regulated power supply IC based on 78XX and 79XX series, Introduction to BJT, it's input-output and transfer characteristics, BJT as a single stage CE amplifier, frequency response and bandwidth.

#### **7. Current Trends and Recent Advancements in the field of Mechanical Engineering.**



**Paper 5: Mechanical Engineering 3**  
**(Main Examination – Descriptive)**

**Marks-200**

**Medium- English**

**Time: 3 hours**

**The structure of the question paper shall be as below:**

No of Questions	Marks Allotted to each Question	Word limit for each Answer	Total Marks
11	10	As per the given space	110
06	15	As per the given space	90

**1. Mathematics:**

- Multivariable Calculus (Integration), Multiple Integration, Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.
- First order ordinary differential equations: Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.
- Ordinary differential equations of higher orders: Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.
- Complex Variable – Differentiation: Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate;

elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

- Complex Variable – Integration: Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

## **2. Manufacturing Processes:**

- Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design. Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy. Principles of welding, brazing, soldering and adhesive bonding, Welding and weld Testing, Classifying Welding process, Fusion versus non-fusion, Pressure versus non-pressure, Energy source of welding, other basis for classification and sub-classification.
- Heat treatment process-Annealing, tempering, normalizing and spheroidising,
- Alloying of steel, properties of stainless steel and tool steels, maraging steels-cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminum and Al-Cu – Mg alloys- Nickel based super alloys and Titanium alloys.
- Unconventional Machining Processes: Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultrasonic Machining, principles and process parameters (5)Electrical Discharge Machining, principle and processes parameters, MRR, surface finish, tool wear, dielectric, power and control circuits, wire EDM; Electro-chemical machining (ECM), etchant & maskant, process parameters, MRR and surface finish. Laser Beam Machining (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining.

### **3. Manufacturing Technology**

- Tooling for conventional and non-conventional machining processes: Mould and die design, Press tools, Cutting tools; Holding tools: Jigs and fixtures, principles, applications and design; press tools – configuration, design of die and punch; principles of forging die design.
- Metrology: Dimensions, forms and surface measurements, Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; Metrology in tool wear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as micro-scale machining, Inspection and workpiece quality.
- Assembly practices: Manufacturing and assembly, process planning, selective assembly, Material handling and devices.
- Linear programming, objective function and constraints, graphical method, Simplex and duplex algorithms, transportation assignment, Traveling Salesman problem; Network models: shortest route, minimal spanning tree, maximum flow model- Project networks: CPM and PERT, critical path scheduling; Production planning & control: Forecasting models, aggregate production planning, materials requirement planning. Inventory Models: Economic Order Quantity, quantity discount models, stochastic inventory models, practical inventory control models, JIT. Simple queuing theory models.

### **4. Metrology and Inspection:**

- Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.

### **5. Computer Integrated Manufacturing:**

- Basic concepts of CAD/CAM and their integration tools. NC/CNC Technology and Part programming, Microprocessors in Automation.

## **6. Power Engineering and Power Plant Engineering:**

- Air and gas compressors; vapor and gas power cycles, concepts of regeneration and reheat.
- Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems
- Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems.
- Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.
- Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems
- Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants.

## **7. Operations Research:**

- Linear programming, simplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM