महाराष्ट्र नागरी सेवा राजपत्रित संयुक्त परीक्षेमधील सन २०२३ पासून पारंपारिक/ वर्णनात्मक स्वरुपात घेण्यात येणा-या खालील परीक्षांकरीता प्रश्नपत्रिकेची रचना (Question Paper Structure) साधारणत: पुढीलप्रमाणे राहील.

१) महाराष्ट्र अभियांत्रिकी सेवा मुख्य परीक्षा गट- अ व ब (स्थापत्य/ यांत्रिकी/ विद्युत/ विद्युत व यांत्रिकी).

२) निरीक्षक, वैधमापन शास्त्र, गट-ब मुख्य परीक्षा.

३) अन्न व औषधी द्रव्ये प्रशासकीय सेवा [सहायक आयुक्त (अन्न) तथा पदनिर्देशित अधिकारी, गट-अ (राजपत्रित) व अन्न सुरक्षा अधिकारी, गट-ब (राजपत्रित)] मुख्य परीक्षा.

Time Allowed: Three Hours	*Maximum Marks: 200*
Medium – English	*Type of Paper- Conventional*

Question Paper Specific Instructions

Please read each of the following instructions carefully before attempting questions:

1. There are **EIGHT** questions divided in two sections, out of which **FIVE** are to be attempted.
2. Questions no. 1 and 5 are compulsory. Out of the remaining questions, THREE are to be attempted choosing at least ONE question from each Sections.
3. The number of marks carried by a question/sub question is indicated against it.
4. Keep in mind the word limit indicated in the question if any.
5. Wherever option has been given, only the required number of responses in the serial order attempted shall be assessed. Unless struck off, attempt of a question shall be counted even if attempted partly. Excess responses shall not be assessed and shall be ignored.
6. Candidates are expected to answer all the sub-questions of a question together. If sub-question of a question is attempted elsewhere (after leaving a few page or after attempting another question) the later sub-question shall be overlooked.
7. Any page or portion of the page left blank in the Answer Booklet must be clearly struck off.
8. Unless otherwise mentioned, symbol and notation have their usual standard meanings. Assume suitable data, if necessary and indicate the same clearly.
9. Neat sketches may be drawn, wherever required.
10. The medium of answer should be mentioned on the answer book as claimed in the application and printed on admission card. The answers written in medium other than the authorized medium will not be assessed and no marks will be assigned to them.

Note - Candidates will be allowed to use Scientific (Non-programmable type) calculators.

Paper I & Paper II

Section A			Maximum Marks
Question No. 1	**Solve any five out of seven.**		40
	a	Short Question	
	b	Short Question	
	c	Short Question	
	d	Short Question	
	e	Short Question	
	f	Short Question	
	g	Short Question	
Question No. 2	a	Long Question	40
	b	Long Question	
	c	Short Question	
Question No. 3	a	Long Question	40
	b	Long Question	
	c	Short Question	
Question No. 4	a	Long Question	40
	b	Long Question	
	c	Short Question	
Section B			**Maximum Marks**
Question No. 5	**Solve any five out of seven.**		40
	a	Short Question	
	b	Short Question	
	c	Short Question	
	d	Short Question	
	e	Short Question	
	f	Short Question	
	g	Short Question	
Question No. 6	a	Long Question	40
	b	Long Question	
	c	Short Question	
Question No. 7	a	Long Question	40
	b	Long Question	
	c	Short Question	
Question No. 8	a	Long Question	40
	b	Long Question	
	c	Short Question	

Note: 1. Long question can be Derivative/Problem/Explain in detail diagram/ sketch question justifying the marks assigned to the question.

2. Short question can be Definition/ short notes justifying the marks assigned to the question.

महाराष्ट्र अभियांत्रिकी सेवा (यांत्रिकी), गट-अ व ब (मुख्य) परीक्षा
Maharashtra Engineering Services (Mechanical), Gr. A & B (Main) Examination

-: परीक्षा योजना :-

प्रश्नपत्रिकांची संख्या - दोन

लेखी परीक्षा - ४०० गुण
मुलाखत - ५० गुण
एकूण - ४५० गुण

विषय	सांकेतांक	गुण	दर्जा	माध्यम	कालावधी	प्रश्नपत्रिकेचे स्वरुप
यांत्रिकी अभियांत्रिकी पेपर क्रमांक - १	१०६८	२००	बी. ई. (यांत्रिकी)	इंग्रजी	तीन तास	पारंपारिक/ वर्णनात्मक
यांत्रिकी अभियांत्रिकी पेपर क्रमांक - २	१०६९	२००	बी. ई. (यांत्रिकी)	इंग्रजी	तीन तास	पारंपारिक/ वर्णनात्मक

-: अभ्यासक्रम :-

Mechanical Engineering - Paper - I

Sr. No.	Topic
Section-A : Materials and Their Behavior	
1	Engineering Materials : Crystalline structure of metals and alloys, defects in crystalline materials, Iron-Carbon equilibrium diagram, plain carbon steel, alloy steel, cast iron and types, Brass and Bronze, Aluminum, lead, Tin, Zinc- their properties and applications, Plastic deformation, bearing materials, plastics, ceramics, composite materials, Heat treatment of steels.
2	Fundamentals : Force, moment, couple, resultant of forces, Equilibrium of forces, friction and friction angle, columb friction, rolling friction and belt friction, frictional torque in pivot and Collar bearings, M.I., Work and energy.
3	Strength of Materials : Normal and Shear stresses, Stress-strain diagram, thermal stresses, shear force and bending moment diagrams, bending stresses in solid, hollow and built up sections, deflection of beams, shear stress distribution diagram, strain energy, torsion of bars, shafts and helical springs, Deflection of beam under different conditions, impact load.
4	Theory of Machines : Kinematic link, pair, chain, Mechanism and structure, degrees of freedom, Cams, Gear trains, fluctuation of speed and energy in flywheel, Gyroscope, Balancing of rotating machines, Static & Dynamic balancing, Balancing of Single and multi-cylinder engines and V-engines, belts and chain drives, Hydrodynamic bearing.

Section-B : Machine Design	
5	Design of Elements: Theories of failure, factor of safety, combined stresses. Pressure vessels, struts and columns. Design of Screw and bolt, riveted, welded joints, power screw, Design of Shafts and springs, keys, couplings. Design of clutches and brakes, design under fatigue loading, stress concentration, reduction in stress concentration, S-N curve, Soderberg & Goodman diagram, modified Good man diagram, fatigue under combined stress.
6	Design of Gears: Spur, helical, bevel and worm
7	System Design: Design of mechanical systems, specification of components, Design of system including material handling systems, power plants, refrigeration and air conditioning systems, pneumatic and hydraulic systems, etc.
8	Dynamics of machines: Inertia force analysis, law of gearing, interference and minimum number of teeth, Longitudinal - transverse and torsional vibration, single degree freedom - undamped free, damped, forced vibrations, whirling of shaft- critical speed, vibration isolation.
Section – C : Manufacturing Science and Processes	
9	Manufacturing Science : Theory of metal cutting, Merchant's force analysis, Tool materials, Taylor's tool life equation, Machinability, economics, cutting fluids, Chip removal, Calculation of cutting force on single point cutting tools, twist drills, milling cutter, broaches, reamers, Jigs and fixtures. Recent machining methods - EDM, ECM, PAM, Ultrasonic and Laser, etc.
10	Manufacturing Processes : Casting, moulding- Types, equipments and defects, hot and cold working of metals - blanking, shearing, punching, piercing, coining, embossing, drawing, spinning and forging, Metal joining processes- welding, soldering, brazing, High energy rate forming, electroplating, surface finishing processes.
11	Manufacturing Management: Production planning and control, forecasting - Moving average, moving range, exponential smoothening, scheduling, assembly line balancing, Inventory Control - ABC analysis, EOQ models, Statistical quality control and TQM, TPM. Elements of cost, job costing, process costing, estimation of machining time.
12	Operation Research: Linear programming - Graphical and simplex methods, transportation and assignment models, game theory, queuing models, CPM and PERT, Replacement models, value analysis.

Section – D : CAD / CAM / CAE	
13	CAD : Overview and benefits of CAD, primitives, 2D / 3D animation, Bazier curves and splines, Wire-frame modeling, surface and solid modeling, kinematic analysis of open and closed loop mechanisms, stiffness matrix, finite element analysis, optimum design, constrained optimization - Penalty function method, computer aided optimum design of gears, bearings and shafts.
14	CAM: Types of automation, Steps in NC manufacturing, manual and NC part programming, APT, Machining centres, FMS, Computer Aided Process Planning, CMM, CIMS & its components, Robotics.
15	Product Development: Design materials, human factors in design, applied ergonomics, product development processes, concept development process, customer needs, product specifications, concept generation- creative & logical techniques- QFD, conceptual decomposition (functional & physical), two/three dimensional morphological chart, concept evaluation, pugh chart, weighted decision matrix, analytical hierarchy method, product architecture, Configuration Design, Parametric design, Detailed Design- Design for manufacturing and Assembly selection of manufacturing processes, materials, cross sections, principles of easier & economic assembly, legal issues in product design.
16	Machine Tool Design: Kinematics of machine Tools, structural and ray diagrams for speed, stepped and step less regulation of speed, static and dynamic rigidity of machine tools, Vibration of machine tools, chatter, Slide ways and guide ways.

Mechanical Engineering - Paper - II

Sr.No.	Topic
Section – A :- Thermodynamics, Heat and Mass Transfer	
1	Thermodynamics: Fundamentals- Work, Heat, Zeroth law, First law- application to thermodynamic system components, efficiency, Second law (theoretical treatment only)- quality of energy, increase of entropy, availability and irreversibility, applications, Third law. Ideal gas, real gases, compressibility factor, Joule - Thomson Coefficient. Gas power cycles- Air standard work output and efficiency, mean effective pressure, indicated power, brake power.

	Vapour Power Cycles- Carnot and Rankine, Reheating and regenerative feed heating, Binary vapour cycle, Thermal efficiency and work ratio.
2	Heat and mass transfer: Various modes of heat transfer, Fourier's, Newton's and Stefan Boltzman's law, combined modes, overall heat transfer coefficient. Conduction-Thermal conductivity, factors influencing, measurement, general differential equation, steady state, linear heat flow through a plain and composite wall, tube and sphere, conduction with heat sources, heat transfer from rods, fins of uniform cross section. Convection- Forced and Natural, Heat Exchangers-Types, performance, analysis restricted to parallel and counter flow exchangers. Thermal Radiation- Black and non black bodies, Kirchoff's law, grey body radiation exchange, Mass transfer- mass and mole concentration.
Section-B : Fluid Mechanics and Machinery, Pneumatics and Hydraulics, Power Plant Engineering, Energy Engineering	
3	**Fluid Mechanics:** Fluid and flow-definition and types, properties of ideal and real fluids, Continuum concept, Lagrangian and Eulerian approach. Fluid statics, Kinematics and Dynamics of fluid, flow in pipes, Laminar flow of viscous fluids, Turbulent flow, Dimensional analysis, Compressible fluid flow.
4	Fluid Machinery: Introduction-Classification, energy transfer between fluid and rotor, flow through machines, ideal and actual slip. Hydraulic turbines, pumps, compressors and blowers.
5	Pneumatics and Hydraulics: Production of compressed air, Pneumatic control-Components and Systems, electro Pneumatic logic circuits, Pneumatic counters, Typical applications, Circuits, Sensors.
6	Power Plant Engineering : Sources of energy, variable load problem, power plant economics and selection. Steam power plant- boilers, general layout, different systems, turbine auxiliary systems, heat balance and efficiency. Gas turbine power plant - regeneration, reheating, cogeneration, auxiliary systems, operation, Nuclear Power Plants - basic components, power stations. Hydro electric power plant - site selection, arrangement, operation. Electrical systems and instrumentation.

7	**Energy Engineering:** Energy conservation methods, audit. Solar energy – collectors, area calculations, Solar Systems – power plants, driers, cookers, refrigeration systems. Wind energy – rotors, system design, site selection. Biogas plants – Types, plant performance, Cogeneration Plants, Geothermal Plants. Direct Energy Conversion – Fuel Cells, Thermoelectric, Thermionic and MHD systems, Govt. policies and programmes for energy and environment conservation.
Section–C : I.C. Engines, Automobile Engineering, Refrigeration and Air Conditioning	
8	**I.C. Engines :** Fuel air cycles, real cycles, volumetric efficiency and thermal efficiency, S.I. Engines – carburetion, combustion, combustion chambers, C.I. Engines – fuel injection, combustion, combustion chambers. Detonation – Knock rating of fuels, parameters. Emission Control Systems. Supercharging – effect of altitude on power output, types of superchargers. Cooling, lubrication and ignition systems, testing of I.C. engines. Compressors – centrifugal and axial, performance. Gas turbines – Ideal cycles, intercooling, regeneration, reheating. Jet propulsion.
9	**Automobile Engineering :** Testing of automobiles, resistances to motion, power requirement for propulsion, Automobile engines, frames, transmission systems, drive line and rear axle, wheels and tyres, steering systems, suspension systems, brakes, starter motors, emission norms.
10	**Refrigeration and Air Conditioning :** Refrigeration and heating systems, vapour compression and vapor absorption refrigeration systems, refrigeration equipment, psychrometrics, solar radiation, estimating requirements, ducting systems, automotive air conditioning.
Section–D : Measurement and Metrology, Numerical Analysis and Computer Programming, Numerical Control of Machine Tools, Automatic Control.	
11	**Mechanical Measurement and Metrology:** Measuring instruments, generalized measuring systems, static and dynamic performance characteristics of devices, calibration, error – sources and analysis. Sensors and Transducers, Measurement of – displacement, angular velocity, pressure, strain, force and torque, temperature, flow, vibration and noise. Data acquisition systems. Metrology: Standards of linear measurement, Limits and Fits, Limit gauges, Measurement of geometric forms, Interferometry, Comparators, Measurement of screw threads and gears, surface texture.

12	Numerical Analysis and Computer Programming : Approximations and round of errors, truncation errors and Taylor series, determination of roots of polynomials and transcendental equations, Programming using C and C++ languages for - Solutions of linear simultaneous algebraic equations, curve fitting, Backward, forward and Central Difference relations, Numerical solution of ordinary differential equations.
13	Numerical Control of Machine Tools : Components, open and closed loop control, actuation and feedback systems, Point to Point, linear and contouring systems, Tooling for NC systems, Computer numerical control, Direct and distributed numerical control, adaptive control.
14	Automatic Control : Components of automation - actuators, sensors, vision systems, controllers, Logic control and PLCs, Factory communication, Mathematical models, transfer function, Block diagrams, proportional controls, derivative and integral control, steady state and transient response analysis, different inputs, root locus, frequency response methods, speed control systems.

दिनांक : २४/०१/२०२३

सचिव
महाराष्ट्र लोकसेवा आयोग