HPCL RAJASTHAN REFINERY LIMITED
Joint Venture between Hindustan Petroleum Corporation Limited (HPCL)
and Government of Rajasthan.
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CIN No.U23201RJ2013GOI043865

Advt. No - HRRL/RECT/02/2025

Computer Based Test (CBT) for Engineer – Mechanical: S/G E2

As per Advt. No - HRRL/RECT/02/2025 clause no. 7 (mentioned in page 51), the syllabus for Engineer - Mechanical: S/G E2 is given as below.

Duration: 2 hours **Total Marks: 100**

All questions of the Computer Based Test (CBT) will be objective and multiple-choice type. Total number of questions in the CBT are 100. Each correct answer carries 1 mark and there is no **negative** marking for wrong answers.

Syllabus

Part-1: General Aptitude (Graduate – Level) **(30 Marks)**

1. Intellectual Potential Test:

- Distance
- Syllogism
- Logical Operations
- Similarities and dissimilarities
- Verbal Comprehension
- Perpetual Reasoning
- Working Memory
- Processing Speed
- Fluid reasoning

2. Logical Reasoning & Data interpretation

- Seating arrangements and puzzles
- Series – verbal and number
- Relationships

- Coding-decoding
- Verbal and numerical Analogy
- Binary Logic
- Games and Tournaments
- Arrangements
- Team Formations
- Order and Ranking
- Table, Data Caselets – Reasoning-Based DI, 3. Column Graphs, Bar Graphs, Line Charts, Pie Charts, Routes and Network

3. Quantitative Aptitude

The test of QA may cover Number systems including questions on simplification, decimals, fraction, LCM and HCF, square root, divisibility test, Ratio & proportion, Percentage, Average, Profit & loss, Discount, Simple and compound interest, Mensuration, Time & Work, Time and distance, Algebraic identities, Problems on Age, Tables & Graphs etc.

4. English Language

Program	Education Level	Course	Subject	Topic	Sub Topic	Concept / Type
General Aptitude	HSC	General Verbal Ability - English	Grammar - English	Question Tags	Negative question tag	Sentence Completion
General Aptitude	HSC	General Verbal Ability - English	Grammar - English	Question Tags	Positive question tag	Sentence Completion
General Aptitude	HSC	General Verbal Ability - English	Grammar - English	Parts of speech	Adjective	Sentence Completion
General Aptitude	HSC	General Verbal Ability - English	Grammar - English	Parts of speech	Adverb	Sentence Completion
General Aptitude	HSC	General Verbal Ability - English	Grammar - English	Parts of speech	Prepositions	Sentence Completion
General Aptitude	HSC	General Verbal Ability	Grammar - English	Parts of speech	Conjunctions	Sentence Completion

		- English				
General Aptitude	HSC	General Verbal Ability - English	Grammar - English	Parts of speech	Verb	Sentence Completion
General Aptitude	HSC	General Verbal Ability – English	Indirect Writing - English	Prose	Syntax and structure	Para Jumbles
General Aptitude	HSC	General Verbal Ability - English	Indirect Writing - English	Sentences	Word Usage and Understanding	One word substitution
General Aptitude	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Appropriate Title	Identify the suitable title for the passage
General Aptitude	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Central theme of the passage	Identify the central theme of the passage
General Aptitude	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Facts	Identify the facts given in the passage
General Aptitude	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Inferences drawn	Identify the inferences drawn from the passage
General Aptitude	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Structure of the passage	Identify the structure of the passage
General Aptitude	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Summary	Select the correct summary for the passage
General Aptitude	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Text to World connection	The most appropriate connection to the real-life situations
General Aptitude	HSC	General Verbal Ability	Reading Compreh	Passage	Tone of the passage	Identify the tone of the

		- English	ension - English			passage
General Aptitude	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Vocabulary	Antonyms of the word
General Aptitude	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Vocabulary	Correct usage of the word in other examples
General Aptitude	HSC	General Verbal Ability - English	Reading Comprehension – English	Passage	Vocabulary	Synonyms of the word
General Aptitude	HSC	General Verbal Ability - English	Reading Comprehension - English	Passage	Vocabulary	Word meaning
General Aptitude	HSC	General Verbal Ability - English	Vocabulary - English	Idioms and Phrases	Idioms	Word-segment substitution
General Aptitude	HSC	General Verbal Ability - English	Vocabulary - English	Idioms and Phrases	Proverbs	Word-segment substitution
General Aptitude	HSC	General Verbal Ability - English	Vocabulary - English	Semantics	Antonyms	Identification of antonym in a sentence
General Aptitude	HSC	General Verbal Ability - English	Vocabulary - English	Semantics	Synonyms	Word meaning in sentence

Part 2: Technical/Professional Knowledge (70 Marks)

1. **Engineering Mechanics:** Analysis of System of Forces, friction and its applications including rolling friction, Centroid and Centre of Gravity, Dynamics; Stresses and Strains- Compound Stresses and Strains, Bending Moment and Shear Force Diagrams, Theory of Bending Stresses- Slope and deflection-Torsion, Thin and thick Cylinders, Spheres. Free-body diagrams and equilibrium; belt-pulley, brakes, clutches, screw jack, wedge, vehicles, etc.; trusses and frames; virtual work; kinematics and dynamics of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations.

2. **Mechanics of Materials**: Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; concept of shear centre; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses; strain gauges and rosettes; testing of materials with universal testing machine; testing of hardness and impact strength.

3. **Theory of Machines:** Types of Kinematics Pair, Mobility, Inversions, Kinematic Analysis, Velocity and Acceleration Analysis of Planar Mechanisms, CAMs with uniform acceleration and retardation, cycloidal motion, oscillating followers; Vibrations –Free and forced vibration of undamped and damped SDOF systems, Transmissibility Ratio, Vibration Isolation, Critical Speed of Shafts. Gears – Geometry of tooth profiles, Law of gearing, Involute profile, Interference, Helical, Spiral and Worm Gears, Gear Trains- Simple, compound and Epicyclic; Dynamic Analysis – Slider – crank mechanisms, turning moment computations, balancing of Revolving & Reciprocating masses, Gyroscopes – Effect of Gyroscopic couple on automobiles, ships and aircrafts, Governors.

4. **Vibrations:** Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.

5. **Machine Design:** Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as bolted and welded joints; shafts, gears, rolling and sliding contact bearings, springs. Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as riveted, welded and bolted joints. Shafts, Spur gears, rolling and sliding contact bearings, Brakes and clutches, flywheels

6. **Fluid Mechanics:** Fluid properties; fluid statics, forces on submerged bodies, stability of floating bodies; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings; basics of compressible fluid flow.

7. **Heat-Transfer:** Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, Stefan- Boltzmann law, Wien's displacement law, black and grey surfaces, view factors, radiation network analysis.

8. **Thermodynamics:** Thermodynamic systems and processes; properties of pure substances, behaviour of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; thermodynamic property charts and tables, availability and irreversibility; thermodynamic relations.

9. **Applications:** Power Engineering: Air and gas compressors; vapour and gas power cycles, concepts of regeneration and reheat. I.C. Engines: Air-standard Otto, Diesel and dual cycles. Refrigeration and air-conditioning: Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes. Turbomachinery: Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines; steam and gas turbines.

10. **Engineering Materials**: Structure and properties of engineering materials, Alloys and Phase diagrams, heat treatment, stress-strain diagrams for engineering materials. Basic Crystallography, Heat Treatment, Ferrous and Non-Ferrous Metals, Non-metallic materials, Basics of Nano-materials, Mechanical Properties and Testing, Corrosion prevention and control.

11. **Casting, Forming and Joining 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.

12. **Machining and Machine Tool Operations:** Mechanics of machining; basic machine tools; single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, jigs and fixtures; abrasive machining processes; NC/CNC machines and CNC programming.

13. **Metrology and Inspection:** Limits, fits and tolerances; linear and angular measurements; comparators; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly; concepts of coordinate-measuring machine (CMM).
    Computer Integrated Manufacturing: Basic concepts of CAD/CAM and their integration tools; additive manufacturing.

14. **Production Planning and Control:** Forecasting models, aggregate production planning, scheduling, materials requirement planning; lean manufacturing.

15. **Inventory Control:** Deterministic models; safety stock inventory control systems.

16. **Operations Research:** Linear programming, simplex method, transportation, assignment, network flow models.

17. **IC Engines, Refrigeration and Air conditioning:** SI and CI Engines, Engine Systems and Components, Performance characteristics and testing of IC Engines; Fuels; Emissions and Emission Control. Vapour compression refrigeration, Refrigerants and Working cycles, Compressors, Condensers, Evaporators and Expansion devices, Other types of refrigeration systems like Vapour Absorption, Vapour jet, thermo electric and Vortex tube refrigeration. Psychometric properties and processes, Comfort chart, Comfort and industrial air conditioning, Load calculations and Heat pumps.

18. **Turbo Machinery:** Reciprocating and Rotary pumps, Pelton wheel, Kaplan and Francis Turbines, velocity diagrams, Impulse and Reaction principles, Steam and Gas Turbines, Theory of Jet Propulsion – Pulse jet and Ram Jet Engines, Reciprocating and Rotary Compressors – Theory and Applications.

19. **Power Plant Engineering:** Rankine and Brayton cycles with regeneration and reheat, Fuels and their properties, Flue gas analysis, Boilers, steam turbines and other power plant components like condensers, air ejectors, electrostatic precipitators and cooling towers – their theory and design, types and applications;

20. **Renewable Sources of Energy:** Solar Radiation, Solar Thermal Energy collection - Flat Plate and focusing collectors their materials and performance. Solar Thermal Energy Storage, Applications – heating, cooling and Power Generation; Solar Photovoltaic Conversion; Harnessing of Wind Energy, Bio-mass and Tidal Energy – Methods and Applications, Working principles of Fuel Cells.

21. **Manufacturing, Industrial and Maintenance Engineering:** Metal Casting-Metal forming, Metal Joining, Machining and machine tool operations, Limits, fits and tolerances, Metrology and inspection, computer Integrated manufacturing, FMS, Production planning and Control, Inventory control and operations research - CPM-PERT. Failure concepts and characteristics-Reliability, Failure analysis, Machine Vibration, Data acquisition, Fault Detection, Vibration Monitoring, Field Balancing of Rotors, Noise Monitoring, Wear and Debris Analysis, Signature Analysis, NDT Techniques in Condition Monitoring.

22. **Mechatronics and Robotics:** Microprocessors and Microcontrollers: Architecture, programming, I/O, Computer interfacing, Programmable logic controller. Sensors and actuators, Piezoelectric accelerometer, Hall effect sensor, Optical Encoder, Resolver, Inductosyn, Pneumatic and Hydraulic actuators, stepper motor, Control Systems-Mathematical modeling of Physical systems, control signals, controllability and observability. Robotics, Robot Classification, Robot Specification, notation; Direct and Inverse Kinematics; Homogeneous Coordinates and Arm Equation of four Axis SCARA Robot.

NOTE: The syllabus/topics mentioned are indicative in nature. Candidates are expected to possess significant knowledge/proficiency pertaining to the relevant subjects and their qualifying degree.