IMPORTANT NOTES

(A) Please fill up the OMR Sheet of this Question-Answer Booklet properly before answering.

(B) The question paper is divided into different unit and parts. The number of questions to be attempted and their marks are indicated in each unit and part.

(C) Attempt answers either in Hindi or English, not in both. For Language Papers, answer in concerned language and script, unless directed otherwise to write in Hindi or English specifically.

(D) The candidates should not write the answers beyond the prescribed limit of words; failing this, marks will be deducted.

(E) Please write answers only in the prescribed space of booklet. Do not write any mark of identity inside the Answer Script (including Paper for rough work) i.e. name, address, telephone number, Name of God etc. or any irrelevant words other than the answer of the question. Such act will be treated as unfair means. The Commission may also deduct 5 marks from the marks obtained, if Roll Number is not filled correctly on the OMR Sheet.

(F) Candidates are directed that they should not write (answer) out side the border line in every page. Answer written out side the border line will not be checked by the Examiner.

(G) If there is any sort of ambiguity/mistake either of printing or factual nature then out of Hindi and English version of the question, the English version will be treated as standard.

(H) It should be ensured that the Question-Answer Booklet is provided in a sealed envelope to the candidate.

(I) Candidate should fill up all desired details on this attached OMR sheet of Question-Answer Booklet with blue ball point pen. Please ensure that this OMR Sheet is not torn or damaged.

(J) This OMR Sheet consists of Two parts, in which some information is pre-printed; remaining details have to be filled by the candidate.

(K) If the Question-Answer Booklet is torn or not printed properly, bring it to notice of invigilator and change the Question-Answer booklet, otherwise the candidate will be liable for that.

Special Notes:
If there is any wrong information filled by the candidate or any attempt is made to damage it or any marking as identification is done, then his candidature for the entire examination shall be rejected by the commission, for which he will be liable.
PART – 1

Note: Attempt all twenty questions. Each question carries 2 marks. Answer should not exceed 15 words.

Very Short Answer Questions

1. Which heuristic scheduling rule minimizes flow time and average number of jobs in a system?

2. What is the 'systems principle' of material handling?

3. What is the use of Berger's Vector in edge dislocation?
4. Miller indices \((x, y, z)\) for the hatched plane in the unit cell given in fig. below, are represented as

\[ (x_1y_1z_1) \]

5. Which is more stable, the pearlitic or the spheroiditic microstructure? Justify.

6. Illustrate the three stages of creep failure.
7. Give the expression for the extreme values of bending moment for a cantilever of length \( l \) that carries a uniformly distributed load with intensity of \( W/\text{length} \).

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8. A short column of external diameter \( D \) and internal diameter \( d \) carries an eccentric load \( W \). Give the expression for the greatest eccentricity which the load can result on column without producing tension on its cross-section.

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9. State Hooke's law and give the expression of Young's modulus from it.

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10. Define the fundamental deviation in Limits, Fits and Gauges.
11. A leadscrew with a 7.5 mm pitch drives a worktable in an NC positioning system. The leadscrew is powered by a stepping motor which has 200 step angles. The worktable is programmed to move a distance of 120 mm from its present position at a travel speed of 300 mm/min. Determine the number of pulses required to move the table to the specified distance.

12. Give the expression of permeability number of sand along with notations used.

13. Give the expression for deflection (δ) at the point load for the beam shown in the following figure.

![Diagram of a beam with a point load](attachment:beam_diagram.png)
14. What is a Globoidal Cam?

15. In a closed coil springs of radius R, wire radius r and length L, the ratio of strain energy due to transverse shear to strain energy due to torsion will be proportional to?

16. A car is moving on a curved horizontal road of radius 100 m with a speed of 20 m/s. The rotating masses of the engine have an angular speed of 100 rad/s in clockwise direction when viewed from the front of the car. The combined moment of inertia of the rotating masses is 10 kg-m². Calculate the magnitude of the gyroscopic moment (in N-m).

17. Define the recrystallization temperature for a metal.
18. A seamless spherical shell, 900 mm in diameter and 10 mm thick is being filled with a fluid under pressure until its volume increases by $150 \times 10^3$ mm$^3$. Calculate the pressure exerted by the fluid on the shell, taking modulus of elasticity for the material of the shell as 200 kN/mm$^2$ and Poisson's ratio as 0.3.

19. The cutter of a broaching machine is pulled by square threaded screw with mean diameter of 50 mm and 10 mm pitch. If the operating nut takes the axial load of 400 N with total torque required as 4410 N-mm, then calculate the efficiency of the screw (in %).

20. Explain the fly back (snap back) method of stopwatch used during work study.
PART - 2

Note: Attempt all twelve questions. Each question carries 5 marks. Answer should not exceed 50 words.

Short Answer Questions: 5 Marks each

21. Figure below shows a rotor with the properties:

\[ \theta_1 = 45^\circ, \theta_2 = 135^\circ, \theta_3 = 240^\circ, m_1 = 4 \, \text{kg}, m_2 = 3 \, \text{kg}, m_3 = 2.5 \, \text{kg}, R_1 = 75 \, \text{mm}, R_2 = 85 \, \text{mm} \text{ and } R_3 = 50 \, \text{mm}. \]

Determine the amount and angle of the counter mass at a radial distance of 75 mm required for the static balance.
22. What is the difference between the states of phase equilibrium and metastability?

23. Derive the atomic packing factor for BCC and FCC crystalline materials.
24. A transmission shaft is subjected to a maximum torque of 7500 N-cm and a maximum bending moment of 12000 N-cm. The loads are suddenly applied with minor shocks having shock & fatigue factors 2.0 and 1.5 for bending and torque respectively. The allowable shear stress is 420 N/cm². Find the diameter of shaft.

25. Compare soldering with fusion-welding processes in terms of
   (a) preheating of workpiece
   (b) temperature requirements
   (c) strength of joint
   (d) post process mechanical properties of workpiece
   (e) post process requirements of heat treatment
26. A new medical facility is to be located in Delhi. The location factors, weights and scores (1 = poor, 5 = excellent) for two potential sites are given in the following table. Which is the best location based on total weighted scores?

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Location Factor</th>
<th>Weight</th>
<th>Location 1</th>
<th>Location 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Facility Utilization</td>
<td>25</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>2.</td>
<td>Total patient km per month</td>
<td>25</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>3.</td>
<td>Average time per emergency trip</td>
<td>25</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>Land and Construction Costs</td>
<td>15</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>5.</td>
<td>Employee preferences</td>
<td>10</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>
27. A factory producing only one item, which it sells for ₹ 12.50 per unit, has a fixed cost of ₹ 60,000 and variable cost of ₹ 7.50 per unit. Find the number of units to be produced to earn a profit of ₹ 12000.
28. A firm buys castings of P and Q type of parts and sells them as finished product after machining, boring and polishing. The purchasing cost for castings are ₹ 3 and ₹ 4 each for parts P and Q and their selling costs are ₹ 8 and ₹ 10, respectively. The per hour capacity of machines used for the machining, boring and polishing for the two products is given below:

<table>
<thead>
<tr>
<th>Capacity per hour</th>
<th>Parts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P</td>
</tr>
<tr>
<td>Machining</td>
<td>30</td>
</tr>
<tr>
<td>Boring</td>
<td>30</td>
</tr>
<tr>
<td>Polishing</td>
<td>45</td>
</tr>
</tbody>
</table>

The running cost for the machining, boring and polishing are ₹ 30, ₹ 22.5 and ₹ 22.5 per hour, respectively. Formulate the linear programming problem to find out the product mix to maximize the profit.
29. A vibrating system consists of a mass of 50 kg, a spring of stiffness 30 kN/m and a damper. The damping provided is only 20% of the critical value. Determine: (i) the damping factor (ii) the critical damping coefficient and (iii) natural frequency of damped vibration.

30. State or mention the applications of neutral, reducing and oxidizing types of flame those are generated during oxy-acetylene gas welding.
31. A manufacturing company purchases 10000 units of a raw material for its annual requirements. The ordering cost per order is Rs. 150 and carrying cost per unit is ₹ 75. Calculate the economic ordering quantity, total annual inventory cost, and the number of orders per year.
32. State the assumptions of simple bending theory for beams.


PART – 3

Note: Attempt all questions. Each question carries 20 marks. Answer should not exceed 200 words.

Long & Descriptive Answer Questions

33. A hydraulic circuit utilizes a spherical pressure tank, which is connected to a piston-cylinder to move the piston. Pressure inside the tank is maintained at 28 N/cm². Assume efficiency as 100%. Determine:

(a) The thickness of the wall-plate of the tank, if diameter of tank is 80 cm. The allowable tensile strength of the steel wall-plate used is 525 N/cm².
(b) Assuming a pressure drop of 2.1 N/cm² between tank and piston-cylinder, determine the piston diameter required to produce an operating force of 2250 N. Assume an allowance for friction in the cylinder is equal to 10 percent of the force.

(c) Determine the thickness of cylinder wall, if the safe stress is 280 N/cm².
34. A helical spring is made from a wire of 6 mm diameter and has outside diameter of 75 mm. If the permissible shear stress is 350 MPa and modulus of rigidity 84 kN/mm², calculate the axial load which the spring can carry and the deflection per active turn by considering:

(a) neglecting the effect of curvature.
(b) the effect of curvature.
35. Explain the Ultra-Sonic Machining process. Discuss the effect of process parameters on Material Removal Rate (MRR).
36. In an epicyclic gear train the compounded wheels A and B as well as internal wheels C & D rotate independently about axis O. The wheels E and F rotate on pins fixed on arm ‘a’. All wheels are of same module. The number of teeth on the wheels are \( T_A = 52 \), \( T_B = 56 \), \( T_E = T_F = 36 \). Determine speed of C when,

(a) wheel D is fixed and arm ‘a’ rotates at 200 rpm clockwise.

(b) wheel D rotates at 200 rpm counter-clockwise and arm ‘a’ rotates at 20 rpm counter-clockwise.
37. A project consists of 7 jobs. Jobs A and F can be started and completed independently. Jobs B and C can start only after job A has been completed. Jobs D, E and G can start only after jobs B, (C and D) and (E and F) are completed, respectively. Time estimates of all the jobs are given in the following table.

<table>
<thead>
<tr>
<th>Job</th>
<th>Time Estimates (Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Optimistic</td>
</tr>
<tr>
<td>A</td>
<td>3</td>
</tr>
<tr>
<td>B</td>
<td>7</td>
</tr>
<tr>
<td>C</td>
<td>4</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
</tr>
<tr>
<td>E</td>
<td>4</td>
</tr>
<tr>
<td>F</td>
<td>5</td>
</tr>
<tr>
<td>G</td>
<td>2</td>
</tr>
</tbody>
</table>
Draw the network and determine the critical path, and its expected duration \( (T_c) \). What is the probability of completing the project in 32 days? Also, determine the total and free slacks of all the jobs.