

MECHANICAL ENGINEERING (Paper I)

Time Allowed : Three Hours

Maximum Marks : 300

QUESTION PAPER SPECIFIC INSTRUCTIONS

(Please read each of the following instructions carefully before attempting questions)

There are EIGHT questions divided in two Sections.

Candidate has to attempt FIVE questions in all.

Question Nos. 1 and 5 are compulsory and out of the remaining, any THREE are to be attempted choosing at least ONE question from each Section.

The number of marks carried by a question/part is indicated against it.

Wherever any assumptions are made for answering a question, they must be clearly indicated.

Word limit in questions, wherever specified, should be adhered to.

SECTION 'A'

1. Attempt any three parts from the following

- (a) What do you understand by inversions of a mechanism? Show two inversions of a slider crank mechanism with the help of neat sketches. 20
- (b) A stepped shaft ABC is 0.8 m long. For a length AB = 0.4 m, shaft diameter is 40 mm and for length BC 0.4 m, shaft diameter is 20 mm. Shaft is fixed at both the ends A and C. At the Section B, a torque T is applied which causes a maximum shear stress of 100 MPa in stepped shaft. Determine the magnitude of torque T. 20
- (c) A cantilever ABC, 200 mm long and 20 mm diameter is fixed at end A as shown in the above figure. A horizontal axial load of 10 kN, a vertical load of 1 kN acts at end C. Torque T applied it section C produces a maximum shear stress of intensity 50 MPa in cantilever. Determine principal stresses at point B of cantilever. 20
- [Figure (printed above the text): Solid circular cantilever ABC of diameter 20 mm (marked "20 mm ϕ "), drawn horizontally in oblique view; end A on the left is built into a wall (hatched); B is the mid-section; C is the free right end; AB = 100 and BC = 100 mm. At end C: a vertical downward load of 1 kN, a horizontal axial load of 10 kN acting along the axis towards A (arrow pointing into the end face, i.e. compressive), and a torque T about the longitudinal axis (curved arrow round the end section).]
- (d) Give the composition and applications of following alloys: (i) Maraging steel (ii) Invar (iii) Beryllium bronze (iv) Aluminium bronze 20

2. (a) In a spring controlled governor, mass of each governor ball is 7 kg and moves radially under the action of a controlling force F. If the speed range is 420 RPM to 440 RPM with range of ball path radius r equal to 12.4 cm to 132 cm. determine the linear relationship between ball path radius and controlling force. Sketch the graph between F and r. What is the equilibrium speed at $r = 12.8$ cm? 20

(b) What do you understand by primary balancing and secondary balancing of multicylinder in line engines? Consider a six cylinder in line engine and show that it is fully balanced. 20

3. (a) At a point A in a strained material, planes AB and AC pass through the point as shown in the above figure. Normal and shear stresses on plane AB are 30 MPa and 50 MPa respectively as shown. Normal and shear stresses on plane AC are 60 MPa and 20 MPa respectively as shown. By graphical or analytical method, determine angle between the planes AB and AC. 30

[Figure (printed above the text): Element at point A bounded by two planes through A: plane AC horizontal (A on the left, C on the right) and plane AB inclined upward to the right at angle θ to AC; the material lies between them (closed on the right by a wavy break line from B down to C), both planes hatched on the material side. On plane AB: a normal stress of 30

MPa drawn as an arrow perpendicular to AB pointing away from the material (up-left, tensile) and a shear stress of 50 (MPa) drawn as an arrow along AB pointing up-right towards B. On plane AC: a normal stress of 60 MPa drawn as an arrow pointing vertically downward, away from the material (tensile), and a shear stress of 20 (MPa) drawn as an arrow along AC pointing to the right towards C.]

- (b) A beam ABCD, 8 m long, hinged at end A and roller supported at end D carries the transverse loads as shown in the above figure. Determine the support reactions and draw the BM diagram for the beam. **30**

[Figure (printed above the text): Horizontal beam ABCD, 8 m long, with a hinge (pin) support at the left end A and a roller support at the right end D; AB = BC = 2 m, and D is 4 m beyond C (the dimension line shows 2 m, 2 m, 2 m, 2 m from A to D, the third division ending at a point 2 m to the right of C). A vertical downward load of 20 kN acts directly on the beam at B. At C a rigid bracket is fixed to the beam: a vertical post rises from the beam at C and turns horizontally to the right; a vertical downward load of 20 kN acts at the end of the bracket arm, which lies 2 m to the right of C (above the point 6 m from A), without touching the beam there.]

4. (a) With the help of neat sketches, differentiate clearly between interstitial and substitutional solid solutions. Comment on Fe – C and Au – Ag solid solutions. **30**
- (b) What do you understand by atomic packing factor? Determine atomic packing factor for BCC structure. **10**
- (c) Explain the mechanisms of (i) Discontinuous yielding in mild steel when tested under tension (ii) Hysteresis loop for a ductile material when subjected to a stress cycle of loading in tension to plastic state unloading, loading in compression and then unloading. **20**
- (d) Give the compositions and applications of Alumen alloy and Nichrome alloy. **10**

SECTION 'B'

5. Attempt any three parts from the following:
- (a) What is a Master Production Schedule? Explain its relationship with Material Planning (MRP), capacity planning and control activities. **20**
- (b) Explain with a neat sketch the salient features of Ultrasonic drilling (USD) covering (i) the basic operating principle (ii) mechanism of metal removal (iii) applications **20**
- (c) (i) List the primary hardware components of a personal computer. (ii) List some of the options for each of the above components. (iii) What do you understand from the following terms? (a) RAM (b) ROM (c) 5 GB (d) 860 MHz (e) 57.6 KBPS **20**
- (d) Write a FORTRAN programme to accept data of heights of up to 100 students of a college. The programme should be able to calculate the main variance, and standard deviation of heights and print (i) the number of students (ii) the serial number and heights of individual students (iii) the mean, variance and standard deviation of heights. **20**
6. (a) (i) Explain the difference between the following two types of motion controls used in CNC machines (a) Point to point or position control (b) Contouring or continuous path control Give an example each of their application. (ii) A stepper motor is used in a CNC positioning system, for driving the table through a lead screw of pitch = 3 mm. The control resolution for the table movement is specified as 0.01 mm. Determine (a) The number of pulses which the motor should give per revolution (b) The size of step angle of the motor. (c) The linear travel rate of the table. The motor works at a pulse rate of 200/s. **20**
- (b) (i) List three high energy rate forming processes. (ii) What are the important reasons behind the use of these processes? (iii) Explain in detail, using a diagram the process of explosive forming of a spherical dome with a flange from sheet steel. **30**
7. (a) Define the following terms in rolling (i) bite angle (ii) percentage reduction in thickness (iii) elongation coefficient (iv) neutral point (v) forward slip. A slab of 300 mm initial thickness, 600

mm wide is given a reduction of 50 mm in a rolling mill with rolls 1000 mm diameter. The spread in this pass is 5 mm. Calculate the values of the bite angle, percentage reduction in thickness and elongation coefficient. How is forward slip determined experimentally? **40**

(b) Solve the following linear programming problem graphically or otherwise

Maximize $Z = 4x_1 + 10x_2$ subject to $2x_1 + x_2 \leq 50$, $2x_1 + 5x_2 \leq 50$, $2x_1 + 3x_2 \leq 50$, $2x_1, x_2 \geq 0$.

20

8. (a) (i) What is an inventory? Explain the salient features of the following inventory models: Deterministic models Probabilistic models Models under uncertainty. (ii) In a deterministic model the ordering cost is Rs. 4500/ order. The cost of each item is Rs. 2500 and carrying cost is 10% per year. If the annual requirement is 10,000 units determine Economic Ordering Quantity (EOQ). If the inventory carrying cost decreases by 10% and ordering cost increases by 10% determine the % change in EOQ. What do you infer? **30**

(b) (i) List four of the most common priority decision rules applicable to jobs to be completed on one single machine. (ii) Six jobs are to be processed through the preparation and paint shops. The operation times are as follows: **30**

Job	Preparation time HRS	Paint shop time HRS
A	10	5
B	7	4
C	5	7
D	3	8
E	2	6
F	4	3

Determine a sequence that will minimize the total completion time. Find the make span time.
