

Sl. No.

8631

CBR-308-HOF-44

000056

MECHANICAL ENGINEERING -2008

PAPER—II

(Conventional)

Time Allowed : Three Hours

Maximum Marks : 200

INSTRUCTIONS

Candidates should attempt Question No. 1 in Section A which is compulsory, TWO questions from Section B and TWO questions from Section C.

Question No. 1 is of short answer type, limiting answer of each part to 30 words.

The number of marks carried by each question is indicated at the end of the question.

Answers must be written in ENGLISH.

Assume suitable data, if necessary and indicate them clearly.

SECTION—A

1. (a) Under what conditions of relative motion between links of a mechanism, Coriolis component of acceleration is generated? Express its magnitude, direction and sense with the help of a sketch.

- (b) What is law of gearing? Express the magnitude of sliding velocity at the point of contact between two meshing gears and its value at pitch point.
- (c) An accelerometer indicates that a structure is vibrating at 80 c.p.s. with a maximum acceleration of $50g$. Determine amplitude of vibration of the structure.
- (d) In a two-cylinder V-engine having 90° including angle between the cylinder axes has crank length equal to 10 cm and reciprocating mass for each cylinder equal to 10 kg. If the crank rotates at 500 r.p.m., determine primary unbalanced force in the engine.
- (e) What different stresses set up in a bolt due to initial tightening, while used as a fastener? Name all the stresses in detail.
- (f) Name the four principal types of roller bearings.
- (g) A prismatic bar in compression has a cross-sectional area $A = 900 \text{ mm}^2$ and carries an axial load $P = 90 \text{ kN}$. What are the stresses acting on—
- (i) a plane transverse to the loading axis;
 - (ii) a plane at $\theta = 60^\circ$ to the loading axis?

(h) A thin cylindrical pressure vessel of inside radius r and thickness of metal t is subjected to an internal fluid pressure p . What are the values of—

(i) maximum normal stress;

(ii) maximum shear stress?

(i) A hollow shaft and a solid shaft constructed of the same material have the same length and the same outside radius. The inside radius of the hollow shaft is 0.6 times of the outside radius. Both the shafts are subjected to the same torque.

(i) What is the ratio of maximum shear stress in the hollow shaft to that of solid shaft?

(ii) What is the ratio of angle of twist in the hollow shaft to that of solid shaft?

(j) (i) Define 'ductility' of metals.

✓ (ii) Arrange the metals mild steel, aluminium, zinc and copper in order of their diminishing ductility (highest first—lowest last).

(k) What is extrusion? Name the process for manufacturing collapsible tubes and draw figures to show the process.

- (l) Name the casting methods by which the following products are made :
- (i) Gear blanks
 - (ii) Blades for gas turbines
 - (iii) Carburettors
 - (iv) Hollow pipes
- (m) Draw labelled figures to show the following, in case of oxy-acetylene welding :
- (i) Carburizing flame
 - (ii) Oxidizing flame
- (n) What is the function of manipulator in a robot? Classify robots as per their path control.
- (o) What is meant by hot hardness, in case of tool materials? Name any two tool materials which are not suitable for low speed applications.
- (p) ✓ Name three types of fits and show a labelled diagram of a clearance fit.
- (q) What is meant by break-even point? Draw a figure to illustrate your answer.

(r) Is Material Requirement Planning a material planning system, a production planning system, or both? Explain.

(s) What are the differences between transportation and assignment problems, in relation to—

(i) structure of the problem;

(ii) procedure for solving?

(t) What are pointers? Explain their use with a suitable program.

2×20=40

SECTION—B

2. (a) A copper rod 6 cm in diameter is placed within a steel tube, 8 cm external diameter and 6 cm internal diameter, of exactly the same length. The two pieces are rigidly fixed together by two transverse pins 20 mm in diameter, one at each end passing through both rod and the tube. Calculate the stresses induced in the copper rod, steel tube and the pins if the temperature of the combination is raised by 50 °C.

Take :

$$E_s = 210 \text{ GPa}, \alpha_s = 0.0000115/^{\circ}\text{C}$$

$$E_c = 105 \text{ GPa}, \alpha_c = 0.000017/^{\circ}\text{C}$$

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(b) A simply supported beam AB of span length 4 m supports a uniformly distributed load of intensity $q = 4\text{ kN/m}$ spread over the entire span and a concentrated load $P = 2\text{ kN}$ placed at a distance of 1.5 m from left end A . The beam is constructed of a rectangular cross-section with width $b = 10\text{ cm}$ and depth $d = 20\text{ cm}$. Determine the maximum tensile and compressive stresses developed in the beam due to bending.

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(c) A both ends hinged cast iron hollow cylindrical column 3 m in length has a critical buckling load of $P\text{ kN}$. When the column is fixed at both the ends, its critical buckling load rises by 300 kN more. If ratio of external diameter to internal diameter is 1.25 and $E = 100\text{ GPa}$, determine the external diameter of the column.

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3. (a) (i) A close-coiled helical spring has coil diameter D , wire diameter d and number of turns n . The spring material has a shearing modulus G . Derive an expression for the stiffness K of the spring.

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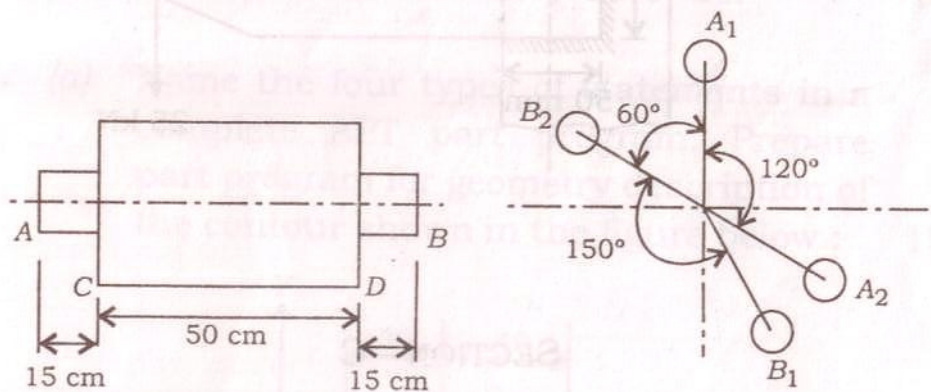
(ii) A close-coiled helical spring has coil diameter to wire diameter ratio of 6 . The spring deflects 3 cm under an axial load of 500 N and the maximum shear stress is not to

exceed 300 MPa. Find the diameter and the length of the spring wire required. Shearing modulus of wire material = 80 GPa.

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- (b) A rotor is balanced by attaching two 2 kg trial masses in each of the planes A and B as shown in the figure below at a radius of 15 cm. Complete dynamic balance is obtained with the angular positions shown in the same figure. Determine the position and mass of the material to be removed from each of the planes C and D at a radius of 10 cm in order to balance the rotor when the trial masses are removed.

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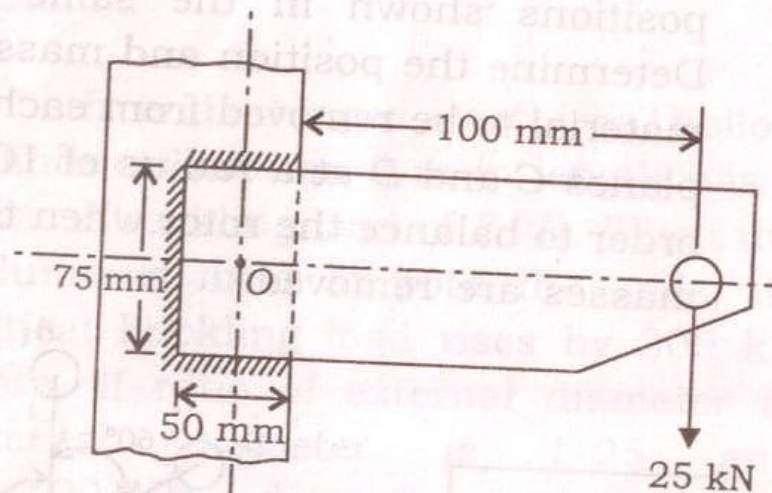
4. (a) A vertical steel shaft of 15 mm diameter is held in long bearings 1 m apart and carries at its middle a disc of mass 15 kg. The eccentricity of the centre of gravity of the disc from the centre of the shaft is 0.30 mm. The modulus of elasticity for the shaft material is 200 GPa and the permissible stress is

70 MPa. Determine the critical speed of the shaft neglecting the mass of the shaft and the range of speed over which it is unsafe to run the shaft.

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- (b) Determine the size of the weld required for static loading in the eccentrically loaded weld as shown in the figure below. Allowable stress for the weld may be taken as 75 N/mm^2 . O is the CG of the weld area.

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SECTION—C

5. (a) Distinguish between drop forging and press forging. Explain the process of manufacturing a part shown in the figure by drop forging. Draw suitable sketches also.

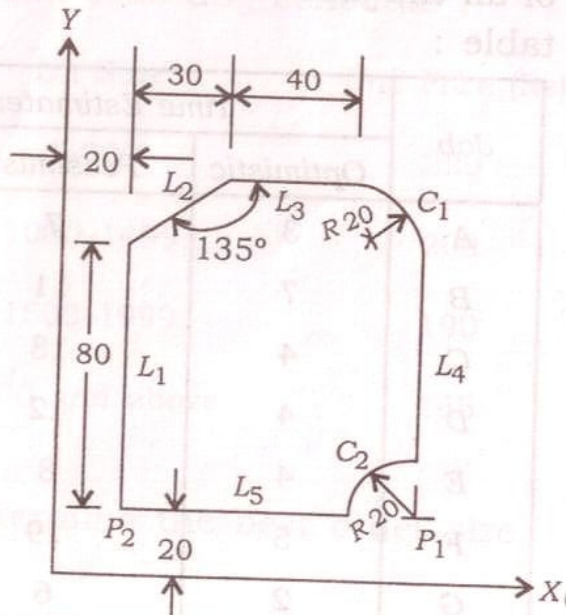
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(b) Calculate the size of a cylindrical riser, whose height and diameter are equal, to feed a steel slab casting $30 \text{ cm} \times 30 \text{ cm} \times 6 \text{ cm}$ with a side riser. Casting is poured horizontally into the mould. Use modulus method. 10

(c) What is an arc blow? How is the arc blow problem taken care of in welding? Calculate the melting efficiency in case of arc welding of steel with a potential of 20 V and current of 200 A. The travel speed is 5 mm/sec and the cross-sectional area of the joint is 20 mm^2 . Heat required to melt steel may be taken as 10 J/mm^3 and the heat transfer efficiency as 0.85. 15

6. (a) Name the four types of statements in a complete APT part program. Prepare part program for geometry description of the contour shown in the figure below : 15



(b) What are the desirable properties that diamond cutting tool materials have? State the functions of electrolyte and the properties it should have in case of electrochemical machining.

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(c) Define the terms tolerances, limits and fits with reference to dimensional measurement. What is a comparator? How does it differ from a measuring instrument? What do you understand by the terms hole basis and shaft basis in terms of assembly fit specifications? Which is preferred and why is it preferred?

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7. (a) 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 :

Job	Time Estimates (Days)		
	Optimistic	Pessimistic	Most Likely
A	3	7	5
B	7	11	9
C	4	18	14
D	4	12	8
E	4	8	6
F	5	19	12
G	2	6	4

Draw the network and determine the critical path, and its expected duration (T_e). What is the probability of completing the project in T_e days? Also, determine the total and free slacks of all the jobs.

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- (b) Name the three costs involved in inventory control. A store procures and sells certain items. Information about an item is as follows :

Expected annual sales
= 8000 units

Ordering cost = Rs 1,800 per order

Holding cost = 10% of average
inventory value

The items can be purchased according to the following schedule :

Lot Size	Unit Price (Rs)
1-999	220
1000-1499	200
1500-1999	190
2000 and above	185

Determine the best order size. 10

- (c) Draw a flow chart and write a program in C to find out the diameter of a solid steel shaft to transmit 20 kW power at 200 r.p.m. The ultimate shear stress for steel is 360 MPa and the factor of safety is 8.

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