

This question paper contains 8+3 printed pages]

HPAS (M)—2015

MECHANICAL ENGINEERING

Paper I

Time : 3 Hours

Maximum Marks : 150

Note :— (1) Attempt total *Five* questions.

(2) Question No. 8 is compulsory.

(3) Use of quality control hand-book, calculator (non-programmable), graph-sheet is allowed.

(4) Assume suitably, missing data, if any.

1. (a) Suppose a person standing at the end of a boat on lake starts walking towards the other end and stops after walking some distance. As a result, the boat would also get moving. The question is how

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far from its original position will the boat be found long after the person has stopped. The mass of the person is ' m ', that of the boat is ' M ' and the boat experiences a force— kv , where v is its speed while moving. 10

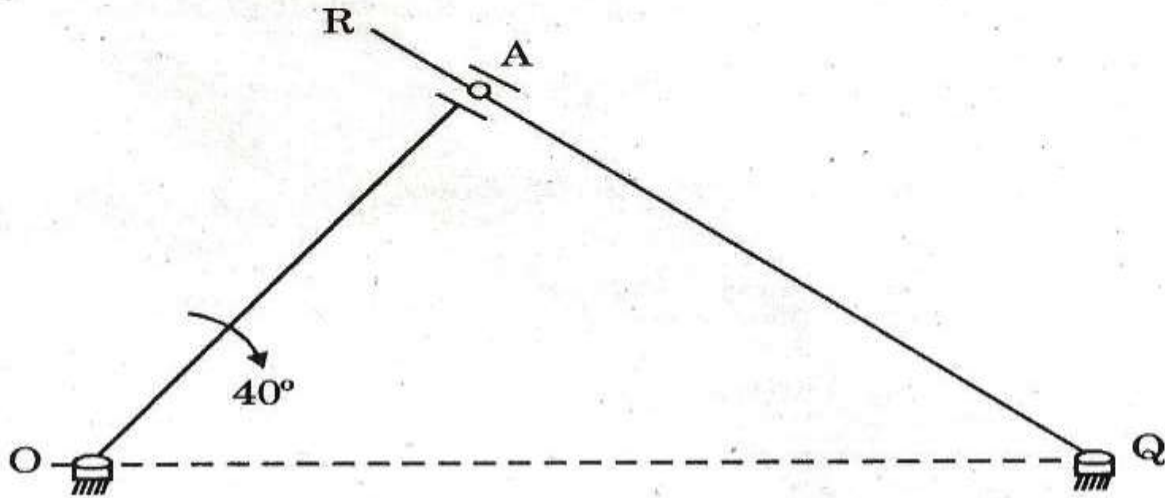
- (b) A cantilever of uniform strength is to be turned from a mild steel bar 50 mm diameter. A load of 4000 N is to be supported from the free end, and maximum stress is limited to 70 N/mm². Determine the maximum length of cantilever and its end deflection. $E = 205,000$ N/mm². 10

- (c) For the inverted slider-crank mechanism shown in figure, find the angular velocity of link QR and the sliding velocity of the block on the link QR. The crank OA is 300 mm long and rotates at 20

rad/s in clockwise direction. OQ is 650 mm and

$$\angle QOA = 40^\circ.$$

10



2. (a) A hollow steel shaft 10 cm external diameter, 5 cm internal diameter, transmits 600 kW at 500 rpm and is subjected to an end thrust of 50 kN. Find what bending moment may be safely applied to the shaft if the greater principal stress is not to exceed 100 N/mm^2 . What will then be the value of the smaller principal stress ?

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(b) A two stout worm rotating at 800 rpm drives a 26-tooth worm gear. The worm has a pitch diameter of 54 mm and a pitch of 18 mm. If coefficient of friction (μ) is 0.06, find :

- (i) the helix angle of worm
- (ii) the speed of gear
- (iii) the centre distance
- (iv) the efficiency
- (v) the lead angle for maximum efficiency. 15

3. (a) An aluminium cube of 12 cm side has to be cast along height equal to its diameter. The riser is not insulated on any surface. If the volume shrinkage of aluminium during solidification is 6 percent, calculate :

- (i) Shrinkage volume of cube on solidification.
- (ii) Minimum size of the riser so that it can provide the shrinkage volume.

(b) A cast-iron surface 300 mm long and 180 mm wide is to be machined on a shaper with cutting-to-return ratio of 3 : 2. Cutting speed, feed and clearance are 24.6 m/min, 2 mm/double stroke and 30 mm respectively. The available ram strokes on the shaper are : 28, 40, 60 and 90 strokes/min. If the depth of cut is 3.5 mm, determine :

(i) Time required to machine the surface

(ii) Material removal rate. 10

(c) Jobs A through E in the aircraft repair facility must each pass through sheet metal centre and then through the paint centre. Find the sequence that minimizes completion time of the last job.

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The processing time for each job in each centre
is shown in Table :

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Work Centre	Job				
	A	B	C	D	E
1	4	17	14	9	11
2	5	7	12	2	6

4. (a) What is Laser Beam Machine (LBM) ? Explain its principle and working with the help of a line diagram. Also discuss its :

(i) Characteristics

(ii) Advantages

(iii) Disadvantages

(iv) Application.

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- (b) Daily demand for a product is normally distributed with a mean of 50 units and a standard deviation of 5. Supply is virtually certain with lead time of six days. The cost of placing the order is Rs. 800 and annual carrying costs are 20 percent of the unit price of Rs. 120. A 95 percent service level is desired for the customers who place orders during the reorder period. Back orders are allowed. Once stocks are depleted, orders are filled as soon as the stocks arrive. There are no stock on costs. Assume sales are made over the entire year. Determine the operating doctrine. 15

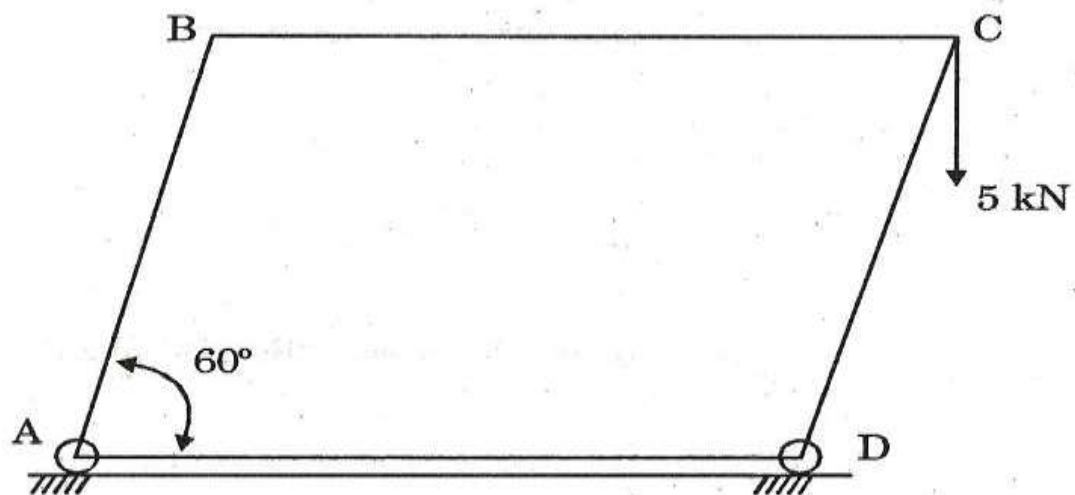
5. (a) Explain the term "Recovery", "Recrystallization" and Grain growth. 12

- (b) Design a triple riveted lap joint with zig-zag riveting for joining two plates of 10 mm thick. The allowable tensile stress is 60 MPa. Use the empirical relation to compute other stresses. Determine the efficiency of the joint. 12

- (c) Is the truss ABCD shown in figure stable or will it collapse when loaded at a corner pin, as shown ?

Give reasons for your answer.

6



6. (a) Calculate the percentage change in cutting speed required to give 60 percent reduction in tool life.

Take $n = 0.22$.

8

- (b) Write a note on Design of Assembly (DFA), disassembly and service. Detail the guidelines for DFA.

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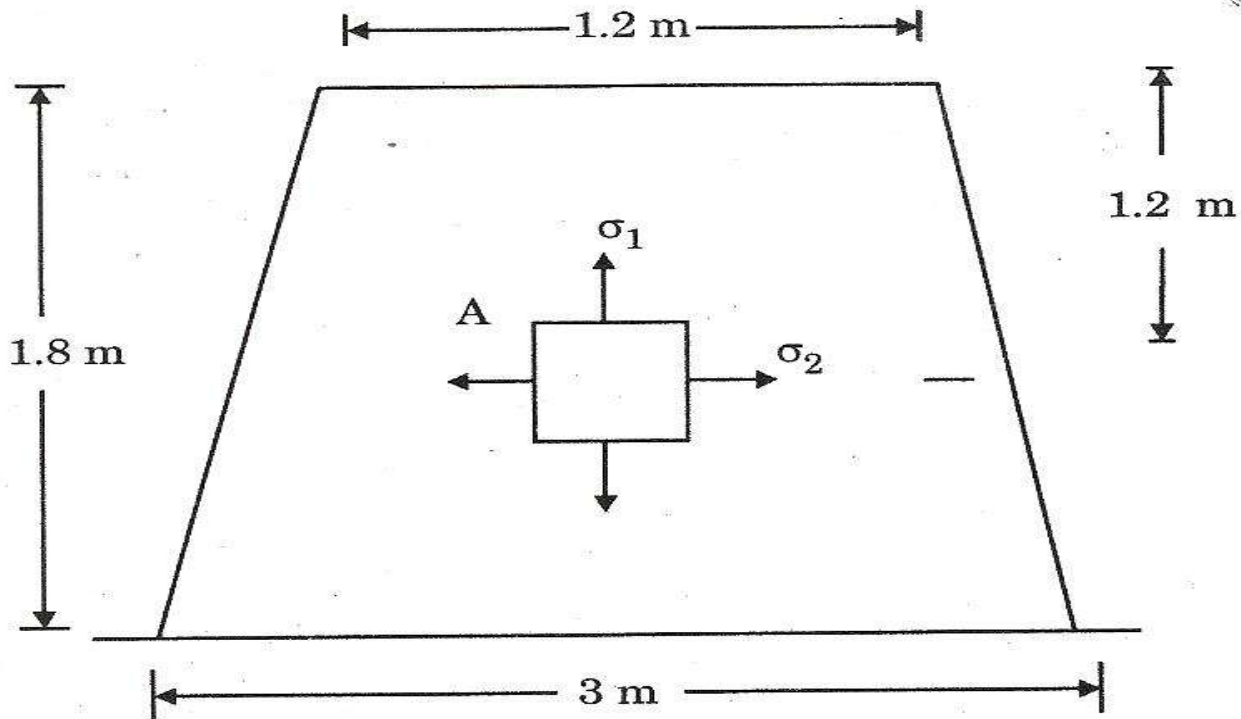
- (c) Discuss the working of Ackermann Steering Gear with the help of line diagram.

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7. (a) A truncated conical tank having the dimensions shown in figure is filled with water ($w = 1 \text{ gm/cm}^3$). Calculate the membrane stresses σ_1 and σ_2 for an element A of the wall situated as shown in figure if $t = 0.03 \text{ cm}$.

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(b) Explain, what is meant by surface integrity. Why should we be interested in it ? 8

(c) Green strength can be important in powder-metal processing. Explain why. 7

8. Write short notes on any *six* of the following : $6 \times 5 = 30$

(a) In a Brinell hardness test, the resulting impression is found to be ellipse. Give possible explanations for this phenomenon.

- (b) What is the significance of slip system ?
- (c) Contrast forecasting and prediction and give an example of each.
- (d) Outline the purpose of MRP.
- (e) What is the relationship between inspection and acceptance sampling ?
- (f) What are free, damped and forced vibration ?
- (g) Principal Moments of Inertia.
- (h) Shear centre.