

H.P.A.S. (Main)—2013

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 permitted.

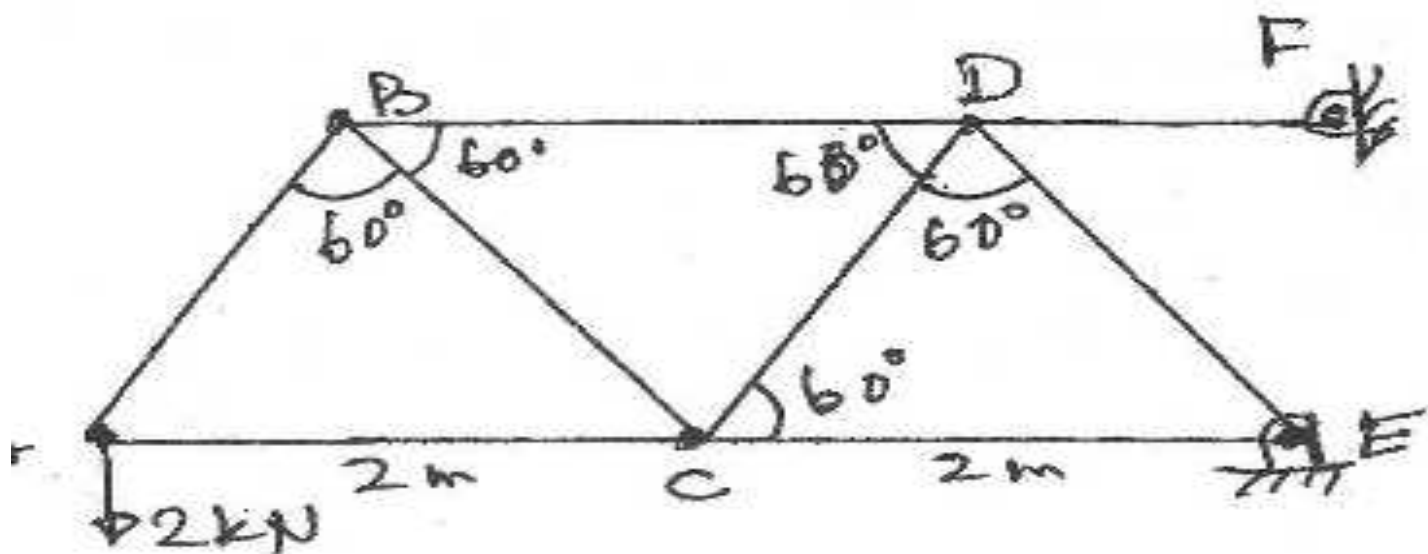
(4) Assume missing data, if any, suitable.

1. (a) A three-panel cantilever-type truss as shown in figure is pinned at E and tied to a vertical

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wall by a member DF. Determine the forces in the bars due to the vertical load 2 kN applied at A.

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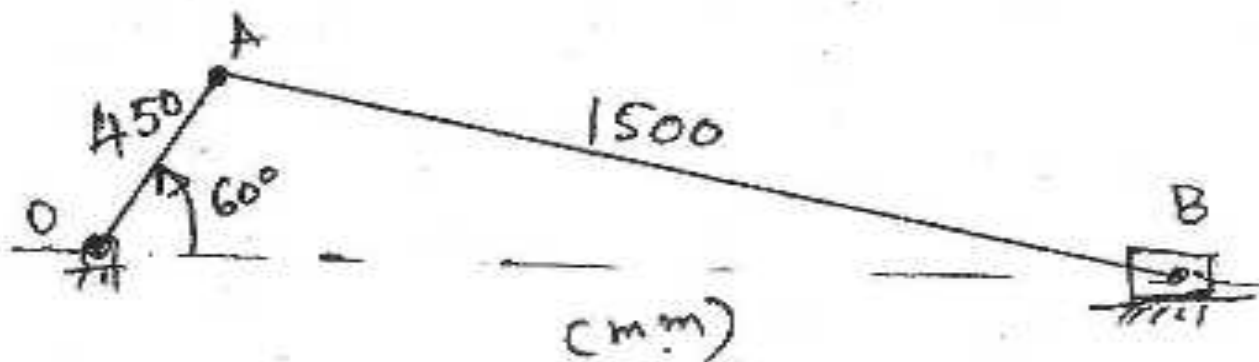
- (b) The principal stresses at a point in an elastic material are  $60 \text{ N/mm}^2$  tensile,  $20 \text{ N/mm}^2$  tensile and  $50 \text{ N/mm}^2$  compressive. Calculate the volumetric strain and the resilience.  $E = 100,000 \text{ N/mm}^2$ ;  $\mu = 0.35$ .

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(c) For the configuration of a slider-crank mechanism shown in figure. Calculate the :

- (i) acceleration of slider at B.  
 (ii) angular acceleration of link AB.

OA rotates at 30 rad/s counter-clockwise. 14



2. (a) What load falling through 25 mm on to the end of a cantilever 3 m long will cause a maximum deflection of 12 mm ?  $I = 80 \times 10^6 \text{ mm}^4$ ;

$E = 200,000 \text{ N/mm}^2$ .

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- (b) Determine the addendum of a teeth of a gear pair consisting of two spur wheels each having 30 teeth to have a minimum contact ratio equal to 2. The circular pitch is 2.5 cm and pressure angle is  $20^\circ$ . 10
- (c) Draw iron-iron carbide (carbon upto 6.67%) phase diagram and explain the main features. 10
3. (a) A machine part having a mass of 2.5 kg vibrates in a viscous medium. A harmonic exciting force of 30 N acts on the part and causes a resonant amplitude of 14 mm with a period of 0.22 seconds. Find the damping co-efficient. 12

(b) What is Dimensional tolerance, and what is the importance of dimensional tolerance control ? With the help of a neat sketch show basic size, deviation, and tolerance on a shaft, according to the ISO system. 12

(c) At a certain petrol pump, customers arrive according to a Poisson process with an average time of 5 minutes between arrivals. The service time is exponentially distributed with mean = 2 minutes. On the basis of this information find out :

(i) What would be the average length ?

(ii) What is the average waiting time of a car before receiving petrol ?

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4. (a) 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. 15

- (b) The turning moment diagram of a four-stroke engine is assumed to be represented by four triangles, the areas of which from the line of zero pressure are :

$$\text{Suction stroke} = 440 \text{ mm}^2$$

$$\text{Compression stroke} = 1660 \text{ mm}^2$$

$$\text{Expansion stroke} = 7200 \text{ mm}^2$$

$$\text{Exhaust stroke} = 660 \text{ mm}^2$$

Each  $\text{mm}^2$  of area represents 3 Nm of energy.

If the resisting torque is uniform, determine the

mass of the rim of a flywheel to keep the speed

between 218 and 222 rpm when the mean-radius

of the rim is to be 1.25 m. 15

5. (a) A 12.5 mm diameter rod is to be reduced to

10 mm diameter by drawing in a single pass at

a speed of 110 m/min. Assuming a die angle of

$5^\circ$  and coefficient of friction between the die and

steel rod as 0.15. Calculate : 12

(i) The power required in drawing.

(ii) Maximum possible reduction in diameter of

the rod.

Take stress of the work material as  $400 \text{ N/mm}^2$ .

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- (b) Find the optimal order quantity for a product for which the price discounts are as :

Order Quantity	Unit Price (Rs.)
$0 \leq Q < 500$	10.00
$500 \leq Q < 750$	9.25
$750 \leq Q$	8.75

The monthly demand for the product is 200 units. storage cost is 2% of unit cost and cost of ordering is Rs. 100.

12

- (c) Discuss combined bending and torsion effect. 6

6. (a) Principles of Jig and Fixture design.

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- (b) In a PERT network, the critical path comprises 6 activities whose estimated duration in days is given in table :

Activity	Optimistic time	Most likely time	Pessimistic time
1	3	6	12
2	8	9	10
3	6	8	10
4	2	5	8
5	3	9	12
6	3	4	4

If the project is scheduled for completion within 42 days, what is the probability of achieving the schedule ?

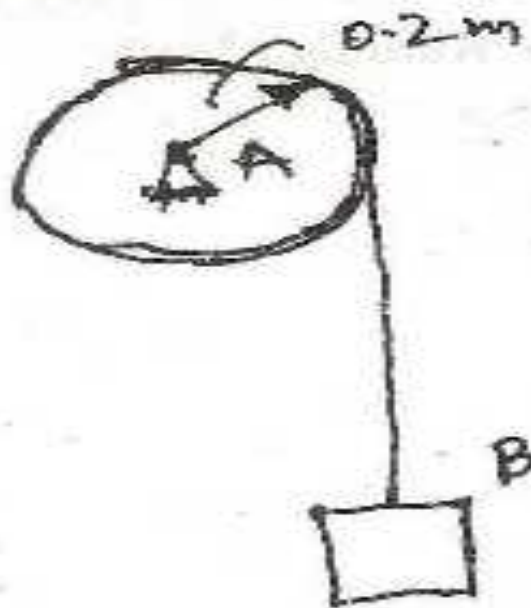
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- (c) Describe the process of EDM with the help of sketch. List advantages and limitations of EDM. 12
- (a) How do control charts differ from acceptance sampling plans ? Under what circumstances is each appropriate ? 10
- (b) Explain how ribs and serrations are helpful in casting flat surfaces that otherwise may warp. Give an illustration. 10
- (c) The block shown in figure has a mass of 6 kg. It is attached to a cord which is wrapped around

the periphery of a 20 kg disk that has a moment of inertia  $I_A = 0.40 \text{ kg.m}^2$ . If the block is initially moving downwards with a speed of 2 m/s, determine its speed in 3 s. Neglect the mass of the cord in the calculation.

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8. Write short notes on : 6×5=30

- (a) Components of material requirement planning system
- (b) Mechanisms of fatigue
- (c) Limitation of Euler's theory
- (d) Inertia Governor
- (e) Interferometry
- (f) Diffusion Welding.