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HPAS (Main)—2016

MECHANICAL ENGINEERING

Paper I

Time : 3 Hours

Maximum Marks : 100

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

(2) Question No. 8 is compulsory.

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

(4) Assume missing data suitably, if any.

1. (a) A projectile of mass 56 kg is moving at constant speed 8 m/sec when it explodes into three pieces K, L and M. K (20 kg) flies on at

P.T.O.

20 m/sec along the line of flight, and L (16 kg) flies at 15 m/sec at 45° to the line of flight in the forward direction. Find the velocity of mass M in magnitude and direction. Also estimate the energy supplied in the explosion. 10

- (b) A two-dimensional truss is loaded as shown in Fig. 1. Determine the forces in all the members of truss. Use method of joints. 10

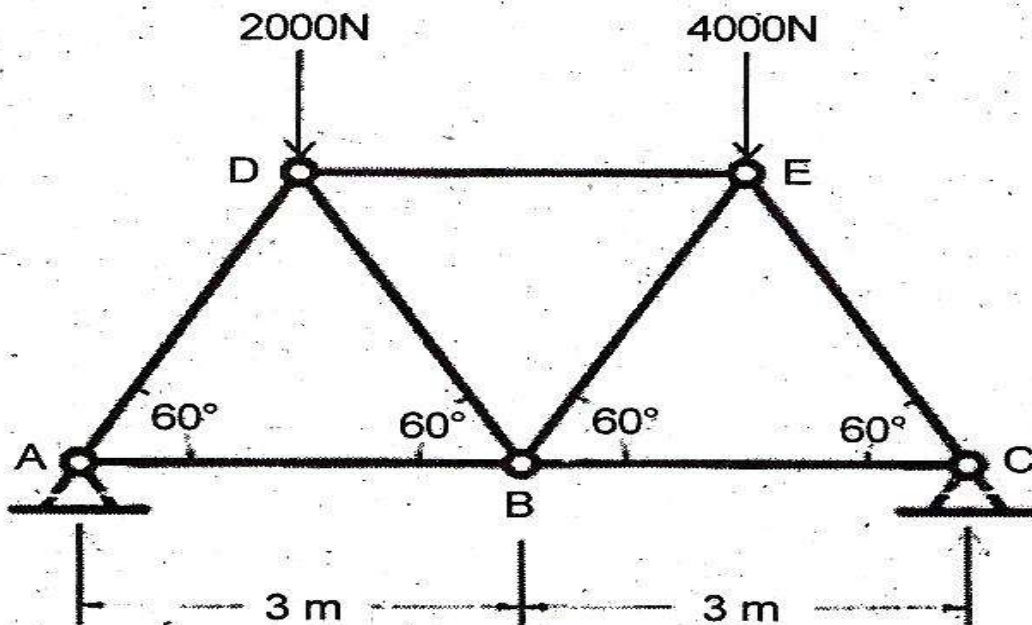


Fig. 1

2. (a) Determine the diameter of a solid shaft which will transmit 90 kW at 160 rpm, if the shear stress in the shaft is limited to 60 N/mm². Find also the length of the shaft, if the twist must not exceed 1 degree over the entire length. Take $C = 8 \times 10^4$ N/mm². 10
- (b) At a point in a strained material, two planes PQ and QR perpendicular to each other carry direct stress of intensity 45 N/mm² on PQ (horizontal) and 68 N/mm² along QR (vertical). The shear stress of intensity along these planes is 38 N/mm². Determine the magnitude of principal stress and directions of principal planes. Solve numerically and show the principal stress and the direction of principal plane diagrammatically (freehand diagram). 10

3. (a) State the properties of instantaneous centre. Explain with example Aronhold Kennedy or Three Centres in Line Theorem. 8
- (b) The balls of a Hartnell governor is having radius of rotation of 7.5 cm at the minimum speed of 290 r.p.m. Determine (i) the speed after the sleeve has lifted by 5.8 cm. Neglecting gravity effect, (ii) the initial compression of the spring, (iii) the governor effort and the power the following data pertains to the governor : Mass of each ball = 3.9 kg; length of ball arm = 14.5 cm; length of sleeve arm = 9.5 cm; and stiffness of the string = 23 N/mm. 12

4. (a) List the objectives of heat treatment of steel. With the help of neat figure show the heating temperature ranges for various heat treatment processes and explain. 10
- (b) Explain the role of riser in sand casting ? List and explain the various design considerations required while designing a riser. 10
5. (a) With diagrams explain the following processes :
- (i) hot extrusion
 - (ii) cold drawing
 - (iii) embossing
 - (iv) SAW

- (b) For orthogonal cutting of a material, determine the shear plane angle, resultant force on the tool and cutting force component. The yield strength of the material = 210 N/mm^2 . The machining data is as follows :

Width of cut = 1.6 mm, length of chip = 4.8 cm,
length of uncut chip = 9.7 cm, rake angle of the
cutting tool = 10° , thickness of the uncut chip
= 0.2 mm, coefficient of friction = 0.75. 8

6. (a) When do you prefer EBM ? Explain with neat diagram the principle and working of EBM. List the advantages, limitations and application of the process. 10

- (b) List the design considerations of Jigs and Fixtures. With neat diagram explain the major elements of Jigs and Fixtures. 10

7. (a) Consider the following Transportation problem involving three resources and four destinations as shown below. The cell entries represent the cost of transportation per unit.

	Destination				Supply	
		1	2	3		4
Source	1	3	1	7	4	300
	2	2	6	5	9	400
	3	8	3	3	2	500
Demand		250	350	400	200	

- Obtain the initial basic feasible solution using the Vogel's Approximation Method. 10

- (b) For the following Project, construct the Network.
Determine : 10

- (i) Critical Path,
(ii) ES, EF, LS, LF,
(iii) TF, FF

Activity	Duration
1—2	15
1—4	3
2—3	7
2—4	0
3—5	4
4—5	3
5—6	11

8. (a) Explain Euler's theory of columns.
(b) Differentiate between static and dynamic balancing with example.
(c) Explain the phenomenon of fatigue and creep.
(d) Write a note on various forecasting models.

5×4=20