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## HPAS (Main)—2017

### 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 steam tables, Mollier diagram, Psychometric charts, Refrigerant Property Table, Non-Programmable calculator, Graph sheet is allowed.

(4) Assume missing data suitably, if any.

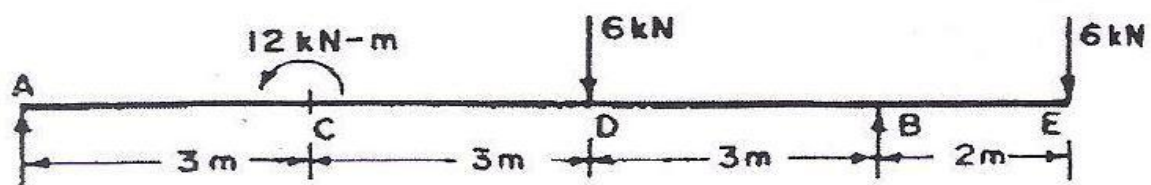
1. (a) A solid cylindrical shaft is to transmit 300 kW power at 100 r.p.m :

P.T.O.

- (i) Find the diameter of the shaft, if the shear stress is not to exceed  $80 \text{ N/mm}^2$ .
- (ii) What percent saving in weight would be obtained if the shaft is replaced by a hollow one whose internal diameter equals to 0.6 of external diameter? Consider the length, material and maximum shear stress to be the same.

- (b) Explain different diffusion methods and thermal methods of surface hardening.

2. (a) For the beam shown in the Figure, draw bending moment and shear force diagrams indicating the principal values.



- (b) Enumerate and discuss the steps involved in 'Powder Metallurgy' process. Name the materials used in 'Powder Metallurgy'. What are the limitations of Powder Metallurgy ?
3. (a) Explain the mechanisms which cause creep to occur in different stages.
- (b) A steel bolt of diameter 10 mm passes through a brass tube of internal diameter 15 mm and external diameter 25 mm. The bolt is tightened by a nut such that the length of the tube is reduced by 1.5 mm. If the temperature of the assembly is raised by 40°C, then estimate the axial stress in the bolt assuming length of tube 1500 mm.  $E_s = 2 \times 10^5 \text{ N/mm}^2$ ,  $E_b = 1 \times 10^5 \text{ N/mm}^2$ ,  $\alpha_s = 12 \times 10^{-6} \text{ per } ^\circ\text{C}$ ,  $\alpha_b = 19 \times 10^{-6} \text{ per } ^\circ\text{C}$ .

4. (a) Explain the principle of ultrasonic machining. Discuss its application, advantages and disadvantages.
- (b) Discuss tolerance, limit and fundamental deviation. Calculate the fundamental deviation and tolerances and hence the limits of size for the shaft and hole for the following fit: 60 mm H8-f7. The diameter steps are 50 mm and 80 mm.
5. (a) Discuss briefly the causes and remedies of the following casting defects :
- (i) Blow holes
  - (ii) Hot tears

- (iii) Shrinkage cavities
  - (iv) Gas porosity
  - (v) Scabs
- (b) The load on a bolt consist of an axial pull of 15 kN together with a transverse shear of 7.5 kN. Determine the diameter of the bolt according to :
- (i) Maximum principal stress theory
  - (ii) Maximum shear stress theory
  - (iii) Maximum strain theory
  - (iv) Strain energy theory

Elastic limit in tension is  $285 \text{ N/mm}^2$ , and a factor of safety of 3 is applied. Take  $\mu = 0.3$ .

P.T.O.

6. (a) A project consists of 7 jobs. Job 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 :

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.

Job	Time Estimates (Days)		
	Optimistic time	Pessimistic time	Most likely time
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

(b) What are the quick-return mechanisms ? Where are they used ? Discuss the functioning of anyone of them.

7. (a) Each arm of a Porter governor is 250 mm long.

The upper and lower arms are pivoted to links of 40 mm and 50 mm respectively from the axis of rotation. Each ball has a mass of 5 kg and the sleeve mass is 50 kg. The force of friction on the sleeve of the mechanism is 40N. Determine the range of speed of the governor for extreme radii of rotation of 125 mm and 150 mm.

(b) Transportation costs from manufacturing plants to warehouses are given in table. They are in rupees. Solve this problem to minimize the cost

of transportation by stating the steps used in the algorithm :

Warehouse	PLANT			
	A	B	C	D
1	10	8	10	8
2	10	7	9	10
3	11	9	8	7
4	12	14	13	10

8. Explain the following :

- (i) Characteristics of good foundry sand
- (ii) Effects of damping on vibratory system
- (iii) Types of chips in metal cutting
- (iv) Welding defects