Total number of printed pages–6

53 (FPT 504) MDPE

2016

MECHANICAL DESIGN OF PROCESS EQUIPMENT

Paper : FPT 504

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions out of **seven**.*

PART–A

*(Answer **any three** questions)*

1. *(a)* What is Machine Design ? What are the basic procedures of design of Machine element ? Explain. 2+8=10

   (b) What are the factors which should be considered while selecting material for a machine component ? Discuss. 10

Contd.

2. *(a)* What is bending stress ? Discuss with diagram. What are the assumptions made during the analysis of bending stress ? 6+4=10

(b) A hollow shaft is required to transmit 500*kW* power at 120*rpm*. The maximum torque is 25% greater than the mean torque. The shaft is made of plain carbon steel 45C8 ($S_{yt} = 380 N/mm^2$) and the factor of safety is 3·5. The shaft should not twist more than 1·5° in a length of 3*m*. The internal diameter of shaft is (3/8) times of external diameter. The modulus of rigidity of shaft material is $80 kN/mm^2$. Determine the external diameter of shaft on the basis of its shear strength and on the basis of permissible angle of twist. 10

3. *(a)* What is stress-strain diagram ? Explain with diagram. What are the properties that can be obtained from tension test ? Explain. 5+5=10

(b) A tensile test was conducted on a mild steel bar. The following data was obtained —

(i) Diameter of the steel bar = 3*cm*

(ii) Gauge length of the bar = 20*cm*

(iii) Load at elastic limit = 250*kN*

(iv) Extension at a load of $150 kN = 0{\cdot}21 mm$

(v) Maximum load = $380 kN$

(vi) Total extension = $60 mm$

(vii) Diameter of the rod at failure = $2{\cdot}25 cm$

Determine :

(a) the Young's modulus

(b) the stress at elastic limit

(c) the percentage elongation

(d) the percentage decrease in area.

2½×4=10

4. Write short notes on : ***(any four)***

4×5=20

(i) Break Even Analysis

(ii) Hook's law

(iii) Modulus of elasticity and modulus of rigidity

(iv) Classification of pressure vessel

(v) Factor of safety

(vi) Double pipe heat exchanger (DPHE).

PART–B

*(Answer **any two** questions)*

1. It is required to design a Cotter joint to connect two steel rods of equal diameter. Each rod is subjected to an axial tensile force of 50kN. Design the joint and specify its main dimension.
(use plain carbon steel of Grade 30C8 ($S_{yt} = 400N/mm^2$) 20

2. *(a)* What is joint efficiency factor ? Discuss different types of joint. 2+4

   (b) A pressure vessel is to be designed for the maximum operating pressure 500kN/m^2. The vessel has a nominal diameter of 1·2m and length of 2·4m. The vessel is made of IS 2002-1962 grade 2B quality steel having allowable design stress of 118MN/m^2 of working temperature 250°C. The corrosion allowance is suggested to 2mm for the life spent expected for the vessel. The vessel is to be fabricated according to 'Class 2' of Indian Standard Specification (medium operation and double welded butt zone with full penetration) which stipulate the weld joint efficiency of 0·85.

(i) What will be the standard plate thickness to fabricate this vessel?

(ii) If a spherical vessel having same diameter and thickness is fabricated with the same quality steel, what maximum internal pressure the sphere will withstand? 7+7=14

3. The layout of a countershaft supporting two pulleys A and B is shown in *Fig.* 1. Power is supplied to the shaft by means of a horizontal flat belt on pulley B, which is then transmitted to pulley A through the countershaft. The flat belt on pulley A is inclined at 45° to the horizontal. The width of each belt on pulley A and B is 125*mm*. The ratio of belt tension on tight side and loose side of pulley A, i.e. $\left(T_1 / T_2 \right)$ is 3 : 1. The shaft runs at 720*rpm*. It is supported on two bearings C and D. Design the shaft, select rolling contact bearings at C and D and specify the proportions for cast iron pulley at A and B.

(use plain carbon steel 45C8 ($S_{ut} = 600 N/mm^2$, and $S_{yt} = 380 N/mm^2$ for countershaft).

Assume the modulus of rigidity $= 79300 N/mm^2$. 20

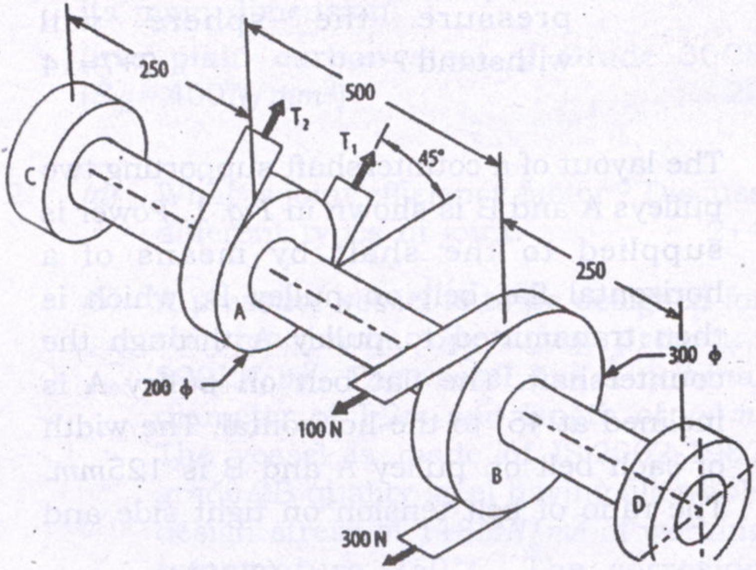

Fig. 1