53 (FPT 504) MDPE

2017

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.

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

   (b) What are the different types of cost involved in Machine Design ? What is BEP ? Explain with suitable diagram. 4+6

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

(b) A shaft transmits $20kW$ power and rotates at 500 *rpm*. The material of shaft is $50C4\left(S_{yt}=460\,N/mm^2\right)$ and the factor of safety is 2.

(i) Determine the diameter of shaft on the basis of its shear strength.

(ii) Determine the diameter of shaft on the basis of its torsional rigidity, if the permissible angle of twist is 3° per meter length and modulus of rigidity of shaft material is $79300\,N/mm^2$. 10

3. *(a)* Define compressive and tensile stresses with diagram. Show that, 5+5

elongation, $\delta=\dfrac{Pl}{AE}$

where, $P=$external force $\left(N/mm^2\right)$

$l=$original length (mm)

$A=$cross - section area $\left(mm^2\right)$

$E=$Modulus of elasticity $\left(N/mm^2\right)$.

(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 $\left(S_{yt} = 380 N/mm^2\right)$ and the factor of safety is 3·5. The shaft should not twist more than 1·5° in a length of $3m$. 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. 5+5

4. Write short notes on : ***(any four)*** 5×4=20

(i) Hook's law

(ii) Classification of pressure vessel

(iii) Double pipe heat exchanger (DPHE)

(iv) Factor of safety

(v) Elastic limit

(vi) Stresses due bending moment.

PART-B

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

1. If 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 dimensions.
(use plain carbon steel of grade $30C8\left(S_{yt}=400\,N/mm^2\right)$. 20

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

(b) A pressure vessel is to be designed for the maximum operating pressure $500\,kN/m^2$. The vessel has a nominal diameter of $1{\cdot}2m$ and length of $2{\cdot}4m$. The vessel is made of IS 2002-1962 grade 2B quality steel having allowable design stress of $118\,MN/m^2$ 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 speherical vessel having same diameter and thickness is fabricated with the same quality steel, what maximum internal pressure the sphere will withstand? 7+7

3. It is required to design a knuckle joint to connect two circular rods subjected to an axial tensile force of $50kN$. The rods are coaxial and a small amount of angular movement between their axes is permissible. Design the joint and specify the dimensions of its components.
(use plain carbon steel of grade $30C8\left(S_{yt}=400N/mm^2\right)$. 20
