53 (FPT-504) MDPE

2018

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 requirements of machine elements ? Discuss. 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 bending stress ? Discuss with diagram. 10

Contd.

(b) A hollow shaft is required to transmit $450\,kW$ 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

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

   (b) What are the basic procedure of Machine Design ? Discuss.   10

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

   (i) Elastic limit

   (ii) Stresses due bending moment

   (iii) Classification of pressure vessel

   (iv) Factor of safety

   (v) Double pipe heat exchanger (DPHE)

   (vi) Hook's law.

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 $50 kN$. Design the joint and specify its main dimensions.

   (use plain carbon steel of grade 3068 $\left(S_{yt} = 400 \, N/mm^2\right)$). 20

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

   (b) A power vessel is to be designed for the maximum operating pressure of $550 kN/m^2$. 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 $118 MN/m^2$ 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 joint with full penetration) which stipulate the weld joint efficiency of 0.85. 7+7

3. A shaft transmits $20 kN$ power and rotates at 450 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 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+10

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