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.***

*Answer question no. **1** and
any four from the rest.*

1. *(a)* Fill in the blanks : 1½×10=15

   (i) A machine is a device which transforms available energy into some _____.

   (ii) Variable cost are the costs, which are _____ of rate of production.

   (iii) In break-even point, there is _____.

(iv) In stress-strain diagram, strain is represented on _____ axis.

(v) In stress-strain diagram, percentage elongation in length = _____ ×100%.

(vi) _____ is defined as the ability of the material to absorb energy before fracture takes place.

(vii) Youngs modulus, $E = \dfrac{\cdots\cdots\cdots}{\cdots\cdots\cdots}$.

(viii) Angle of twist, $\theta = \dfrac{\cdots\cdots\cdots}{\cdots\cdots\cdots}$.

(ix) Factor of safety, $FoS = \dfrac{\cdots\cdots\cdots}{\cdots\cdots\cdots}$.

(x) For brittle materials, allowable stress, $\sigma = \dfrac{\cdots\cdots\cdots}{\cdots\cdots\cdots}$.

(b) True **or** False :   1×5

(i) The relation between modulus of elasticity, the modulus of rigidity and Poisson's ratio is given by $E = 2G(1+\mu)$.

(ii) Non-recurring costs are directly related to manufacture of the product.

(iii) Permissible shear stress, $\tau = \dfrac{S_{sy}}{FoS}$

S_{sy} = Yield stress, FoS = Factor of safety.

(iv) In Cotter joint, for the purpose of stress analysis, it is assumed that the rods are subjected to compressive force.

(v) Polar moment of inertia of a solid circular bar of diameter 'd' is given by $J = \dfrac{\pi d^4}{32}$.

2. (a) What is Machine Design ? What are the basic requirements of machine elements ? Discuss.   2+8

(b) What is BEP ? Explain with suitable diagram. What are the different types of cost involved in Machine Design ?   5+5

3. (a) What is shear stress and shear strain ? Discuiss with diagram. 5+5

(b) A rod 150cm long and of diameter 2cm is subjected to an axial pull of 20kN. If the modulus of elasticity of the material of the rod is $2 \times 10^5 N/mm^2$; determine :

    (i) the stress

    (ii) the strain

    (iii) the elongation of the rod.

                  3+3+4

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

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

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

    (a) Elastic limit

    (b) Classification of pressure vessel

    (c) Factor of safety

(d) Double Pipe Heat Exchanger (DPHE)

(e) Hooke's law

(f) Bending stress.

6. 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 dimensions. [use plain carbon steel of grade 3068 $\left(S_{yn} = 400 N/mm^2\right)$] 20

7. (a) What is joint efficiency factor ? Discuss different types of joint. 3+7=10

(b) A hollow shaft is required to transmit 450kW power at 120rpm. The maximum torque is 30% greater than the mean torque. The shaft is made of plain carbon steel 45C8 $\left(S_{yn} = 380 N/mm^2\right)$ and the factor of safety is 3. The shaft should not twist more than 1·5° in a length of 3m. The internal diameter of the shaft is 3/8 times of external diameter. The modulus of rigidity of shaft material is 80kN/mm^2. Determine the external diameter of the shaft on the basis of its shear strength and on the basis of permissible angle of twist. 5+5=10

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