*Name* : .....

*Roll No.* : .....

*Invigilator's Signature* : .....

**CS/B.TECH(FT)/SEM-3/FT-304/2010-11**

**2010-11**

# MECHANICAL DESIGN OF PROCESS EQUIPMENT

*Time Allotted* : 3 Hours Full Marks : 70

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words as far as practicable.*

## GROUP – A

**( Multiple Choice Type Questions )**

1. Choose the correct alternatives for the following :

10 × 1 = 10

i) Design pressure is equal to

a) working pressure

b) operating pressure

c) 1.05 × maximum pressure

d) 0.95 × maximum pressure.

ii) Law of gearing is satisfied if

a) two surfaces slide smooth

b) common normal at the point of contact passes through the pitch point on the line joining the centres of rotation

c) no. of teeth = PCD/module

d) addendum is greater than dedendum.

iii) Monoblock high pressure vessel wall can be prestressed by a method of

a) ribbon wounding b) auto-frettage

c) coil layering d) shrink fit.

iv) If the bolt spacing selected in a flange is too large then

a) flange thickness will be higher

b) larger gasket will be required

c) possibility of leakage will be there

d) all of these.

v) Out of roundness vessel wall is very detrimental against

a) internal pressure b) external pressure

c) dead weight d) ecentric load.

vi) In a cross belt drive the angle of wrap between belt and pulley is

a) $\theta = ( 180^\circ + 2\alpha )$ b) $\theta = ( 90^\circ + 2\alpha )$

c) $\theta = ( 180^\circ - 2\alpha )$ d) $\theta = ( 180^\circ + 3\alpha )$.

vii) Which stress is more significant in case of designing a cylindrical or spherical vessel subjected to internal pressure ?

a) Hoop stress b) Longitudinal stress

c) Shear stress d) Compressive stress.

viii) The ratio of lateral strain to linear strain is called

a) modulus of elasticity

b) modulus of rigidity

c) bulk modulus

d) Poisson's ratio.

ix) When a rectangular bar of length $L$, breadth $b$ and thickness $t$ is subjected to an axial pull $P$, the linear strain is given by

a) $btE/P$ b) $P/btE$

c) $bt/PE$ d) $PE/bt$.

x) The material having same elastic properties in all directions are called

a) Ideal material b) Elastic material

c) Isotropic material d) Anisotropic material.

## GROUP – B

### ( Short Answer Type Questions )

Answer any *three* of the following. 3 × 5 = 15

2. Write short notes on Machinability, Formability and Weldability.

3. What are anti-corrosion methods for corrosion prevention ? Explain.

4. Prove that the longitudinal stress is half of the circumferential or hoop stress.

5. A thin cylindrical pressure vessel of 1.2 m diameter generates steam at a pressure of 1.75 $N/mm^2$. Find the minimum wall thickness, if

   a) the longitudinal stress does not exceed 28 MPa; and

   b) the circumferential stress does not exceed 42 MPa.

$2\frac{1}{2} + 2\frac{1}{2}$

6. Write short notes on corrosion allowance and design loading.

## GROUP – C

### ( Long Answer Type Questions )

Answer any *three* of the following. $3 \times 15 = 45$

7. a) For a thick walled circular cylinder, inner radius is 5 cm, outer radius is 10 cm, internal and external pressures are 100 $N/cm^2$ and 50 $N/cm^2$ respectively. Obtain the maximum values of tangential and radial stresses.

   b) A cylinder is subjected to an internal pressure of 500 $N/cm^2$. Inner radius of the cylinder is 15 cm. Maximum shear stress is 800 $N/cm^2$. Find thickness of the cylinder. 8 + 7

8. A vessel is to be designed to withstand an internal pressure of 150 $MN/m^2$. An internal diameter of 300 mm is specified and steel having a yield point of 450 $MN/m^2$ has been selected. Calculate the wall thickness required by the various theories with a factor of safety, 1.5.

9. a) A thin walled cylindrical tank has radius $r$ = 50 m, wall thickness $t$ = 3 mm and is subjected to an internal pressure of 7.5 N/m $^2$ . Calculate the magnitude of shear stress along a 45° helix.

   b) A thin walled spherical shell has 1 m inside diameter and is 7 mm thick. The shell is completely filled with an unpressurised liquid. Through a small hole an additional 1000 cm $^3$ of the same liquid is pumped into the shell, tugs increasing the shell radius. Find the pressure after the additional liquid has been introduced and the hole has been closed. For material of the shell, allow E = 114 GPa and yield point ( tensile ) of the material as 830 MPa. Take Poisson's ratio = 0.33.

5 + 10

10. Power is transmitted using a V-belt drive. The inclined angle of V grooves is 30°. The belt is 2 cm deep and maximum width is 2 cm. If the mass of the belt is 3.5 gm per cm length and maximum allowable stress is 140 N/cm $^2$ , determine the maximum power transmitted when angle of lap is 140° and coefficient of friction is 0.15.

11. The velocity ratio of a pair of friction wheels is 5 : 3, and the wheels are to operate at a centre distance of 20 cm. The driver wheel is faced with leather and rotates at 200 RPM; the driven wheel is of cast iron, and 5 kW power is to be transmitted. Find the diameter and face width of a set of wheels for these conditions, if coefficient of friction is 0·135 and allowable pressure per cm of face width is 10·34 kN.