Name : ……………………………………………………

Roll No. : …………………………………………………

Invigilator's Signature : …………………………………

CS/B.TECH(FT-OLD)/SEM-3/FT-304/2011-12

2011

MECHANICAL DESIGN OF PROCESS EQUIPMENT

Time Allotted : 3 Hours   Full Marks : 70

The figures in the margin indicate full marks.

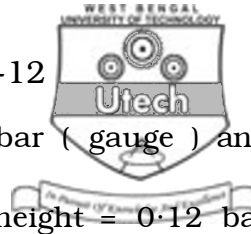*Candidates are required to give their answers in their own words as far as practicable.*

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following :

$10 \times 1 = 10$

   i)   Design pressure is equal to

       a)   working pressure

       b)   operating pressure

       c)   1.05 (maximum working pressure)

       d)   0.95 (maximum operating pressure).

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ii) If maximum working pressure = 3 bar (gauge) and maximum static head due to liquid height = 0·12 bar (gauge), then effective design pressure is equal to

a) 3 bar

b) 3·12 bar

c) 3·15 bar

d) 3·276 bar.

iii) The correct equation for thickness determination of non-circular heads and covers is

a) $CD\sqrt{\dfrac{p}{f}}$

b) $CZ_a\sqrt{\dfrac{p}{f}}$

c) $CD_e\sqrt{\dfrac{p}{f}}$

d) $(P_iD_o)\ /\ (2fJ)$.

iv) A standard dished head has

a) only spherical portion

b) spherical + torus sections

c) spherical + torus + cylindrical sections

d) something different.

v) The equations given in IS code for unfired pressure vessels are applicable when pressure rating D_o / D_i ratio does not exceed

   a) 20 MN/m^2 and 1·25

   b) 15 MN/m^2 and 1·5

   c) 10 MN/m^2 and 1·25

   d) 20 MN/m^2 and 1·5

vi) Corroded thickness of vessel wall is nothing but

   a) thickness taken for corrosion allowance

   b) theoretical thickness calculated

   c) (Theoretical thickness) + (Corrosion allowance)

   d) (Actual thickness) – (Corrosion allowance).

vii) A motor rotating at 900 RPM drives a pump to rotate at 200 RPM through the medium of spur gearing. The combination of tooth numbers should be

   a) 72/16   b) 84/18

   c) 96/22   d) 100/24.

viii) For class one vessel design, the weld joint efficiency factor should normally be taken as

a)   0·70   b)   0·85

c)   1·00   d)   1·10.

ix)   Key is used

a)   to prevent relative motion between shaft and pulley

b)   to connect pulley permanently with the shaft

c)   to prevent friction between belt and pulley

d)   to provide leak tight joint.

x)   Sand casting is advantageous because

a)   it produces smooth surfaces

b)   close tolerance in dimensions can easily be achieved

c)   almost any metal can be used for casting

d)   machining after casting is not at all necessary.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. A spherical vessel subjected to an internal working pressure of 300 kN/m^2 is having wall thickness 10 mm including corrosion allowance 1·5 mm. The vessel is fabricated with mild steel whose allowable stress value at design temperature is 80 MN/m^2. If it is a class 2 vessel, determine its internal volume.

3. A cylindrical shell having outer diameter 1200 mm is designed for a maximum working pressure (internal) of 0·8 MN/m^2. Assuming allowable stress value of 100 MN/m^2 at design temperature and weld joint efficiency factor 0·8, the thickness selected is 8 mm neglecting corrosion allowance. Determine the maximum diameter of the opening (d_0) that can be made in the shell, away from any welded joint, which will not require any reinforcement :

   Data :

Φ-weakening factor	0·700	0·645	0·545	0·465	0·390
$(d_0)\ /\sqrt{D_0 t}$	0·75	1·00	1·50	2·00	2·50

4. What are the common types of formed heads used in process equipment and how to select them ?

5. A thick walled pressure vessel having ID and OD 200 mm and 400 mm respectively is subjected to an internal pressure of 1000 bar. Determine the maximum induced stress in the wall according to the maximum principal stress theory.

6. Write notes on friction drives and belt drives.

GROUP – C
(Long Answer Type Questions)
Answer any *three* questions.   3 × 15 = 45

7. a) How is optional type flange joint related with integral type and loose type flange joints ?

   b) What is the function of gaskets in flange joints and on what basis are gasket materials selected ?

   c) Explain how bolt-spacing of flange joint is decided.

8. 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.

9. From the data given below determine the area to be compensated by a ring pad for the nozzle opening in a cylindrical shell. Find the dimensions of the ring pad whose thickness should not be less than 12 mm.

Outside diameter of the shell = 2 m

Max. working pressure = 3·5 MN/m^2

Wall thickness of the shell = 0·05 m

Corrosion allowance = 3×10^{-3} m

Weld joint efficiency factor = 1

Allowable stress at design temperature = 96 MN/m^2

Outside diameter of nozzle (seamless) = 0·25 m

Nozzle wall thickness = 0·016 m

Length of nozzle above shell surface = 0·1 m

Inside protrusion of nozzle = 0 m

10. 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 a steel having a yield point of 450 MN/m ^{2} has been selected. Calculate the safe thickness of the wall with factor of safety 1·5.

11. A cylindrical storage tank is to be designed for storing 1×10^6 litres of milk having specific graity 1·03. From the following cost figure, express total cost as a function of diameter and then applying differential calculus, calculate the diameter and height of the storage vessel which can be fabricated with minimum total cost.

If allowable stress value of material of construction is 100 MN/m ^{2} , find the maximum theoretical thickness of the storage tank.

a) The land is available free of cost

b) The cost of foundation 0·80 time the cost of fabricated bottom per unit area.

c) The cost of fabrication for shell is 1·5 times the cost of fabrication of tank bottom per unit area.

d) The fabricated cost of roof per unit projected area is 1·4 times the cost of fabrication of tank bottom per unit area.

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