Ref No: Ex/ME/5/T/423B/2017 (old)

Bachelor of Mechanical Engg. (Part Time) 4TH YR 2ND Sem Exam 2017(old)

Design of Pressure Vessels [ELECTIVE II]

Time : 3 hours Full Marks :100

Answer any five questions

1. A vertical cylindrical PV is supported by a skirt. Design the skirt thickness with the help of following data: Diameter of the PV : 2500 mm, Height of the vessel: 36000 mm, Weight of the vessel :1850000 N, Diameter of the skirt: 2500 mm, Height of the skirt: 5000 mm, Wind pressure : 1000 N/m^2 up to the height less equal 20 m, and 1500 N/m^2 above the height greater than 20 m. Design the skirt thickness (i) considering wind load only (ii) considering wind load and seismic load simultaneously. Assume seismic coefficient : 0.04 (moderate damage)

2. A PV, subjected to a design pressure of 1 MPa, consists of a cylindrical shell with 2 m inside diameter and 10 mm thickness. An opening with inner diameter of 300 mm and wall thickness of 10 mm is provided in the shell. The Corrosion allowance is 2 mm and weld joint efficiency : 85 %. The extension of the opening inside the shell is `5 mm. The yield strength of the material used for the shell and the opening is 210 N/mm^2. A reinforcing pad made of 10 mm thick plate provided for the opening. Determine the inner and outer diameters of the pad.

3. Design the thickness of a pressure vessel (PV) as per Distortion Energy Theory with the following data.
   a. Outer diameter of the PV : 1400 mm.
   b. Internal pressure : 1 N/mm^2
   c. Joint Efficiency : 0.85 (spot radio graphed)
   d. Corrosion allowance: 2 mm.
   e. Allowable stress for the PV material: 130 N/mm^2
   f. Weight of the vessel and its content : 3500 N
   g. Torque due to offset of piping : 0.8 kN-m

4. A cylindrical PV (outer dia : 45 mm, inner dia : 25 mm) has been autofrettaged by compound cylinder method. Outer diameter of the jacket is 65 mm. Allowable stress : 110 N/mm^2 , The PV is subjected to Internal pressure : 300 MPa. Calculate the shrinkage pressure . Plot the stress distribution of individual PV and jacket as well as resultant stress distribution of them both for radial and tangential stress.

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5. A 200mm diameter C.I pipe has a thickness of 12 mm and closely wound with a layer of 5 mm diameter steel wire under a tensile stress of 65N/mm^2. If now water under a pressure of 3.9 N/mm^2 is admitted into the pipe, find the stress induced in the pipe and steel wire. For C.I take E = 1 X 10^5 N/mm^2 and for steel take E = 2 X 10^5 N/mm^2, poissions ratio = 0.3

6. (a) According to maximum shear stress theory of failure $\tau = \frac{S_{yps}}{fs} = \frac{\sigma_1 - \sigma_2}{2}$ where σ_1, σ_2 are principal stresses. Apply this theory to thick cylinders with open ends and prove that cylinder wall thickness t is given by $t = \frac{D_i}{2}\left[\sqrt{\frac{\tau}{\tau - P_i}} - 1\right]$

   (b) A thick cylinder is made of ductile material with closed ends having inner diameter D_i and subjected to internal pressure P_i. According to the distortion energy theory of failure, $\sigma = S_{yt} / FOS = \sqrt{\frac{1}{2}[(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2]}$ where σ_1, σ_2 and σ_3 are principal stresses.

   Apply this theory to prove that the cylinder wall thickness is given by: $t = \frac{D_i}{2}[(\frac{\sigma}{\sigma - \sqrt{3}P_i})^{1/2} - 1]$.

   Symbols have usual meaning.

7. Write short notes on :
   (a) Justify sphere is an ideal PV
   (b) Sketch and use of elliptical head and hemispherical head
   (c) Explain autofrettage and explain its different method
   (d) Sketch a horizontal PV showing different categories of weld.