Ref No: Ex/ME/5/T/413A/2019

Bachelor of Engg. (Mechanical Engg) 4TH YR 1st Sem Exam 2019

Design of Pressure Vessels [ELECTIVE II]

Time : 3 hours Full Marks :100

Answer any five questions

1. A compound Cylinder consists of two concentric cylinder with the outer cylinder [dia 60 mm and dia 40 mm] shrunk into the inner one [dia 20 mm and dia 40 mm]. The maximum principal stress induced in any tube limited to 100 MPa at the inner surface. Calculate the shrinkage pressure. Now the cylinder is put into service with an internal pressure of 300 MPa. Plot the resultant stress distribution before autofrettage and after autofrettage. Take E = 2.1 X 10^5 MPa.
2. A pressure vessel subjected to a design pressure of 0.75 MPa, consists of a cylindrical with 2m 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 is 85 %. The extension of the opening inside the shell is 15 mm. The yield strength of the material used for the shell and the opening is 210 N/mm^2. A reinforcing pad made of a 10 mm thick plate is provided for the opening. Determine the inner outer diameters of the pad.
3. Design a vertical PV with the following data: Outer diameter : 1000 mm, Internal pressure: 0.6 N/mm^2, Allowable stress: 150 N/mm^2, Joint Efficiency : 0.95, Material : Stainless steel, Weight of the vessel & its content = 3000 kg. Assume torque for offset piping = 1 kN-m. Apply Distortion Energy Theory. Calculate the value of the thickness of the shell and check for different loading.
4. A 200mm diameter C.I pipe has a thickness of 10 mm and closely wound with a layer of 5 mm diameter steel wire under a tensile stress of 60 N/mm^2. If now water under a pressure of 4 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
5. Design the skirt thickness of a vertical cylindrical PV with the help of following data: Diameter of the PV : 2550 mm, Height of the vessel : 37500 mm, Weight of the vessel : 1850000 N, Diameter of the skirt : 2500 mm, Height of the skirt : 5050 mm, Wind pressure : 1000 N/m^2 up to the height less equal 20 m, 1500 N/m^2 above the height greater than 20 m. Design the skirt thickness considering (i) wind load only (ii)Wind load and seismic load simultaneously.Assume seismic coefficient : 0.03 (moderate damage)
6. (a) 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.

[Turn over

(b) 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

$$t = \frac{D_i}{2}\left[\sqrt{\frac{\tau}{\tau - P_i}} - 1\right]$$

7. (a) Sketch and mention different catagories of weld

(b) Justify sphere is an ideal PV

(c) Autofrettage

(d) Industrial Classification of PV