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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH DEGREE EXAMINATION APRIL-MAY 2017

MECHANICAL ENGINEERING (MACHINE DESIGN)

01ME 6104 DESIGN OF PRESSURE VESSELS AND PIPING

Max. Marks : 60 Time : 3 Hours

Answer any two full questions from Part A, B & C

PART A

1) (a) Derive the relation for dilation in thin cylindrical and spherical pressure vessels (3 marks)
(b) Discuss the modes of failure in an ellipsoidal head to a cylindrical pressure vessel and suggest suitable remedial steps (2 marks)
(c) Sketch and explain the stresses near the shell and end closure junction (4 marks)

2) Derive the expression for hoop stress and radial stress for thick walled cylinders subjected to internal and external pressure and also obtain expression for radial displacement (9 marks)

3) (a) A thick cylinder of internal and external radii 300 mm and 500 mm respectively is subjected to a gradually increasing internal pressure. Determine the value of pressure when
   i. Material of the cylinder first commences to yield
   ii. Material yielded up to middle of cylinder
   iii. Cylinder material suffers complete collapse. Yield strength- 600 MN/m^2 (6 marks)

(b) Sketch the hoop stress and radial stress variation across the thickness of a built up cylinders (i) at the end of shrink fit (b) after applying internal pressure (3 marks)

PART B

4) A horizontal vessel 6 m long with hemispherical heads and 2 m diameter is subjected to 2.5 MPa pressure. It is supported on two saddles of 120° separated by 4 m. The vessel carries an operating weight of 60 tonnes. Allowable stress (shell and support) 110 MPa. Design the vessel and supports. Provide sketches (9 marks)

5) Design a tall vertical pressure vessel with skirt support for the following data:
Shell inside diameter: 1.8 m, shell overall height: 45m, skirt height: 3 m. Wind load: top section- 4000 N/m(32-48m), middle section: 3000 N/m(16-32m), bottom section: 2000 N/m (0-16m). Approximate Dead weight: section 2: 40 Tonnes, section 3: 70 Tonnes, bottom of vessel: 115 Tonnes, base: 125 Tonnes, Design pressure: 2 MPa, Design temperature: 50°C, Allowable stress (Shell, Skirt): 100 MPa (9 marks)

6) (a) Design reinforcement for the nozzle opening in a cylindrical shell for the following data:
Outside diameter of shell: 2.2 m, Max. Working pressure: 30 kgf/cm^2 , shell wall thickness: 45 mm, Corrosion allowance 3 mm, Allowable stress (shell and nozzle) 1080 kgf/cm^2, outside diameter of nozzle: 220 mm, nozzle wall thickness: 20 mm, length of nozzle above surface: 100 mm, No protrusion of nozzle inside the shell, allowable stress: 960 kgf/cm^2 (pad), Mill tolerance is 12.5% (7 marks)
(b) Briefly Explain the seismic loading distribution adopted for design of pressure vessels (2 marks)

PART C

7) (a) What is meant by pressure temperature rating? What are its classification under ASME codes (2 marks)

(b) Sketch and explain classification of flanges based on facings (4 marks)

(c) Check whether schedule 40 pipe thickness is sufficient for 6" NB pipe subjected to an external pressure of 30 bars at 400 °C. Mill tolerance is 12.5% and corrosion allowance is 1.6 mm. Factor of safety is 4. Spacing to diameter ratio is 30. If not, find minimum thickness required (6 marks)

8) (a) Derive the minimum buckling pressure relation for a long thin cylindrical shell under external pressure (10 marks)

(b) Discuss effect of plastic yielding and initial non circularity on the buckling pressure (2 marks)

9) (a) Find the allowable displacement stress range for a pipe line operated in a 6 hour cycle every 24 hours. The life span of the plant is 20 years. The operating temp is 300°C and pipe material is ASTM A 106 Gr. B. Allowable stress at room temperature is 138 MPa and at operating temperature is 120 MPa. The stress range reduction factor is 0.7. (3 marks)

(b) Explain quick method of flexibility analysis of piping systems in case of a two anchor point uniform size piping system with no intermediate restraints (6 marks)

(c) Explain guided cantilever method in expansion loops to increase flexibility of piping systems (3 marks)