

KATHMANDU UNIVERSITY
End Semester Examination
February, 2025

Marks Scored:

Level : B.E.

Year : III

Exam Roll No. :

Time: 30 mins.

Registration No.:

Course : CHEG 325

Semester : II

F. M. : 10

Date : 23

FEB 2025

SECTION "A"

[20 Q. × 0.5 = 10 marks]

Choose and encircle the most appropriate option from each set of choices

1. What is the primary goal of process design in chemical engineering?
 - a. Minimize equipment cost
 - b. Ensure safety and efficiency in the production process
 - c. Maximize energy consumption
 - d. Reduce raw material availability

2. Which of the following is a critical factor for selecting a material of construction in process equipment design?
 - a. Low-density materials
 - b. Aesthetic appearance
 - c. Ease of fabrication
 - d. Resistance to corrosion and temperature

3. What is the primary purpose of implementing safety instrumentation in process systems?
 - a. To increase production efficiency
 - b. To control operating costs
 - c. To detect abnormal conditions and activate safety systems
 - d. To monitor product quality

4. What is the primary function of pipe supports in a piping system?
 - a. To prevent fluid leakage
 - b. To provide structural stability & prevent pipe sagging
 - c. To maintain fluid temperature
 - d. To reduce fluid turbulence

5. Which of the following is a common method used to minimize pressure drops in a piping system?
 - a. Reducing the number of fittings & bends
 - b. Using sharp bends in the layout
 - c. Increasing pipe roughness
 - d. Reducing pipe diameter

6. In line sizing, what happens to pressure drop if the pipe diameter is increased?
 - a. Pressure drop decreases
 - b. Pressure drop increases
 - c. Pressure drop remains constant
 - d. Pressure drop fluctuates

7. Which factor determines the maximum allowable height of liquid in a flat-bottom cylindrical tank?
 - a. Tank diameter
 - b. Material strength & stress analysis
 - b. Foundation type
 - d. External temperature variations

8. In the design of a flat-bottom tank, what is the purpose of the annular ring at the base?
 - a. To prevent fluid leakage
 - b. To support the tank walls and distribute load evenly
 - c. To allow easy drainage of the fluid
 - d. To increase tank volume

9. The most critical stress to consider in the cylindrical shell of a pressure vessel is:
 - a. Bending stress
 - b. Axial stress
 - c. Hoop stress
 - d. Shear stress
10. In pressure vessel design, the term "CA" accounts for:
 - a. Extra material thickness to account for expected corrosion during service life
 - b. Value of 'CA' is always 1.5 – 2 mm
 - c. An increase in operating pressure to account for environmental conditions
 - d. A safety margin for thermal expansion
11. Which of the following codes or standards is widely used for designing pressure vessels?
 - a. ASTM D1785
 - b. ASME Section VIII, Division 1
 - c. ISO 14001
 - d. API 650
12. Which of the following is commonly used to anchor vertical vessels to the foundation?
 - a. Bolts and nuts
 - b. Reinforced clamps
 - c. Welded brackets
 - d. Anchor bolts and base plates
13. Which type of vessel support is most commonly used for horizontal cylindrical vessels?
 - a. Leg support
 - b. Lug support
 - c. Saddle support
 - d. Skirt support
14. What is the effect of increasing the internal pressure on a thin pressure vessel?
 - a. Decrease in circumferential stress
 - b. Increase in hoop stress
 - c. Decrease in axial stress
 - d. Increase in vessel thickness
15. The circumferential stress induced in a thin-walled spherical vessel under internal pressure is
 - a. $pd / 2t$
 - b. $pd / 4t$
 - c. pd / t
 - d. $pd / 8t$
16. What is the main structural feature of a double tube heat exchanger?
 - a. A single tube enclosed in a rectangular shell
 - b. Two concentric tubes, one inside the other
 - c. A coiled tube immersed in a liquid tank
 - d. A bundle of small tubes enclosed in a shell
17. Wall thickness of the tubes in a shell and tube heat exchanger is primarily influenced by:
 - a. The corrosiveness of the fluid and operating pressure
 - b. The thermal conductivity of the material
 - c. The length of the tube and flow velocity
 - d. The fouling tendency of the fluids
18. Which of the following factors primarily determines the thickness of the tube sheet in a shell and tube heat exchanger?
 - a. The type of fluids used
 - b. Operating pressure and temperature differences
 - c. Operating pressure and temperature of tube side
 - d. Operating pressure and temperature of shell side
19. What is the primary function of a pressure safety valve (PSV) in equipment?
 - a. To regulate process temperature
 - b. To maintain a constant pressure in the system
 - c. To prevent overpressure by releasing excess pressure
 - d. To control flow rate in the system
20. Which of the following describes the setting of a pressure safety valve?
 - a. It is set below the OP
 - b. It is set above the OP but below the DP
 - c. It is set equal to MAWP
 - d. It is set to the atmospheric pressure.

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Level : B.E.
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Time : 2 hrs. 30mins.

23
~~24~~ FEB 2025

Course : CHEG 325
Semester : II
F. M. : 40

SECTION "B"

[4 Q. × 5 = 20 marks]

Attempt **ANY FOUR** questions.

1. Water is pumped from point A to point B. Neglecting, change in elevation, find the total pressure drop in piping system, based on data: [5]

Flowrate of water	1.25	Kg/sec
Total length of pipe	15	m
Available pressure at inlet of pipe	125	kPa.g
Discharge pressure from pipe required	1	atm
No of 90° elbows in pipe line ($k=0.24$)	8	
No of Glove valve ($k=0.75$)	1	
Viscosity	0.0001	mPa.s / cP
Density	1000	Kg/m ³

2. Why BOD is required before starting process/equipment design? Design "a process of your choice" following concept of process design? Should include all the standard items of BOD list. [5]
3. Perform detailed mechanical design of a cylindrical flat-bottomed tank with provided data. [Diameter: 3m; height: 10m, density of liquid: 1000kg/m³, permissible stress: 65 N/mm², Gap & type between two plates for welding: 2mm & Butt welding. Find the pressure at bottom of tank, thickness of shell required at bottom of tank, & also the total number of standard plates required for construction of given tank, assuming proper standard plate size, CA & Joint efficiency applicable for the case? [5]
4. Make a detailed design of skirt support for a vertical vessel with data given below. Vessel size: 3000 mm ID x 10 mm thk., 45 m total length (including skirt); Operating weight of vessel: 2500 kN; Wind pressure: 1500 N/m² (H > 20 m), 1000 N/m² (H < 20 m); Permissible stress for skirt: Tensile: 140 Mpa / Compressive: 60 Mpa; Assume: $K_1=0.7$; $K_2 = 2$; $C=0.04$. Find the required thickness of plate to fabricate skirt support. [5]
5. Design a single pass fixed tube-sheet for a heat exchanger with following data. Number of tubes = 100; $k_1=0.319$; $n=2.142$; OD of tubes = 20 mm; Tube side design pressure = 0.4 MPa; Shell side design pressure = 0.6 MPa; Allowable stress for shell and tubes = 95 MPa; CA = 1 mm (shell side and tube-side). $F=1$; $\eta = 0.42$; Calculate shell ID & thickness (t); along with the tube-sheet thickness (T_{sheet}) (against bending). [5]

P.T.O.

SECTION "B"

[5 Q. × 4 = 20 marks]

Attempt *ANY FIVE* questions.

6. Explain the following concepts briefly with an example. [2+2]
 - a. Single Vs. Dual Train
 - b. Process design Vs. Equipment design
7. Compare internal constrain with external constrain. How it affects design process, explain with example. [4]
8. Size a tank for working volume of 3,000 liters, assuming required buffer margins for safety. *Maintain the L/D ratio below 1.5 for designed tank.* [4]
9. Write short note on various types of support that could be provided to pressure vessel? [4]
10. A thin cylindrical pressure vessel of 1.2m diameter generates steam at a pressure of 1.75 N/mm². *If the longitudinal stress does not exceed 28 MPa; & the circumferential stress does not exceed 42 MPa.* Find the minimum wall thickness? [2+2]
11. Compare pressure safety valves with vacuum safety valves. Also mention their usage in the chemical process industry? [4]

List of Formula:

- $\Delta P/L = 4.07 \times 10^{10} \dot{m}^{1.84} \mu^{0.16} D_i^{-4.84} \rho^{-1} \parallel \Delta P_{E \text{ Fittings}} = (K_i \rho v^2)/2$
- $p = \rho(H-0.3) \times 9.807 \times (10^{-6}) \text{ N/mm}^2 \parallel t = (pD/2fJ) + CA$
- $f_d = W/(\Pi \cdot D_{sk} \cdot t_{sk}) \parallel P_{wi} = K_1 K_2 P_i H_i D_{oi} \parallel f_{wb} = \pm 4M_w/(\Pi \cdot (D_{sk})^2 \cdot t_{sk})$
- $m_s = (\frac{2}{3}) \cdot CWH \parallel F_t = \text{Max}(F_{wb}, F_{sb}) - f_d \parallel F_c = \text{Max}(F_{wb}, F_{sb}) + f_d$
- $D_b = d_o \cdot (\frac{Nt}{k_1})^{(\frac{1}{n})} \parallel t = \frac{P.R}{S.E-0.6P} + CA \parallel T_{Sheet} = \frac{F \cdot G}{3} \cdot \sqrt{\frac{p}{\eta \cdot s}} + CA$