Roll No.											

PRESIDENCY UNIVERSITY

BENGALURU

End - Term Examinations – December 2025

Date: 09- 12-2025 **Time:** 01:00pm – 04:00pm

School: SOE	**Program:** B. Tech. MECHANICAL ENGINEERING	
Course Code: MEC3440	**Course Name:** Fixed Equipment in Oil and Gas Industry	
Semester: VII	**Max Marks**: 100	**Weightage**: 50%

CO - Levels	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
Marks	**14**	**14**	**14**	**20**	**20**	**18**

Instructions:

(i) Read all questions carefully and answer accordingly.

(ii) Do not write anything on the question paper other than roll number.

(iii) Use of Data Handbook permitted.

Part A

Answer ALL the Questions. Each question carries 2marks. **10Q x 2M=20M**

1.	What is the role of a cap rock in a petroleum reservoir?	**2 Marks**	**L1**	**CO1**
2.	What are two key safety standards mentioned for pressure vessels?	**2 Marks**	**L1**	**CO1**
3.	What is the difference between upstream and downstream operations in the oil and gas industry?	**2 Marks**	**L1**	**CO2**
4.	What is the purpose of baffles inside a shell-and-tube heat exchanger?	**2 Marks**	**L1**	**CO2**
5.	Compare a Code and a Standard in terms of legal mandate.	**2 Marks**	**L2**	**CO3**
6.	Identify the two loads that comprise the Sustained Stress for piping systems under ASME B31.3.	**2 Marks**	**L3**	**CO3**
7.	What is the TEMA 3-Letter Code nomenclature used to define?	**2 Marks**	**L1**	**CO6**
8.	List two negative consequences if the Shell-to-Bundle Clearance is too large.	**2 Marks**	**L2**	**CO6**
9.	Identify two major disadvantages of Radiographic Testing.	**2 Marks**	**L3**	**CO6**
10.	Compare the types of defects detected by Surface Testing and Volumetric Testing.	**2 Marks**	**L2**	**CO6**

Part B

Answer the Questions. **Total Marks 80M**

11.	**a.**	A cylindrical pressure vessel with an inside diameter of 60 inches is to be constructed from SA-516 Grade 70 steel with a double-welded butt joint. The vessel will operate at a design temperature of 600°F and a design pressure of 200 psi. Assuming joint efficiency E = 0.85 and an allowable stress (S) of 40,000 psi, solve for the minimum thickness of the shell.	**10 Marks**	**L3**	**CO1**
	b.	Explain the role of ASME and API standards in the design and lifecycle of static equipment. Why are these standards considered "safety critical"?	**10 Marks**	**L2**	**CO2**
Or					
12.	**a.**	Explain the difference between Recuperative and Regenerative heat exchangers with an example for each.	**10 Marks**	**L2**	**CO1**
	b.	A spherical pressure vessel is made of SA-240 Type 304 stainless steel with an inside radius of 40 inches. The vessel has a seamless shell and operates at a design temperature of 500°F. If the minimum required thickness of the shell is 0.5 inches, solve for the maximum allowable working pressure (MAWP)?	**10 Marks**	**L3**	**CO2**

13.	**a.**	Analyze the differences between Sustained Stress (S_L), Occasional Stress (S_occ), and Displacement Stress (S_E) in a piping system. Your analysis must identify the source of the loads causing each stress and state the corresponding maximum allowable stress limits defined by ASME B31.3.	**10 Marks**	**L4**	**CO3**
	b.	A piping loop operates in a Severe Cyclic Service environment. The pipe material is ASTM A106. Given the following data: Minimum Metal Temperature (Tc): 70 deg F; Maximum Metal Temperature (Th): 900 deg F, Equivalent Cycles (N): 50,000 cycles; Calculated Sustained Stress (S_L): 7,500 psi. solve for the Allowable Displacement Stress Range (S_A) for this piping system. (Assume S_c = 20,000 psi and S_h = 10,000 psi).	**10 Marks**	**L3**	**CO6**
Or					
14.	**a.**	Explain the concept of "Code Integration" in fixed equipment design. Detail the specific responsibilities of ASME Section VIII Division 1, TEMA, and ASME B31.3 when designing and constructing a Shell and Tube Heat Exchanger and its connected piping.	**10 Marks**	**L2**	**CO3**

	b.	A horizontal, fluid-filled pipe must be supported such that the maximum vertical deflection between supports does not exceed the industry limit of 0.1 inch. Given the pipe is treated as a simply supported beam, solve for the maximum allowable span (L) in feet. Given Data: Total Uniform Load (w): 38.77 lb/ft; Modulus of Elasticity (E): 29×10^6 psi; Moment of Inertia (I): 72.5 in^4.	**10 Marks**	**L3**	**CO6**

15.	**a.**	A designer is choosing a rear head for a new STHX. Compare and contrast the design considerations for a Fixed Tube Sheet versus a Floating Head. Your analysis must focus on thermal expansion management and maintenance (shell-side cleaning).	**10 Marks**	**L4**	**CO4**
	b.	Analyze the design trade-offs involved in setting the Shell-to-Bundle Clearance (C_sb) and Baffle Spacing in a Shell and Tube Heat Exchanger. Explain how TEMA standards manage the competing requirements of Thermal Performance and Maintainability/Structural Integrity.	**10 Marks**	**L4**	**CO4**
		Or			
16.	**a.**	A TEMA AES heat exchanger is being designed. Apply the TEMA nomenclature by detailing the specific Stationary Head, Shell Type, and Rear Head Type. Discuss the primary advantage of the S-type floating head in this configuration compared to a fixed tube sheet.	**10 Marks**	**L3**	**CO4**
	b.	Draw a labeled diagram illustrating the basic setup and components of the Shielded Metal Arc Welding (SMAW) process. Apply your knowledge to explain the specific dual function of the electrode's flux coating and the resulting slag layer, focusing on atmospheric protection and metallurgical control.	**10 Marks**	**L6**	**CO4**

17.	**a.**	Draw and explain the working principle of Ultrasonic Testing as a volumetric NDT method for detecting internal flaws in a thick component.	**10 Marks**	**L2**	**CO5**
	b.	Compare and contrast Radiographic Testing and Ultrasonic Testing as volumetric NDT methods.	**10 Marks**	**L4**	**CO5**
		Or			
18.	**a.**	Draw a diagram of the Stress Corrosion Cracking "Three-Legged Stool" model. Use this model to analyze the failure mechanism when a stainless-steel component fails prematurely in a service contaminated with chlorides.	**10 Marks**	**L4**	**CO5**
	b.	Analyze the structural danger posed by Undercut and Cold Lap defects in a full-penetration groove weld. Explain why Visual Testing alone is insufficient to guarantee the integrity of a pressure-retaining butt weld.	**10 Marks**	**L4**	**CO5**