Roll No.												

PRESIDENCY UNIVERSITY

BENGALURU

Mid - Term Examinations – March 2026

Date: 13- 03-2026 **Time:**11.45am to 01.15pm

School: SOE	**Program:** B.Tech.-PET	
Course Code: PET2106	**Course Name:** Heat and Mass Transfer for Petroleum Engineering	
Semester: IV	**Max Marks**: 50	**Weightage**: 25%

CO - Levels	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Marks	**12**	**24**	**14**	**-**	**-**

Instructions:

(i) Read all questions carefully and answer accordingly.

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

Part A

Answer ALL the Questions. Each question carries 2 marks. **5Q x 2M=10M**

1	State Newton's Law of Cooling.	**2 Marks**	**L1**	**CO1**
2	List the uses of Pin-fin for hot surfaces.	**2 Marks**	**L1**	**CO2**
3	Define 'Film' Boiling of heat transfer.	**2 Marks**	**L1**	**CO2**
4	Describe the Log Mean Temperature Difference for counter flow heat exchanger.	**2 Marks**	**L1**	**CO3**
5	Define Kirchhoff's Law of heat radiation.	**2 Marks**	**L1**	**CO3**

Part B

Answer the Questions. **Total Marks 40M**

6.	**a.**	In a furnace, hot combustion gases are separated from the surrounding ambient air at 25 °C by a brick wall of thermal conductivity 0.2 W/(m·K) and surface emissivity 0.8. Under steady-state conditions, the temperature of the inner surface of the wall is measured to be 450 °C. Estimate the required thickness of the brick wall such that the outer surface temperature does not exceed 150 °C. Radiation heat transfer between the combustion gases and the inner wall surface may be neglected. The convective heat-transfer coefficients at the inner and outer surfaces are 50 W/(m^2·K) and 20 W/(m^2·K), respectively.	**10 Marks**	**L2**	**CO1**
		Or			
7.	**a.**	A 150 mm thick concrete wall having thermal conductivity k = 0.8 W/(m °C) is exposed to air at 60°C on one side and to air at 20°C on the opposite side. The average convective heat transfer coefficients are 40 W/(m^2 °C) on the 60°C side and 10 W/(m^2 °C) on the 20°C side. Estimate the heat transfer rate per unit surface area of the wall and the surface temperatures of the wall on both sides. Also, label the equivalent electrical network system.	**10 Marks**	**L2**	**CO1**

8.	**a.**	Sketch the different boiling regimes of the pool boiling curve with a neat diagram, including natural convection, nucleate boiling, transition boiling, and film boiling, marking the onset of critical heat flux, and the Leidenfrost point.	**10 Marks**	**L3**	**CO1**
		Or			
9.	**a.**	Differentiate between 'Dropwise Condensation' and 'Filmwise Condensation'. A student argues that dropwise condensation should result in a lower heat-transfer coefficient because liquid droplets act as thermal insulators compared to a thin continuous liquid film. Examine the validity of this argument and explain, using the concepts of thermal resistance and surface exposure, why dropwise condensation actually provides heat-transfer coefficients 5–10 times higher than those of filmwise condensation.	**10 Marks** **(6+4)**	**L3**	**CO1**

10.	**a.**	Starting from the general heat conduction equation, restructure the steady-state heat conduction equation of a cylindrical coordinate control volume and predict the thermal diffusivity of the medium.	**10 Marks**	**L3**	**CO2**
		Or			
11.	**a.**	Illustrate the heat transfer rate for the boundary condition at the adiabatic fin tip ($Q_{fin\ tip} = 0$) by considering the base case.	**10 Marks**	**L3**	**CO2**

12.	**a.**	Demonstrate the absorptivity, reflectivity and transmissivity for different types of bodies with proper explanation. Differentiate between the total emissive power and monochromatic emissive power of a Real surface, Blackbody and Graybody.	**10 Marks (6+4)**	**L3**	**CO3**
		Or			
13.	**a.**	A shell and tube heat exchanger is used for cooling crude oil from 400 K to 360 K. Crude oil flows through the tube at 3650 kg/h. Water enters the shell side at 310 K and has a flow rate of 1600 kg/h. Assume the heat capacity of crude oil and water as 2.5 kJ/(kg K) and 4.187 kJ/(kg K), respectively. If the overall heat transfer coefficient is 300 W/(m^2 K). and the streams are countercurrent, then determine the heat transfer rate area in m^2.	**10 Marks**	**L3**	**CO3**