Roll No.											

PRESIDENCY UNIVERSITY

BENGALURU

End - Term Examinations – May / June 2026

Date: 29- 05-2026 **Time:**09:30am – 12:30pm

School: SOE	**Program:** B.Tech.-PET	
Course Code: PET2106	**Course Name:** Heat and Mass Transfer for Petroleum Engineering	
Semester: IV	**Max Marks**: 100	**Weightage**: 50%

CO - Levels	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Marks	**14**	**10**	**26**	**24**	**26**

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 2marks. **10Q x 2M=20M**

1.	Tabulate the steady-state heat transfer rate per unit area through an 80 mm thick homogeneous slab with its two faces maintained at uniform temperatures of 40°C and 20°C, respectively. The thermal conductivity of the material is 0.20 W/(m K).	**2 Marks**	**L1**	**CO1**
2.	The average forced convective heat transfer coefficient for a hot fluid flowing over a cold surface is 200 W/(m^2 °C). The fluid temperature upstream of the cold surface is 100°C, and the surface is held at 20°C. Tabulate the heat transfer rate per unit surface area from the fluid to the surface.	**2 Marks**	**L1**	**CO1**
3.	Describe Prevost's Theory of Heat Exchange.	**2 Marks**	**L1**	**CO3**
4.	Describe why Planck's law is the basic law of thermal radiation.	**2 Marks**	**L1**	**CO3**
5.	Tabulate the main differences between the transfer-type and the storage-type heat exchangers.	**2 Marks**	**L1**	**CO3**
6.	Define Reynolds' number for fluid flow over a uniform circular pipe and for a uniform flat plate.	**2 Marks**	**L1**	**CO4**

7.	Define Calendria Type Evaporator and its steam economy.	**2 Marks**	**L1**	**CO4**
8.	Describe Mass Transfer with a suitable example.	**2 Marks**	**L1**	**CO5**
9.	Outline the two mechanisms (modes) involved in Mass transfer.	**2 Marks**	**L1**	**CO5**
10.	Outline a relationship between mass concentration, mole concentration, mass fraction and mole fraction of a species *i*.	**2 Marks**	**L1**	**CO5**

Part B

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

11.	Starting from the general heat conduction equation, extrapolate the steady-state heat conduction equation of a cylindrical coordinate control volume and predict the thermal diffusivity of the medium.	**10 Marks**	**L2**	**CO1**
Or				
12.	A 0.8 m high, 1.5 m wide double-pane window consists of two 4 mm thick layers of glass (k = 78 W/m K) and is separated by a 10 mm wide stagnant air space (k = 0.026 W/m K). The room is at 20°C and the outside air is at −10°C. The heat transfer coefficients are h_i = 10 and h_o = 40 W/m^{2}K. Estimate: (i) The rate of heat transfer through the window, (ii) the inside surface temperature.	**10 Marks**	**L2**	**CO1**

13.	A 50 mm x 50 mm iron bar 0.4 m long is connected to the walls of two heated reservoirs, each at 120°C. The ambient air temperature is 35°C, and the convective heat transfer coefficient is 17.4 W/m^2 K. Calculate the rate of heat loss from the bar and the temperature of the bar midway between the reservoirs. The thermal conductivity of iron is 52 W/m K.	**10 Marks**	**L3**	**CO2**
Or				
14.	Illustrate the heat transfer rate for the boundary condition at an infinitely long pin-fin by considering the base case.	**10 Marks**	**L3**	**CO2**

15.	Sketch the absorptivity, reflectivity and transmissivity for different types of bodies with explanation. Differentiate between the total emissive power and monochromatic emissive power of a Real surface, Blackbody and Realbody.	**10 Marks**	**L3**	**CO3**
Or				

16.	a. Demonstrate Kirchhoff's Law of heat radiation. b. Classify different types of electromagnetic wave spectrums along with their producing source, along with their particular wavelength range.	**10 Marks** **(6+4)**	**L3**	**CO3**

17.	a. Sketch the different types of flow arrangements in a recuperative heat exchanger. b. Sketch the Shell and Tube type heat exchanger along with the mechanism and temperature profile for parallel flow.	**10 Marks** **(4+6)**	**L3**	**CO3**
	Or			
18.	In a food processing plant, a brine solution is heated from 8°C to 14°C in a double-pipe heat exchanger by water entering at 55°C and leaving at 40°C at the rate of 0.18 kg/s. If the overall heat transfer coefficient is 800 W/(m2 K), calculate the area of the heat exchanger required (a) for a parallel flow arrangement, and (b) for a counterflow arrangement. Take c_p for water = 4.186 kJ/(kg K).	**10 Marks**	**L3**	**CO3**

19.	a. Using the concept of the Boiling Curve, analyze how the heat transfer mechanism changes as the surface temperature increases from free convection boiling to film boiling. b. Illustrate the working of falling film and climbing film heating evaporators with suitable diagrams. Also interpret the advantage of Agitated thin film evaporators over the other two types.	**20 Marks** **(10+10)**	**L4**	**CO4**
	Or			
20.	a. Categorise the various classifications of Multiple effect evaporator based on the feed mode. b. Explain in detail the structure of the turbulent boundary layer over a uniform flat plate, differentiating the various layers based on Reynolds number effects, velocity profiles, dominant forces (viscous vs. inertial), and their practical significance in drag prediction and heat transfer for engineering applications like pipeline flow. c. Breakdown the differences between 'Dropwise' and 'Filmwise' condensation.	**20** **Marks** **(10+6+4)**	**L4**	**CO4**

21.	a. Explain Fick's Law of Diffusion and breakdown in terms of mole fraction, mass fraction and partial pressure, considering two concentrations A & B.	**20 Marks** **(10+10)**	**L4**	**CO5**

	b. A mixture of noble gases [He, Ar, Kr, Xe] is at a total pressure of 100 kPa and a temperature of 200K. If the mixture has equal Kmol fractions of each of the gases, examine: i. Composition of mixture in terms of mass fractions, ii. Total Molar Concentrations (Kmol/m^3), iii. Total Mass density (kg/m^3)			
Or				
22.	a. Debate between Equimolar Counter Diffusion and Unimolecular Diffusion. b. A mixture of He and N_2 gas is contained in a pipe at 298 K and 1 atm total pressure, which is constant throughout. At one end of the pipe at point 1 the partial pressure, P_{A1} of He is 0.6 atm, and at the other end 0.2 m away; P_{A2} = 0.20 atm. Calculate the flux of He at steady state if DAB of the He-N_2 is 0.687 x 10^{-4}m^2/s. The universal gas constant, R is given as 82.057 cm^3.atm/gmol.K	**20 Marks** **(10+10)**	**L4**	**CO5**