Name: **Enrolment No:**	UPES UNIVERSITY OF TOMORROW

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2022

Course: Heat and Mass Transfer **Semester: IV**
Program: B. Tech. Food Technology **Time : 03 hrs.**
Course Code: MECH 2037 **Max. Marks: 100**

Instructions: Instructions: Assume any missing data. The notations used here have the usual meanings. Draw the diagrams, wherever necessary.

Q. 1	**Section-A (20Q x 1.5M= 30)**		**COs**
I	Prandtl is reciprocal of (a) thermal diffusivity/Momentum diffusivity (b) Momentum diffusivity /thermal diffusivity (c) Momentum diffusivity × thermal diffusivity (d) Mass diffusivity/thermal diffusivity	**1.5**	CO1
II	A wall has two layers of material A and B. Both the layers have same thickness. The thermal conductivity of material A is twice that of B. Under equilibrium, the temperature difference across the wall is 36 ^{o}C. The temperature difference across layer A is …… ^{o}C. (a) 6 (b) 12 (c) 18 (d) 24	**1.5**	CO1
III	Which law gives the monochromatic emissive power for a black body? (a) Planck's law (b) Kirchhoff's law (c) Wien –Displacement law (d) Stefan's Boltzmann's law	**1.5**	CO1
IV	For a fully developed laminar flow in a uniformly heated circular tube, if the velocity of the flow is doubled and the diameter is halved, the heat transfer coefficient will be (a) same as before (b) Double of original (c) Half of original (d) 4 times of original	**1.5**	CO 1

V	Heat transfer occurs by natural convection because change in temperature causes differences in …….. (a) Viscosity (b) density (c) thermal conductivity (d) heat capacity	**1.5**	CO1
VI	The wall of an oven consists of two layers of insulating bricks. In between the layers there is an air gap. The presence of air gap will (a) cause an increase in heat transfer rate through the composite wall (b) cause a decrease in heat transfer rate through the composite wall (c) have no influence on the rate of heat transfer (d) none of these	**1.5**	CO1
VII	Dittus-Boelter equation is used for the determination of heat transfer coefficient is valid (a) for liquid metals (b) for fluids in laminar flow (c) for fluids in turbulent flow (d) when Gr number is important	**1.5**	CO1
VIII	What is the emissivity of a black body? (a) 1 (b) 0 (c) 0.9 (d) 0.5	**1.5**	CO1
IX	Which of the following is unimportant in forced convection? (a) Reynolds number (b) Prandtl number (c) Grashoff number (d) Nusselt number	**1.5**	CO1
X	If a surface emits 300 W at a temperature of T, how much energy will it emit at a temperature of 3T ? (a) 900 W (b) 2700 W (c) 8100 W (d) 24300 W	**1.5**	CO1
XI	What is the physical significance of the absorption factor A? (a) it is the ratio of the slopes of the equilibrium line and the operating line (b) it is the ratio of the individual gas phase and liquid phase mass transfer coefficients (c) it is fractional absorption of the feed gas (d) none of these	**1.5**	CO2

XII	In binary systems, the separation is very efficient when relative volatility is (a) 1 (b) >1 (c) <1 (d) 0.5	**1.5**	CO2
XIII	Reboiler is considered as one theoretical plate because (a) of assumption that vapor and liquid leaving the reboiler are in equilibrium (b) vapor recycled to column (c) reboiler itself contain one plate (d) none of these	**1.5**	CO2
XIV	In batch distillation, the overhead product composition …… with time. (a) increases (b) decreases (c) does not vary (d) none of these	**1.5**	CO3
XV	In rectifying section of a continuous distillation column (a) vapor is enriched with less volatile component (b) vapor is enriched with more volatile component (c) liquid is stripped of less volatile component (d) none of these	**1.5**	CO3
XVI	At minimum reflux ratio for the given separation (a) number of plates is zero (b) number of plates is infinity (c) minimum number of theoretical plates is required. (d) separation is most efficient	**1.5**	CO3
XVII	Leaching is (a) favored by high temperature. (b) favored by low temperature (c) not affected by temperature (d) none of these	**1.5**	CO5
XVIII	Can two tie lines intersect within the two phase region of an LLE diagram? (a) Yes (b) No	**1.5**	CO5
XIX	Which of the following operations doesn't involve leaching? (a) dissolving gold from ores (b) dissolving pharmaceutical products from bark or roots (c) dissolving sugar from the cells of the beet (d) removing nicotine from its water solution by kerosene	**1.5**	CO5
XX	Azeotropic distillation is employed to separate ……. (a) constant boiling mixture (b) high boiling mixture	**1.5**	CO4

	(c) mixture with very high relative volatility (d) heat sensitive materials		
Section-B (4Q x 5M = 20 M)			
2.	Discuss the applications of heat transfer in the food processing operations.	**5**	CO4
3.	Differentiate between extractive and azeotropic distillation.	**5**	CO5
4.	State the Fick's law of diffusion.	**5**	CO2
5.	What are the advantages of triangular pitch over square pitch?	**5**	CO4
Section-C (2Q x 15M = 30 M)			
6.	Calculate the following for an industrial furnace in the form of a black body and emitting radiations at 2500 ^{0}C. (a) monochromatic emissive power at 1.2 μm wavelength, (b) wavelength at which the emission is maximum, (c) maximum monochromatic emissive power, (d) total emissive power and (e) total emissive power of the furnace if it is assumed as a real surface with emissivity equal to 0.9.	15	CO1
7.	A counter-flow double-pipe heat exchanger is to heat water from 20°C to 80°C at a rate of 1.2 kg/s. The heating is to be accomplished by geothermal water available at 160°C at a mass flow rate of 2 kg/s. The inner tube is thin-walled and has a diameter of 1.5 cm. Specific heats of water and geothermal fluid to be 4.18 and 4.31 kJ/kg-°C, respectively If the overall heat transfer coefficient of the heat exchanger is 640 W/m^2-°C, determine the length of the heat exchanger required to achieve the desired heating.	15	CO5
Section-D (2Q x 10M = 20 M)			
8.	Discuss the type of contactors used in the processing of food.	10	CO4
9.	Oxygen (A) is diffusing through carbon monoxide (B) under steady state condition, with carbon monoxide non-diffusing. The total pressure is 1×10^5 N/m^2 and the temperature 0 ^{0}C. The partial pressure of oxygen at two planes, 2.0 mm apart is, 13000 and 6500 N/m^2, respectively. The diffusivity of the mixture is 1.87×10^{-5} m^2/s. Calculate the rate of diffusion of oxygen in kmol/s through each square meter of the two planes. Steady state rate of diffusion of A through non-diffusing B is given by $$N_A = \frac{D_{AB}\, p_t}{RTz} \ln \frac{\bar{p}_{B2}}{\bar{p}_{B1}}$$	10	CO2