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**PRESIDENCY UNIVERSITY**

**Bengaluru**

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| **End - Term Examinations – JANUARY 2025** |
| **Date:** 15 – 01- 2025 **Time:** 01:00 pm – 04:00 pm |

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| **School:** SOE | **Program:** B. Tech in Petroleum Engineering | |
| **Course Code:** PET2008 | **Course Name:** Heat and Mass Transfer for Petroleum Engineering | |
| **Semester**: III | **Max Marks**: 100 | **Weightage**: 50% |

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| **CO - Levels** | **CO1** | **CO2** | **CO3** | **CO4** | **CO5** |
| **Marks** | **24** | **24** | **52** | **-** | **-** |

**Instructions:**

1. *Read all questions carefully and answer accordingly.*
2. *Do not write anything on the question paper other than roll number.*

**Part A**

|  |  |  |  |  |
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| **Answer ALL the Questions. Each question carries 2marks. 2Mx10Q=20M** | | | | |
| **1** | State Newton’s law of cooling. | **2 Marks** | **L1** | **CO1** |
| **2** | Define thermal conductivity. | **2 Marks** | **L1** | **CO1** |
| **3** | Recall white body. State one example. | **2 Marks** | **L1** | **CO2** |
| **4** | Suppose, you have kept a hot cup of tea (70°C) in a closed environment. Consider, the closed environment temperature was maintained at 25°C. After sometimes, you will observe that the tea temperature is reduced. Tell the mode of heat transfer took place behind this. | **2 Marks** | **L1** | **CO2** |
| **5** | Define Emissive power. State its unit. | **2 Marks** | **L1** | **CO3** |
| **6** | Define molar density with the help of mathematical expression. | **2 Marks** | **L1** | **CO3** |
| **7** | Recall the Fick’s law of mass transfer diffusion. | **2 Marks** | **L1** | **CO3** |
| **8** | Recall diffusion velocity in mass transfer and its mathematical expression. | **2 Marks** | **L1** | **CO3** |
| **9** | Define molar density with the help of mathematical expression. | **2 Marks** | **L1** | **CO3** |
| **10** | Consider gaseous molecule B is diffusing into gaseous molecule A from tank 1 to tank 2, as depicted in figure below. The distance of the diffusional path between both the tank is Y. Find the general expression for molar flux of the given system. | **2 Marks** | **L1** | **CO3** |

**Part B**

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| **Answer ALL Questions. Each question carries 20 marks. 4QX20M=80M** | | | | | |
| **11** | **a.** | In counter flow heat double pipe heat exchanger, water is heated from 25°C to 65°C by oil with specific heat of 1.45 KJ/Kg.K and mass flow rate of 0.9 kg/s. The oil is cooled from 230°C to 160°C. If overall heat transfer coefficient (U) is 420 W/m2K. Solve the following (i) the rate of heat transfer (ii) the mass flow rate of water, if its specific heat is 4.2 KJ/Kg.K (iii) the surface area of the heat exchanger. | **20**  **Marks** | **L3** | **CO1** |
| **or** | | | | | |
| **12** | **a.** | Consider a large plane wall of thickness L = 0.2 m, thermal conductivity k=1.2 W/m · °C, and surface area A = 15 m2. The two sides of the wall are maintained at constant temperatures of T1=120°C and T2 = 50°C, respectively, as shown in Figure below. Solve (a) the variation of temperature within the wall and the value of temperature at x 0.1 m and (b) the rate of heat conduction through the wall under steady conditions.  page20image20874880 | **20**  **Marks** | **L3** | **CO1** |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| **13** | **a.** | Two very large parallel plates are maintained at uniform temperatures T1=800K and T2=500K and have emissivities €1=0.2 and €2=0.7, respectively, as shown in Figure below. Determine the net rate of radiation heat transfer between the two surfaces per unit surface area of the plates. | **20 Marks** | **L3** | **CO2** |
|  | **b.** | The radiation shape factor of the circular cylinder surface of thin hollow cylinder of 10 cm diameter and 10 cm length is 0.1716. Determine the shape factor of curved surface of cylinder with respect to itself. | **L3** | **CO2** |
| **or** | | | | | |
| **14** | **a.** | Hot air at 66°C is cooled up to 38°C by means of cold air at 15.5 °C. Mass flow rates of hot and cold air are 1.25 kg/s and 1.6kg/s respectively. Specific heat of hot and cold air is 1.05 KJ/kg.K and overall heat transfer coefficient (U) is 80 W/m2K, assume that it is a parallel flow heat exchanger. Solve (i) the LMTD (ii) the area of the heat exchanger for parallel flow counter flow configuration. | **20**  **Marks** | **L3** | **CO2** |
|  |  |  |  |  |  |
| **15** | **a.** | In a mass transfer diffusion develop that- | **20 Marks** | **L3** | **CO3** |
|  | **b.** | Construct that for an ideal gas the mass transfer diffusion DAB=DBA | **L3** | **CO3** |
| **or** | | | | | |
| **16** | **a.** | A mixture of Helium (He) and Nitrogen (N2) gas is contained in a pipe at 298K and 1 atm total pressure, which is constant throughout. At one end of the pipe (at point 1), the partial pressure of He is 0.6 atm. At the end (at point 2), it is 0.2 atm. Both the point are 0.2 m (20 cm) away. Calculate the flux of Helium (He) at steady-state if DAB of the He-N2 mixture is 0.687 10-4 m2/s. | **20**  **Marks** | **L3** | **CO3** |
|  |  |  |  |  |  |
| **17** | **a.** | A mixture of noble gases (helium (MW=4kg), argon (MW=40kg), krypton (MW=84 kg) and xenon (MW=131 kg)) is at total pressure of 100 KPa and a temperature of 200K. If the mixture has equal kmole fraction of each of the gases, Solve,  a) The composition of mixture in terms of mass fractions  b) Total molar concentration  c) The mass density | **20 Marks** | **L3** | **CO3** |
| **or** | | | | | |
| **18** | **a.** | The following equation describe the molecular mass transfer: , where symbols have usual meaning. (i) Identify the name of the law; (ii) Construct the assumptions of this law. | **20 Marks** | **L3** | **CO3** |
| **b.** | With proper examples and diagram explain conductive and convective mass transfer. | **L3** | **CO3** |

**\*\*\*\*\* BEST WISHES \*\*\*\*\***