Roll No											

PRESIDENCY UNIVERSITY
BENGALURU

SET B

SCHOOL OF ENGINEERING
END TERM EXAMINATION - JAN 2024

Semester : Semester III - 2022

Course Code : PET2008

Course Name : Heat and Mass Transfer for Petroleum Engineering

Program : B.Tech.

Date : 05-JAN-2024
Time : 9:30AM - 12:30 PM
Max Marks : 100
Weightage : 50%

Instructions:
(i) Read all questions carefully and answer accordingly.
(ii) Question paper consists of 3 parts.
(iii) Scientific and non-programmable calculator are permitted.
(iv) Do not write any information on the question paper other than Roll Number.

PART A

ANSWER ALL THE QUESTIONS **5 X 2M = 10M**

1. Define molar density with the help of mathematical expression.

(CO2) [Knowledge]

2. Define Emissive power. State its unit.

(CO2) [Knowledge]

3. Distinguish between conductive and convective mass transfer.

(CO3) [Knowledge]

4. State general heat conduction equation for spherical co-ordinate.

(CO1) [Knowledge]

5. Define white body. State one example.

(CO3) [Knowledge]

PART B

ANSWER ALL THE QUESTIONS **5 X 10M = 50M**

6. A mixture of noble gases (helium (MW = 4 kg), argon (MW = 40 kg), krypton (MW = 84 kg) and xenon (MW = 131 kg)) is at total pressure of 100 KPa and a temperature of 200 K. If the mixture has equal kmole fraction of each of the gases (R = 8.314 J/mol.K), estimate

1. The composition of mixture in terms of mass fractions
2. Total molar concentration
3. The mass density

(CO3) [Comprehension]

7. The following equation describe molecular mass transfer: $J_{Az} = -D_{AB}\frac{dC_A}{dz}$, where symbols have usual meaning. (i) Identify the law; (ii) Explain the law with proper assumptions.

(CO3) [Comprehension]

8. Scaling and fouling of heat exchanger are prevalent challenges encountered in various industries, impacting the efficiency and performance of industrial processes and equipment. Explain the mechanisms of scaling and fouling in heat exchangers. Also, discuss preventive measures and strategies to mitigate scaling and fouling issues in the context of heat exchanger design and operation.

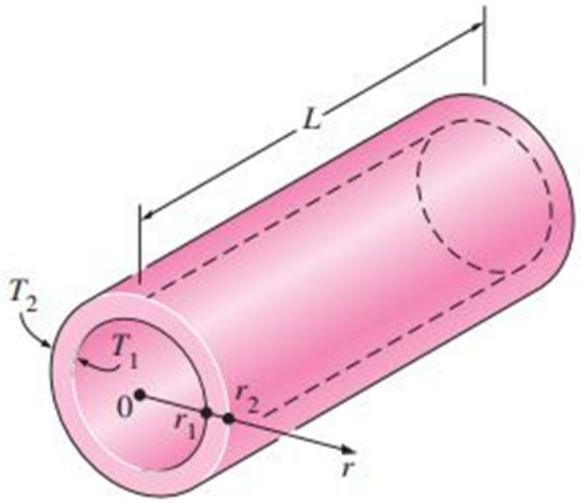
(CO2) [Comprehension]

9. Radiation heat transfer involves the movement of heat through the emission, transmission, and absorption of electromagnetic waves. Unlike conduction and convection, which depend on a medium for heat transfer, radiation can take place in a vacuum and is not contingent on the presence of matter. Various fundamental laws govern this phenomenon. Discuss the following laws that governs radiation heat transfer:

1. Stefan's Boltzmann Law
2. Planck's law

(CO2) [Comprehension]

10. Consider a steam pipe of length L = 20 m, inner radius r1 = 6 cm, outer radius r2 = 8 cm, and thermal conductivity k = 20 W/m · °C, as shown in Figure. The inner and outer surfaces of the pipe are maintained at average temperatures of T1 = 150°C and T2 = 60°C, respectively. Predict a general relation for the temperature distribution inside the pipe under steady conditions, and estimate the rate of heat loss from the steam through the pipe.



(CO1) [Comprehension]

PART C

ANSWER ALL THE QUESTIONS **2 X 20M = 40M**

11. 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. Calculate 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.

(CO2) [Application]

12. 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.

(CO2) [Application]