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PRESIDENCY UNIVERSITY BENGALURU

SCHOOL OF ENGINEERING

MAKE UP EXAMINATION - JULY 2024

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| **Semester : III & V** | **Date :09.07.2024** |
| **Course Code : PET2008** | **Time :9:30 AM-12:30PM** |
| **Course Name : Heat and Mass Transfer for Petroleum Engineering** | **Max Marks : 100** |
| **Program: B.Tech. in Petroleum Engineering** | **Weightage : 50%** |

**Instructions:**

1. *Read all questions carefully and answer accordingly.*
2. *Question paper consists of 3 parts.*
3. *Scientific and non-programmable calculator are permitted.*
4. *Do not write any information on the question paper other than Roll Number.*

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| **PART A** | | | |
| **ANSWER ANY 5 QUESTIONS 5Q X 2M=10M** | | | |
| 1 | Describe conduction and provide an example. | (CO 1) | [Knowledge] |
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| 2 | Define thermal resistance and state the general formula for its calculation | (CO 1) | [Knowledge] |
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| 3 | Describe boiling and condensation. | (CO 1) | [Knowledge] |
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| 4 | Define black body. State one Example. | (CO 3) | [Knowledge] |
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| 5 | Define convective mass transfer with an example. | (CO 3) | [Knowledge] |
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| 6 | Describe Emissive power. State its unit. | (CO 4) | [Knowledge] |
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| 7 | State the significance of Nusselt number. | (CO 2) | [Knowledge] |
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| **PART B** | | | |
| **ANSWER ANY 5 QUESTIONS 5Q X 10M=50M** | | | |
| 8 | Estimate the following in the given scenario: A steel rod, 1 cm in diameter and 5 cm in length, functions as a fin with one end insulated, exposed to surroundings at 65 °C with a heat transfer coefficient of 50 W/m^2K. The base temperature is 98 °C.   1. Temperature at the tip of the fin 2. Heat loss from the fin 3. Fin efficiency | (CO 1) | [Comprehension] |
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| 9 | The classic pool boiling curve represents a graph that displays the relationship between heat flux (q) and excess temperature (ΔTexcess = Tw - Tsat). As the magnitude of the excess temperature rises, the curve progresses through four distinct phases: (1) natural or free convection, (2) nucleate boiling, (3) transition boiling, and (4) film boiling. Elucidate the statement. | (CO 1) | [Comprehension] |
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| 10 | The radiation shape factor of the circular cylinder surface of thin hollow cylinder of 10 cm diameter and 10 cm length is 0.1716. Estimate the shape factor of curved surface of cylinder with respect to itself. | (CO 4) | [Comprehension] |
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| 11 | Explain the mechanisms of scaling and fouling in heat exchangers. Provide detailed insights into the factors influencing these phenomena and their detrimental effects on heat exchanger performance. Additionally, discuss preventive measures and strategies to mitigate scaling and fouling issues in the context of heat exchanger design and operation. | (CO 2) | [Comprehension] |
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| 12 | 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 | (CO 4) | [Comprehension] |
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| 13 | 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. Also, it is given that the total mixture is measure as 200 kmole. If the mixture has equal kmole fraction of each of the gases, estimate   1. The composition of mixture in terms of mass fractions 2. Total molar concentration 3. The mass density | (CO 4) | [Comprehension] |
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| 14 | The given equation describes molecular mass transfer: , where the symbols have their usual meanings. (i) Identify the name of the law; (ii) Explain the law with appropriate assumptions. | (CO 4) | [Comprehension] |
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| **PART C** | | | |
| **ANSWER ANY 2 QUESTIONS 2Q X 20M=40M** | | | |
| 14 | A Steam at T1 = 345°C flows in a cast iron pipe (k = 80 W/m · °C) whose inner and outer diameters are D1 = 5 cm and D2 = 5.5 cm, respectively. The pipe covered with 3-cm-thick glass wool insulation with k = 0.05 W/m · °C. Heat is lost to the surroundings at T2 = 5°C by natural convection and radiation, with a combined heat transfer coefficient of h2 = 18 W/m2 · °C. Taking the heat transfer coefficient inside the pipe to be h1 = 60 W/m2 · °C, determine the rate of heat loss from the steam per unit length of the pipe. Also, calculate the temperature drops across the pipe shell and the insulation. | (CO 1) | [Application] |
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| 15 | Consider a 20 cm diameter spherical ball at 800 K suspended in air. Assuming the ball closely appropriates a black body (σ = 5.67 x 10-8 W/m2. K4). Determine (i) the total emissive power (ii) the total amount of radiation emitted by the ball in 5 min (iii) the monochromatic black body emissive power at a wave length of 3 µm. | (CO 3) | [Application] |
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| 16 | 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. | (CO 2) | [Application] |
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