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PRESIDENCY UNIVERSITY BENGALURU

SCHOOL OF ENGINEERING

SUMMER TERM END TERM EXAMINATION – AUGUST 2024

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| **Semester :** | **Date : 06.08.2024** |
| **Course Code : PET2008** | **Time : 9:30 AM – 12:30 PM** |
| **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 coefficient of thermal conduction (K). State at least on example of metal which has good thermal conductivity. | (CO 1) | [Knowledge] |
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| 2 | State newton’s law of cooling along with its mathematical expression. | (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 | State Fick’s First Law of diffusion. | (CO 3) | [Knowledge] |
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| 6 | Describe Emissive power. State its unit. | (CO 4) | [Knowledge] |
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| 7 | Define shape factor in context of radiation heat transfer. | (CO 4) | [Knowledge] |
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| **PART B** | | | |
| **ANSWER ANY 5 QUESTIONS 5Q X 10M=50M** | | | |
| 8 | In an experiment to determine ‘k’ of a very long solid cylindrical fin of 2.5 cm diameter. The base of fin is placed in a furnace with its large portion of it projecting into the room at 22 °C. After steady state, the temperature at two points, 10 cm apart are found to be 110 °C and 85 °C. Assuming the convective heat transfer coefficient (h) between rod and surrounding is 28.4 W/ m2 K. Estimate the coefficient of conductivity of fin material (k). | (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 | There are two cubical containers and they are fully filled with water as shown in figure A and B. The temperature values at the upper and lower surfaces are shown in the figure. Neglecting the heat transfer from all other sides, Identify the mode(s) of heat transfer between upper and lower surfaces and justify your answer. | (CO 1) | [Comprehension] |
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| 14 | 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. Assuming it a parallel flow heat exchanger, estimate LMTD. | (CO 4) | [Comprehension] |
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| **PART C** | | | |
| **ANSWER ANY 2 QUESTIONS 2Q X 20M=40M** | | | |
| 14 | Consider a person standing in a room maintained at 22°C at all times. The inner surfaces of the walls, floors, and the ceiling of the house are observed to be at an average temperature of 10°C in winter and 25°C in summer. Determine the rate of radiation heat transfer between this person and the surrounding surfaces if the exposed surface area and the average outer surface temperature of the person are 1.4 m2 and 30°C, respectively. (Given that the emissivity of a person is 0.95; σ = Steffan Boltzmann constant = 5.67 x 10­8 W/m2 K4.) | (CO 3) | [Application] |
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| 15 | A pin fin (k=30 W/mk), 10 cm diameter and 5 cm long with insulated tip end is used as a higher heat transfer element. It is used as a higher heat transfer element. It is exposed to surrounding temperature at 65 ⁰C & convective heat transfer (h) = 50 W/m2K. The temperature of the base of fin is 98 ⁰C. Compute the following   1. LMTD 2. Temperature at the tip of the fin 3. Heat loss from the fin 4. Fin efficiency 5. Fin effectiveness | (CO 1) | [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 the overall heat transfer coefficient (U) is 420 W/m^2K. 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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