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**Presidency University**

**Bengaluru**

**SCHOOL OF ENGINEERING**

**Summer Term End Term Examinations, August 2024**

**Semester**: VI

**Course Code**: MEC 209

**Course Name**: Heat and Mass Transfer

**Program & Sem**: B. Tech& VI Sem

**Date**: 05-08-2024

**Time**: 9.30 am to 12.30 pm

**Max Marks**: 100

**Weightage**: 50%

**Instructions:**

1. *Read the all questions carefully and answer accordingly.*

**Part A [Memory Recall Questions]**

**Answer Nine Questions. Each question carries 2 marks. (9Qx2M=18M)**

1. Define Radiation heat transfer with an example. (CO1, Knowledge Level)
2. Define Convection heat transfer with an example. (CO3, Knowledge Level)
3. Define NTU in heat exchangers with formula. What does NTU signifies. Also define capacity rate ratio.  (CO2, Knowledge Level)
4. Define Absorptivity, Reflectivity and Transmissivity with a proper numerical example and diagram.  Also define monocromatic emissive power and monocromatic emissivity.

(CO4, Knowledge Level)

1. Define Black Body. Does Thermally black body always appear black to human eye(Yes/No)

(CO3, Knowledge Level)

1. Define Thermal Conductivity.  (CO2, Knowledge Level)
2. Define Fins. Write the formula for heat transfer through fin of length= L, Perimeter= P, Thermal conductivity= K, Area= A, Convective heat transfer coefficient of air=h, Temperature of wall on which fins are kept = T_{w} , Temperature of ambient air = T_{a}. Wall temperature is more than ambient air temperature and assume that the length of fin is Finite and tip Insulated.

(CO1, Knowledge Level)

1. Define Heat Exchanger. Write down the expression for energy transfer in heat exchanger. Use standard notations. (CO1, Knowledge Level)
2. Air enters a counter flow HE at 70°C and leaves at 40°C. Water enters at 30°C and leaves at 50°C,Find  the LMTD in degree C. (CO4, Knowledge Level)
3. What is Kirchoff"s law of radiation. Also state Stefan-Boltzmann law with equation. (CO2, Knowledge Level)

**Part B [Thought Provoking Questions]**

**Answer Three Questions. Each question carries 12 marks. (3Qx12M=36M)**

1. What is Fourier Law of Conduction. With neat and clean diagram derive Fourier Law of Conduction. Also integrate Fourier law and obtain the final equation of heat transfer. (CO1, Comprehension Level)
2. Consider two surfaces (surface 1 and surface 2) with radiation heat exchange with each other. Surface temperature, area and radiosity for surface 1 is T_{1} , A_{1} and J_{1}  and T_{2} , A_{2} and J_{2} for surface 2 respectively. Derive the surface and space resistance between both surfaces with proper diagram, Assume T_{1} is greater then T_{2}. (CO2, Comprehension Level)
3. Define Absorptivity, Reflectivity and Transmissivity with a proper numerical example and diagram.  Also define monocromatic emissive power and monocromatic emissivity. (CO3, Comprehension Level)
4. Define effectiveness of Heat exchanger. Derive the formula of effectiveness of heat exchanger in the term of temperature only. (two cases when either of the fluids have greater heat capacity rate and when both fluids have equal heat capacity rate) (CO4, Comprehension Level)

**Part C [Problem Solving Questions]**

**Answer Three Questions. Each question carries 15.33 marks. (3Qx15.33M=46M)**

1. A metal ball of diameter 60 mm is initially at 220°C. The ball is suddenly cooled by an air jet of 20°C. The heat transfer coefficient is 200 W/m^{2}-K. The specific heat, thermal conductivity and density of the metal ball are 400 J/kgK, 400 W/mK and 9000 kg/m^{3}, respectively. Find the ball temperature (in °C) after 2 minutes. (CO1, Application Level)
2. In a counter flow heat exchanger, for the hot fluid the heat capacity = 2 kJ/kg-K, mass flow rate = 5 kg/s, inlet temperature = 150°C, outlet temperature = 100°C. For the cold fluid, heat capacity = 4 kJ/kg K, mass flow rate = 10 kg/s, inlet temperature = 20°C. Neglecting heat transfer to the surroundings, Find the outlet temperature of the cold fluid in °C. (CO2, Application Level)
3. In a condenser, water enters at 30°C and flows at the rate 1500 kg/hr. The condensing steam is at a temperature of 120°C and cooling water leaves the condenser at 80°C. Specific heat of water is 4.187 kJ/kgK. If the overall heat transfer coefficient is 2000 W/m^{2}- K, Find the heat transfer area in m^{2}.  
   Draw the temperature profile of heat exchanger with temperature limits.

(CO3, Application Level)

1. A Copper Sphere of 10 kg is heated in a furnace to a temperature of 300°C and is suddenly taken out to ambient air at 25°C and if it takes 60 minutes to cool copper sphere to temperature of 35°C , Calculate convective heat transfer coefficient (h).  
   Density of copper = 8950 kg/m^{3}  
   Specific heat of copper= 383 kJ/kg-C (CO4, Application Level)