Sub Code: BMET 503 **ROLL NO……………..…………….**

SEMESTER EXAMINATION, 2022 – 23

3rd Year , B. Tech Mechanical Engineering

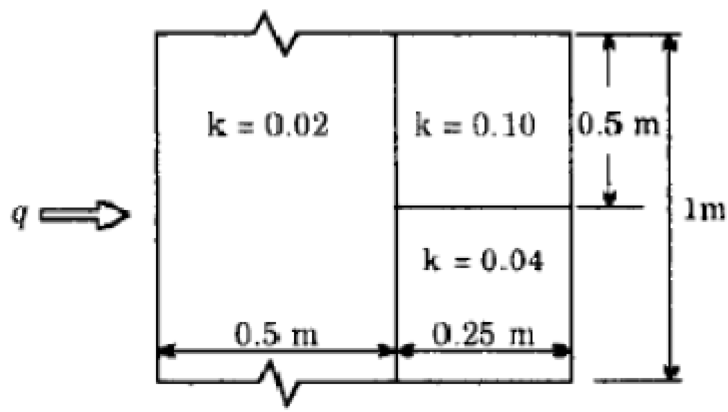
Heat & Mass Transfer

Duration: 3:00 hrs **Max Marks: 100**

Note: - Attempt all questions. All Questions carry equal marks. In case of any ambiguity or missing data, the same may be assumed and state the assumption made in the answer.

*****Heat and Mass Transfer Data Book is Allowed***

Q 1.	Answer any four parts of the following. a) Define the following: i) Total hemispherical emissive power, ii) Monochromatic emissive power iii) Emissivity iv) Monochromatic emissivity b) Obtain an expression for the effectiveness of a counter flow heat exchanger in terms of NTU and the capacity ratio C. c) Derive an expression for instantaneous temperature and heat transfer rate for a body subjected to heating or cooling in terms of Biot number. d) What is Reynolds analogy? Explain with suitable mathematical proof. e) Explain the Fick's law of diffusion. f) What is the forced convective boiling. Explain with suitable example.	5x4=20
Q 2.	Answer any four parts of the following. a) It is desired to increase the heat dissipation rate over the surface of an electronic device of spherical shape of 5 mm radius exposed to convection with h = 10 W/m^2K by encasing it in a spherical sheath of conductivity 0.04 W/mK, For maximum heat flow, calculate the diameter of the sheath. b) A 320 cm high vertical pipe at 150°C wall temperature is in a room with still air at 10°C. This pipe supplies heat at the rate of 8 kW into the room air by natural convection. Assuming laminar flow, calculate the height of the pipe needed to supply 1 kW only. c) A 0.5 m thick plane wall has its two surfaces kept at 300°C and 200°C. Thermal conductivity of the wall varies linearly with temperature and its values at 300°C and 200°C are 25 W/mK and 15W/mK respectively. Then calculate the steady heat flux through the wall. d) In a counter flow heat exchanger, hot fluid enters at 60°C and cold fluid leaves at 30°C. Mass flow rate of the hot fluid is 1 kg/s and that of the cold fluid is 2 kg/s. Specific heat of the hot fluid is 10 kJ/kgK and that of the cold fluid is 5 kJ/kgK. Calculate the Log Mean Temperature Difference (*LMTD*) for the heat exchanger in °C. e) Two large parallel grey plates with a small gap, exchange radiation at the rate of 1000 W/m2 when their emissivities are 0.5 each. By coating one plate, its emissivity is reduced to 0.25. Temperature remains unchanged. Calculate the new rate of heat exchange. f) The average Nusselt number in laminar natural convection from a vertical wall at 180^{o}C with still air at 20 ° C is found to be 48. If the wall temperature becomes 30^{o}C, all other parameters remaining same, calculate the new average Nusselt number.	5x4=20

Q 3.	Answer any two parts of the following. a) Distinguish between conduction, convection and radiation modes of heat transfer with suitable examples. b) Derive an expression for general three-dimensional heat conduction equation in cylindrical coordinate. c) Explain the following: 1) Black body and opaque body 2) Stefan Boltzman Law 3) Wein's displacement law 4) Plank's Law 5) Shape factor	10x2= 20
Q 4.	Answer any two parts of the following. a) Heat flows through a composite slab, as shown below. The depth of the slab is 1 m. The k values are in W/mK. Calculate the overall thermal resistance in K/W.  b) Calculate the heat lost per hour across a wall 4 m high, 10 m long and 115 mm thick, if the inside wall temperature is 30°C and outside ambient temperature is 10°C. Conductivity of brick wall is 1.15 W/mK, heat transfer coefficient for inside wall is 2.5 W/m^2K and that for outside wall is 4 W/m^2K. c) A hollow pipe of 1 cm outer diameter is to be insulated by thick cylindrical insulation having thermal conductivity 1 W/mK. The surface heat transfer coefficient on the insulation surface is 5 W/m^2K. What is the minimum effective thickness of insulation for causing the reduction in heat leakage from the insulated pipe?	10x2= 20
Q 5.	Answer any two parts of the following. a) Determine the net radiant interchange between two parallel oxidized iron plate, placed at a distance of 30 mm, having size of 4 m x 4 m. The surface temperatures of the two plates are 120°C and 40°C respectively. The Emissivity of both the plates is 0.736. b) Air at 20°C flows over a flat plate maintained at 75°C. Measurements show that temperature at a distance of 0.5 mm from the surface of plate is 50°C. Presuming thermal conductivity of air as 0.0266 W/m-deg, estimate the value of local heat transfer coefficient. c) Two long rods of the same diameter, one made of brass (k = 85 W/m.K) and the other made of copper (k = 375 W/m.K) have one of their ends inserted into a furnace. Both the rods are exposed to same environment. At a distance of 105 mm away from the furnace, the temperature of brass rod is 120°C. At what distance from the furnace, the same temperature would be reached in the copper rod ?	10x2= 20

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