Code No: R2022351 **R20** **SET - 1**

II B. Tech II Semester Supplementary Examinations, December - 2022
HEAT AND MASS TRANSFER
(Agricultural Engineering)

Time: 3 hours **Max. Marks: 70**

Answer any **FIVE** Questions each Question from each unit
All Questions carry **Equal** Marks

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UNIT – I

1 a) A cold storage room has walls made of 220 mm of brick on the outside, 90 mm of plastic foam and finally 16 mm of wood on the inside. The outside and inside air temperatures are 25°C and -3°C, respectively. If the inside and outside heat transfer coefficients are respectively 30 and 11 W/m2°C, and the thermal conductivities of brick, foam and wood are 0.99, 0.022 and 0.17 W/m°C, respectively. Determine the rate of heat removal by refrigeration of the total wall is 85m^2 and also find the temperature of the inside surface of the brick. [7M]

b) Define conduction, convection and radiation and discuss with suitable examples. [7M]

Or

2 a) Derive an expression to determine the rate of conduction through multiple layers or composite cylinder. [7M]

b) A steel pipe with 50 mm outside diameter with a 6.4 mm asbestos insulation (k=0.166 W/mK) followed by a 25 mm layer of fibre-glass insulation (k=0.0485 W/mK). The pipe wall temperature is 393K and the outside insulation temperature is 311K. Calculate the interface temperature between the asbestos and fibre-glass. [7M]

UNIT – II

3 a) Define critical thickness, list out its application and discuss about the factors effecting thermal conductivity. [7M]

b) A wire of 6.5 m diameter at a temperature of 60°C is to be insulated by a material having k=0.174 W/m°C. Convection heat transfer coefficient (h_o)=8.722 W/m^2°C. The ambient temperature is 20°C. For maximum heat loss, what is the minimum thickness of insulation and heat loss per meter length? Also find percentage increase in the heat dissipation too. [7M]

Or

4 a) Derive an expression for critical insulation thickness for a sphere and represent with neat diagram. [7M]

b) Calculate the critical radius of insulation for asbestos (k=0.162 W/m K) surrounding a pipe and exposed to room air at 350 K with h=3.0 W/m K. Calculate the heat loss from a 500 K, 60 mm diameter pipe when covered with the critical radius insulation and without insulation. [7M]

UNIT – III

5 a) Define Plank's law, Stefan-Boltzman law, Krichhoff's law and write about its application. [7M]

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b) A thin metal plate of 5 cm diameter is suspended in atmospheric air whose temperature is 285 K. The plate attains a temperature of 300 K when one of its face receives radiant energy from a heat source at the rate of 2 W. If heat transfer coefficient on both surfaces of the plate is stated to be 90.0 W/m^2°C, workout the reflectivity of the plates. [7M]

Or

6 a) Assuming sun to be a black body emitting radiation with maximum intensity at λ=0.49 μm, calculate the surface temperature of the sun and the heat flux at surface of the sun. [7M]

b) A black body of total area 0.045 m^2 is completely enclosed in a space bounded by 5 cm thick walls. The walls have a surface area 0.5 m^2 and thermal conductivity 1.07 W/m-deg. If the inner surface of the enveloping wall is to be maintained at 215°C and the outer wall surface is at 30°C, calculate the temperature of the black body. Neglect the difference between inner and outer surfaces areas of enveloping material. [7M]

UNIT – IV

7 a) What are Fourier and Biot number? What is the physical significance of these numbers? [7M]

b) What are advantages and limitations of dimensionless numbers? [7M]

Or

8 a) What is the role of fin heat transfer, list the application of fins/extended surfaces and enlist the assumptions made for the analysis of heat flow through the pin. [7M]

b) Show dimensional analysis for forced convection Nu=Ø (Re, Pr) [7M]

UNIT – V

9 a) Explain working mechanism of plate heat exchanger with schematic diagram. [7M]

b) Orange juice, flowing at 3600 kg/h, is to be pasteurized by heating it from 10 to 80^{o}C in a simple shell and tube exchanger. Water enters at 90^{o}C and flows counter-currently to the orange juice, leaving at 34^{o}C. The heat exchanger consists of tubes 1.50 m in length and 0.026 m external diameter. If the overall heat transfer coefficient (based on the external area of the tubes) is 1700 W/ m^2 K, determine the necessary mass flow rate of water and the number of tubes required. Assume the mean heat capacity of orange juice and water to be 3.80 and 4.18 kJ/kg K respectively. [7M]

Or

10 a) Define Log mean temperature difference (LMTD) and derive the expression for LMTD for a counter flow heat exchanger. [7M]

b) Water is chilled by brine in a counter-current heat exchanger. If the flow rate of the brine is 1.8 kg/s and that of the water is 1.05 kg/s, estimate the temperature to which the water is cooled if the brine enters at −8°C and leaves at 10°C. The water enters the heat exchanger at 32^{o}C. If the heat transfer surface area of the exchanger is 5.50 m^2, determine the overall heat transfer coefficient. Take the mean heat capacity of brine to be 3.38 kJ/ kg K. [7M]