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

II B. Tech II Semester Regular Examinations, June/July - 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) What are the different modes of heat transfer, define and explain with examples [7M]

b) The brick work of a terrace is built up of layers laid of fire clay and red brick and the space between the two layers of brick work is filled with crushed diatomite brick. The fire clay is 120 mm thick. The thickness of the diatomite filling is 50 mm and thickness of the red brick layer is 250 mm. The thermal conduction of these three materials are 0.93, 0.13, 0.7 W/m°C. What should be the thickness of red brick layer of the brick work which is to be laid without the diatomite filling between the two layers so that the heat flux through the brick work remain constant. [7M]

Or

2 a) Derive an expression for steady state heat conduction through a plane wall with internal heat generation. [7M]

b) A 5 m height and 12 m long composite wall of a cold storage is made up of 100 mm thick brick wall as the outside wall. The inner wall surface is of fibre glass of 60 mm thick. In between the two walls an insulating board 20 mm thick is placed. The coefficient of thermal conductivity for the three layers are given below:
Brick wall=1.5 W/m.K
Fibre glass=0.05 W/m.K
Insulating board=0.08 W/m.K
If the outside atmospheric temperature is 30°C and cold room temperature is 10°C. Calculate the heat loss per hour through the wall. Also determine the interface temperature. [7M]

UNIT – II

3 a) Calculate the critical radius of insulation for asbestos (k=0.172 W/m K) surrounding a pipe and exposed to room air at 300 K with h=2.8 W/m^2 K. Also Calculate the heat loss from a 475 K, 60 mm diameter pipe when covered with the critical radius insulation and without insulation. [7M]

b) Derive an equation for calculating combined conduction and convection and overall heat transfer coefficient [7M]

Or

4 a) Define critical thickness of insulation and derive an expression for critical insulation thickness for a cylinder. [7M]

b) A 10 mm cable is to be laid in atmosphere of 20°C with outside heat transfer coefficient 8.5 W/m^2°C. The surface temperature of cable is likely to be 65°C due to heat generation within. Will the rubber insulation, k=0.155 W/m°C, be effective? If yes how much? [7M]
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UNIT – III

5 a) Explain the terms blackbody, white body and grey body with the help of absorptivity (α), reflectivity (ρ) and transmissivity (τ). [7M]

b) A polished metal pipe 5 cm outside diameter and 370 K temperature at the outer surface is exposed to ambient conditions at 295 K temperature. The emissivity of the surface is 0.2 and the convection coefficient of heat transfer is 11.35 W/m^2 ^oC. Calculate the heat transfer by radiation and natural convection per metre length of the pipe. Take thermal radiation constant. What would be the overall coefficient of heat transfer by the combined mode of convection and radiation? [7M]

Or

6 a) Define a geometrical or shape factor and derive an expression for the shape factor in case of radiation exchange between two parallel surfaces. [7M]

b) A thin metal plate of 4 cm diameter is suspended in atmospheric air whose temperature is 290 K. The plate attains a temperature of 295 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 87.5 W/m^2°C, workout the reflectivity of the plates. [7M]

UNIT – IV

7 a) What is the role of fin heat transfer, list the application of fins/extended surfaces and draw the different configurations of fins. [7M]

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

Or

8 a) Discuss the physical significance of the following dimensionless numbers Re, Nu, Pr, St, Gr. [7M]

b) Derive an expression for heat transfer in an unsteady state system with negligible internal thermal resistance. [7M]

UNIT – V

9 a) Derive an expression for effectiveness of a parallel flow heat exchanger by NTU method. [7M]

b) Milk is being pasteurized in a concentric tube heat exchanger using hot water as a heating medium. The inlet temperature of milk and water are 30 °C and 95°C, respectively. The outlet temperature of water is 65°C. The heat exchanger is counter flow type. Specific heat capacitance of milk and water are 3.8 and 4.2 kJ/Kg-K. The flow rate of milk and water are 0.3 and 0.4 kg/s, respectively. Calculate the milk outlet temperature and the area of the heat exchanger. Overall heat transfer coefficient is 1000 W/m^2 K. [7M]

Or

10 a) Briefly discuss about the principles of Mass Transfer? [7M]

b) In a counter flow type heat exchanger milk is being cooled by chilled water 1°C. The milk is flowing at a rate of 200 kg/h and cooled from 40°C to 4°C. The flow rate of water is four times the flow rate of milk. If the overall thermal conductance of the exchange is 510 kcal/hr-m^2°C and the specific heat of milk is 0.93 kcal/kg-°C, estimate the cooler surface area. [7M]