QP Code: RD21BTECH045 | Reg. No | | | | | | | | | | | AR 21

# GIET UNIVERSITY, GUNUPUR – 765022

B. Tech (Third Semester - Regular) Examinations, December – 2022

## 21BAEES23001– Heat and Mass Transfer

## (AGE)

Time: 3 hrs | Maximum: 70 Marks

**Answer ALL questions**

**(The figures in the right hand margin indicate marks)**

**PART – A** **(2 x 5 = 10 Marks)**

| Q.1. Answer ***ALL*** questions | CO # | Blooms Level |
|---|---|---|
| a. Define the contact resistance. | CO1 | K2 |
| b. Differentiate between convection and conduction. | CO3 | K1 |
| c. Define Emissivity. | CO1 | K1 |
| d. Write the expression of LMTD for a parallel flow heat exchanger. | CO4 | K1 |
| e. Define Reynolds Number. State the condition for laminar flow and turbulent flow.. | CO2 | K1 |

**PART – B** **(15 x 4 = 60 Marks)**

| **Answer the following questions** | Marks | CO # | Blooms Level |
|---|---|---|---|
| 2. a. Hot air at a temperature of $65^0$C is flowing through a steel pipe of 120 mm diameter. The pipe is covered with two different layers of insulating materials of thickness 60 mm and 40 mm and their corresponding thermal conductivities are 0.24 and 0.4 W/m$^0$C. The inside and outer heat coefficients are 60 and 12 W/ m$^{2o}$C. The atmosphere is at $20^0$C. Find the rate of heat loss from 60 m length of pipe. | 10 | CO1 | K2 |
| b. A plane wall is 150 mm thick and its wall area is 4.5 m$^2$. If its conductivity is 9.25 W/m$^0$C and surface temperature are steady at $150^0$C and $45^0$C respectively. Determine- a) heat flow across the plane wall b) temperature gradient in the flow direction. | 5 | CO1 | K2 |
| (OR) | | | |
| c. Derive the expression for steady state one dimensional heat conduction equation in Cartesian system with internal heat generation. | 10 | CO2 | K2 |
| d. A surface area 3 m$^2$ at 200 $^0$C exchanges heat with another surface at $30^0$C by radiation. If the emissivity of the surface is 0.69, calculate- a) rate of heat transfer b) equivalent convective heat transfer coefficient. | 5 | CO1 | K2 |
| 3.a. A vertical cylinder 1.5 m high and 180 mm in diameter is maintained at $100^0$C in an atmospheric environment of $20^0$C. Calculate the heat loss by free convection from the surface of the cylinder. Assume the properties of air at mean temperature are: $\rho$= 1.09 kg/m$^3$, k=0.1042 kW/m$^0$C, Pr= 0.7, v = -18.97$\times$ $10^{-6}$ m$^2$/s, $c_p$=1.004 kJ/kg.$^0$C. | 10 | CO3 | K2 |
| b. Define Grashoff Number, Stanton Number with expression. | 5 | CO3 | K1 |
| (OR) | | | |
| c. Calculate the amount of energy required to solder together two very long pieces of bare copper wire 1.5 mm in diameter with solder that melts at $190^0$C. The wires are positioned vertically in air at $20^0$C. Assume that the heat transfer coefficient | 10 | CO2 | K2 |

| | | | | |
|---|---|---|---|---|
| | on the wire surface is 20W/ $m^2$ $^0$C and thermal conductivity of wire alloy is 330 W/$m^0$C. | | | |
| d. | List out the assumptions made for analysis of heat flow through fins. | 5 | CO2 | K1 |
| 4.a. | A liquid (Cp=0.9 kJ/kg K) is entering a counter flow heat exchanger at 35°C at a rate of 4.5 kg/s. It is heated to 75°C by another fluid (Cp=1 kJ/kg K) with a flow rate of 2.5 kg/s entering at 900°C. With these things remaining same, what will be percentage change in the area of heat exchanger if the fluid is heated up to 600°C instead of 750°C? | 10 | CO4 | K2 |
| b. | Explain condenser and evaporator type heat exchanger. | 5 | CO4 | K1 |
| | (OR) | | | |
| c. | Explain the laws associated with radiative heat transfer. | 8 | CO1 | K1 |
| d. | A longitudinal copper fin (k= 380 W/m $^O$C) 600 mm long and 5 mm in diameter is exposed to air stream at 20 $^O$C. The convective heat transfer coefficient is 20W/$m^2$ $^O$C. if the fin base temperature is 150 $^O$C, calculate heat dissipated and efficiency of the fin. | 7 | CO4 | K2 |
| 5.a. | A mild steel tank of wall thickness 12 mm contains water at 95 $^O$C. The thermal conductivity of mild steel is 50W/m$^O$C and the heat transfer coefficients for the inside and outside the tank are 2850 and 10W/$m^{2O}$C respectively. If the atmospheric temperature is 15$^O$C, calculate the rate of heat loss per sq. metre of the tank surface and temperature of the outside surface of the tank. | 12 | CO1 | K2 |
| b. | Define critical thickness and write expression for critical thickness of a sphere. | 3 | CO2 | K1 |
| | (OR) | | | |
| c. | The effective temperature of a body having an area of 0.1 $m^2$ is 627 $^O$C. Calculate the total rate of energy emission, intensity of normal radiation and wavelength of maximum monochromatic emissive power. | 8 | CO1 | K2 |
| d. | Calculate the net radiant heat exchange per $m^2$ area for two parallel plates at temperatures of 427$^0$C and 27$^0$C respectively. The emissivity of hot plate and cold plate are 0.9 and 0.6 respectively. | 7 | CO1 | K2 |

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