Reg.No. \_\_\_\_\_\_\_\_\_\_\_\_



**UNIVERSITY**

(Karunya Institute of Technology & Sciences)

(Declared as Deemed-to-be University under Sec.3 of the UGC Act, 1956)

**End Semester Examination – Nov/Dec – 2016**

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|  |  | **Semester :** | **2016-17 ODD** |
| **Code :** | **14ME2019** | **Duration :** | **3hrs** |
| **Sub. Name :** | **Heat and Mass Transfer** | **Max. marks :** | **100** |

**ANSWER ALL QUESTIONS (5 x 20 = 100 Marks)**

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| **Q. No.** | **Sub Div.** | **Questions** | **Course**  **Outcome** | | **Marks** | |
| 1. | a. | A hollow cylinder 5cm inner diameter and 10cm outer diameter has inner surface temperature of 200oC and outer surface temperature of 100oC. Determine heat flow through the cylinder per meter length. Also determine the temperature of the point half way between the inner and outer surfaces. Take thermal conductivity as 1.2 W/mK. | CO1 | | 16 | |
| b. | A Solid sphere (k=39 W/mK) 10cm in diameter generates heat at a uniform rate of 5x106 W/m3. The outer surface of sphere is exposed to an ambient at 500C with heat transfer coefficient of 400 W/m2K. Calculate the maximum temperature in the solid and its location. | CO1 | | 4 | |
| (OR) | | | | | | |
| 2. |  | Derive the general equation for the three dimensional cylindrical coordinates with uniform rate of heat generation. | | CO1 | | 20 |
| 3. | a. | Ice ball of 10 mm diameter at -320C are exposed to an air current at 150C with a convection heat transfer coefficient of 200 W/m2K. Determine the time when the surface layer will began to melt. Also determine the center, mid surface temperatures and heat removed. Use the following property values, density=920kg/m3, specific heat= 2040 J/kgK. Thermal conductivity =2 W/mK. | | CO1 | | 15 |
|  | b. | A long rod of square cross section (3 cm x 3 cm), has its top and bottom surface maintained at 0°C while the left and right surface are maintained at 50°C and 100°C respectively. Determine the steady state temperature distribution in the rod, using a node spacing of 1 cm. | | CO1 | | 5 |
| (OR) | | | | | | |
| 4. | a. | An Aluminium sphere weighting 6 kg and initially at temperature of 350oC is suddenly immersed in a fluid at 30oC with convection coefficient of 60 W/m2 oC. Estimate the time required to cool the sphere to 100oC. Take thermo physical properties as C = 900 J/kgK, ρ = 2700 kg/m3 and k = 205 W/mK. | | CO1 | | 16 |
|  | b. | A horizontal pipe 15 cm in diameter and 4 m long is buried in the earth at a depth of 20 cm. The pipe wall temperature is 750C, and the earth surface temperature is 50C. Assuming that the thermal conductivity of the earth is 0.8 W/m.0C, Calculate the heat lost by the pipe. | | CO1 | | 4 |
| 5. | a. | Differentiate Forced and Free Convection with examples. | | CO1 | | 4 |
|  | b. | Water at 200 C with a flow rate of 0.015 kg/s enters a 2.5 cm ID tube which is maintained at a uniform temperature of 900C. Assuming hydrodynamically and thermally fully developed flow determine the heat transfer coefficient and the tube length required to heat the water to 700C. | | CO1 | | 16 |
| (OR) | | | | | | |
| 6. | a. | One end of long rod 1 cm diameter having a thermal conductivity of 45 W/mK is placed in a furnace. The rod is exposed to air at 30°C over its surface and the convection coefficient is estimated at 35 W/m2K. If the temperature is read as 265°C at a distance of 39.3 mm from the furnace end, determine the base temperature of the rod. | | CO1 | | 4 |
|  | b. | A 30 cm long glass is hung vertically in the air at 27oC, while its temperature is maintained at 77oC. Calculate the boundary layer thickness at the trailing edge of the plate. If the similar plate is placed in a wind tunnel and air is blown over it at a velocity of 4 m/s. Estimate the boundary layer thickness at the trailing edge of the plate. | | CO1 | | 16 |
| 7. | a. | A hot fluid at 200 0C enters a heat exchanger at a mass flow rate of 104 kg/hr. Its specific heat is 2000 J/kgK. It is to be cooled by another fluid entering at 250C with a mass flow rate 2500 kg/hr and specific heat 400 J/kgK. The overall heat transfer coefficient based on outside area of 20 m2 is 250 W/m2K. Find the exit temperature of the hot fluid when the fluids are in parallel-flow | | CO2 | | 16 |
|  | b. | What is fouling? What are its effects on heat exchanger performance? | | CO2 | | 4 |
| (OR) | | | | | | |
| 8. | a. | Explain Fick’s law of diffusion. What is mass diffusivity? What is its dimension? | | CO1 | | 4 |
|  | b. | CO2 and air experience equimolar counter diffusion in a circular tube whose length and diameter are 1 m and 50 mm, respectively. The system is at a total pressure of 1 atm and a temperature of 250C. The ends of the tube are connected to large chambers in which the species concentrations are maintained at fixed values. The partial pressure of CO2 at one end is 190 mm of Hg while at the other end is 95 mm of Hg. Estimate the mass transfer rate of CO2 and air through the tube. | | CO1 | | 16 |
|  | | **Compulsory:** | |  | |  |
| 9. | a. | A thin aluminum sheet with an emissivity of 0.1 m on both sides is placed between two very large parallel plates that are maintained at uniform temperatures T1=800 K and T2=500 K and have emissivities ε1=0.2 and ε1=0.7 respectively. Determine the net rate of radiation heat transfer between the two plates per unit surface area of the plates and compare the result to that without the shield. | | CO1 | | 16 |
|  | b. | Explain the reciprocity theorem. | | CO1 | | 4 |

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