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



**End Semester Examination – Nov / Dec – 2019**

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| **Code :** | **16ME2011** | **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. | Determine the heat transfer through the composite wall shown in figure. Take the conductivities of A,B,C,D and E as 50, 10,7,20 and 30 W/mK respectively and assume one-dimensional heat transfer. The width of the composite wall is 50cm, and other dimensions are also in cms. | CO1 | 15 |
| b. | A spherical shaped vessel of 1.4m diameter is 90mm thick. Find the rate of heat leakage, if the temperature difference between the inner and outer surfaces is 2200C. Thermal conductivity of the material of the sphere is 0.083 W/m0C. | CO1 | 5 |
| **(OR)** | | | | |
| 2. | a. | A 240mm steam main, 210 metres long is covered with 50 mm of high temperature insulation (k=0.92 W/m0C) and 40 mm of low temperature insulation (k=0.062 W/m0C). The inner and outer surface temperatures as measured are 3900C and 400C repespectively. Calculate i) the total heat loss per hour, ii) the heat loss per m2 of pipe surface, iii) the total heat loss per m2 of outer surface, and iv) the temperature between two layers of insulation. Neglect heat conduction through pipe material. | CO1 | 15 |
| b. | A plane wall 10 cm thick generates heat at the rate of 4 x 104 W/m3 when an electric current is passed through it. The convective heat transfer coefficient between each face of the wall and the ambient air is 50 W/m2K. Determine the maximum temperature in the wall. | CO1 | 5 |
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| 3. | a. | A 1.6 m diameter sphere is buried in soil with centre at a depth of 5.5 m. Heat is generated in the sphere at a rate of 580 W. If the conductivity of the soil is 0.51 W/moC and the soil surface is at 60C, calculate the surface temperature of the sphere under steady state conditions. | CO1 | 5 |
| b. | A steel ball, 5 cm in diameter and initially at a temperature of 4500C is suddenly placed in a controlled environment in which the temperature is maintained at 1000C. Calculate the time required for the ball to attain a temperature of 1500C. Take the properties of steel as k = 35 W/mK, c=0.46 kJ/kg K, ρ=7800 kg/m3. The convection heat transfer coefficient is 10 W/m2K. | CO1 | 15 |
| **(OR)** | | | | |
| 4. |  | An iron sphere of diameter 5 cm is initially at a uniform temperature of 2250C. It is suddenly exposed to an ambient at 250C with convection coefficient of 500 W/m2K. Calculate i) the centre temperature 2 minute after the start of exposure ii) the temperature at the depth of 1 cm from the surface after 2 minute of exposure  iii) the energy removed from the sphere during this period. Take thermophysical properties of iron plate : k=60 W/m.K, ρ=7850 kg/m3, C=460 J/kg. | CO1 | 20 |
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| 5. |  | Water entering at 100C is heated to 400C in the tube of 0.02m ID at a mass flow rate of 0.01 kg/s. The outside of the tube is covered with an insulated electric heating element that produces a uniform heat flux of 15000 W/m2 over the surface. Neglecting any entrance effect, determine i) Reynolds Number ii) The heat transfer coefficient iii) The length of pipe needed for a 300C increase in average temperature iv) The inner tube surface temperature at the outlet v) The friction factor vi) The pressure drop in the pipe vii) The pumping power required, if the pump is 50% efficient. | CO1 | 20 |
| **(OR)** | | | | |
| 6. | a. | Differentiate between free and forced convection. | CO1 | 4 |
| b. | A thin 80cm long and 8 cm wide horizontal plate is maintained at a temperature of 1300C in a large tank full of water at 700c. Estimate the rate of heat input into the plate necessary to maintain the temperature of 1300C. | CO1 | 16 |
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| 7. |  | A heat exchanger is required to cool 55,000 kg/h of alcohol from 660C to 400C using 40000 kg/h of water entering at 50C. Calculate (i) exit temperature of water (ii) heat transfer rate (iii) surface area required for a) parallel flow type b) counter flow type of heat exchanger. Take overall heat transfer coefficient U = 580 W/m2.K, Cp(alcohol) = 3760 J/kg.K, Cp(water) = 4180 J/kg.K. | CO2 | 20 |
| **(OR)** | | | | |
| 8. | a. | Explain Fick’s law of diffusion. What is mass diffusivity? What is its dimension? | CO3 | 4 |
| b. | CO2 and air experience equimolar counter diffusion in a circular tube whose length and diameter are 1m 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. | CO3 | 16 |
|  | | **Compulsory**: |  |  |
| 9. |  | Two large parallel planes with emissivities of 0.3 and 0.5 are maintained at temperatures of 5270C and 1270C respectively. A radiation shield having emissivities of 0.05 on both sides is placed between them. Calculate i) Heat transfer rate between them without shield ii) Heat transfer rate between them with shield. | CO1 | 20 |