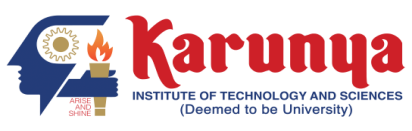
Reg.No. \_\_\_\_\_\_\_\_\_\_\_\_\_



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

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| **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. | Derive general differential equation of heat conduction in Cartesian coordinates and explain the importance of thermal diffusivity in heat conduction problems. | CO1 | 20 |
| (OR) | | | | |
| 2. | a. | A steel pipe line (k = 50 W/mK) of I.D. 100 mm and O.D. 110 mm is to be covered with two layers of insulation each having a thickness of 50 mm. The thermal conductivity of first insulation material is 0.06 W/mK and that of the second is 0.12 W/mK. Calculate the loss of heat per metre length of pipe and the interface temperature between the two layers of insulation when the temperature of inside tube surface is 250 °C and that of the outside surface of insulation is 50 °C. | CO1 | 15 |
| b. | The average heat produced by the oranges ripening is estimated to be 300 W/m2. Taking the average size of the orange to be 8 cm and assuming it to be a sphere with k = 0.15 W/mK, calculate the temperature at the centre of the orange. | CO1 | 5 |
|  |  |  |  |  |
| 3. | a. | What is conduction shape factor? Explain its significance in graphical analysis of two dimentional heat conduction problems. | CO1 | 5 |
|  | b. | A stainless steel rod of outer diameter 1 cm originally at a temperature of 320 °C is suddenly immersed in a liquid at 120 °C for which the convective heat transfer coefficient is 100 W/m2K. Determine the time required for the rod to reach a temperature of 200 °C. | CO1 | 15 |
| (OR) | | | | |
| 4. | a. | What are Heisler Charts? Explain their significance in solving transient conduction problems. | CO1 | 5 |
|  | b. | The average heat transfer coefficient for a flow of 100 °C air over a flat plate is measured by observing the temperature time history of a 3 cm thick copper slab exposed to 100 °C air. In one test run, the initial temperature of the plate was 210°C and in 5 min, the temperature decreased by 40°C. Calculate the heat transfer coefficient for this case. | CO1 | 15 |
|  |  |  |  |  |
| 5. | a. | Air at 20°C is flowing along a heated flat plate at 134°C at a velocity of 3 m/s. The plate is 2 m long and 1.5 cm wide . Calculate the thickness of the hydrodynamic layer, the skin friction coefficient and local heat transfer coefficient at 40 cm from the leading edge of the plate and the heat transferred from the first 40 cm of the plate. | CO1 | 20 |
| (OR) | | | | |
| 6. | a. | A metal plate 0.609 m high forms the vertical wall of an oven and is at a temperature of 161°C. Within the oven air is at a temperature of 93 °C and 1 atm. Assuming natural convection conditions hold near plate, estimate the mean heat transfer coefficient and the rate of heat transfer per unit width of the plate. | CO1 | 20 |
|  |  |  |  |  |
| 7. | a. | A counter flow concentric tube heat exchanger is used to cool engine oil ( c = 2130 J/kgK) from 160°C to 60°C with water, available at 25 °C as the cooling medium. The flow rate of cooling water through the inner tube of 0.5 m diameter is 2 kg/s while the flow rate of oil through the outer annulus O.D. = 0.7 m is also 2 kg/s. If the value of overall heat transfer coefficient is 250 W/m2K, how long must the heat exchanger be to meet its cooling requirement? | CO2 | 20 |
| (OR) | | | | |
| 8. | a. | A refrigerator is designed to cool 250 kg/h of hot liquid of specific heat 3350 J/kgK at 120°C using a parallel flow arrangement. 1000 kg/h of cooling water is available for cooling purposes at a temperature of 10°C. If the overall heat transfer coefficient is 1160 W/m2K and the surface area of the heat exchanger is 0.25 m2, calculate the outlet temperatures of the cooled liquid and water and also the effectiveness of the heat exchanger. | CO2 | 15 |
|  | b. | Describe various mechanisms of mass transfer. | CO1 | 5 |
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|  | | **Compulsory**: |  |  |
| 9. | a. | The outlet header of a high-pressure steam super heater consists of a pipe (ϵ = 0.8) of diameter 27.5 cm. Its surface temperature is 500 °C. Calculate the loss of heat per unit length by radiation if it is placed in an enclosure at 30°C. If the header is now enveloped in a steel screen of diameter 32.5cm and emissivity 0.7 and the temperature of the screen is 240°C, find the reduction in heat by radiation due to the provision of this screen. | CO3 | 20 |