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

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**End Semester Examination – Nov/Dec – 2018**

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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 an expression for one dimensional heat conduction in a cylinder. | CO1 | 10 |
| b. | A hollow sphere is made up of two materials: first with k = 70 W/mK is having a inner diameter on 10 cm and outer diameter of 30 cm and the second with k = 15 W/mK forms the outer layer with outer diameter of 40 cm. The inside and outside temperatures are 300ºC and 30 ºC respectively. Estimate the rate of heat flow through the sphere assuming perfect contact between two materials. | CO1 | 10 |
| (OR) | | | | |
| 2. |  | Derive the general three-dimensional heat conduction equation in spherical coordinate system. | CO1 | 20 |
|  |  |  |  |  |
| 3. | a. | Derive an expression for internal heat generation in a plane wall. | CO1 | 15 |
| b. | The average heat produced by oranges ripening is estimated to be 300 W/m2. Taking the average size of an 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 |
| (OR) | | | | |
| 4. | a. | The average heat transfer coefficient for flow of 100ºC air over a flat plate is measured by observing the temperature time history of a 3 cm thick copper slab exposed to 100ºC air. In one test run, the initial temperature of the plate was 210ºC and in 5 minutes the temperature dropped by 40ºC. Calculate the heat transfer coefficient for this case. | CO1 | 10 |
| b. | The inside dimensions of a furnace are 4m x 3m x 2m. The walls are 20 cm thick and have a thermal conductivity of 1.6 W/mk. If the inner and outer surface temperatures are 220ºC and 50ºC respectively, calculate the rate of heat loss. | CO1 | 10 |
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| 5. | a. | Explain the concept of velocity and thermal boundary layer with neat sketch. | CO1 | 10 |
| b. | The surface temperature of a steel wall (k = 53.6 W/mK) 0.3 m thick are maintained at 100ºC and 40ºC. Water at a temperature of 20ºC flows over the surface at 40ºC. Calculate the convection coefficient associated with the water flow. | CO1 | 10 |
| (OR) | | | | |
| 6. | a. | Calculate the convective heat loss from a radiator 0.5 m wide and 1 m high maintained at a temperature of 84ºC in a room at 20ºC. Assume the radiator as a vertical plate. | CO1 | 10 |
| b. | A thin 80 cm long and 8 cm wide horizontal plate is maintained at a temperature of 130ºC in a large tank full of water at 70ºC. Estimate the rate of heat input into the plate necessary to maintain the temperature of 130ºC | CO1 | 10 |
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| 7. |  | Hot oil with a capacity rate of 2500 W/mK flows through a double pipe heat exchanger. It enters at 360ºC and leaves at 300ºC. Cold fluid enters at 30ºC and leaves at 200ºC. If the overall heat transfer coefficient is 800 W/m2K, determine the heat exchanger area required for i) parallel flow and ii) counter flow. Solve by LMTD method. | CO2 | 20 |
| (OR) | | | | |
| 8. |  | In a food processing plant water is to be cooled from 18ºC to 6.5ºC by using brine solution entering at an inlet temperature of -1.1ºC and leaving at 2.9ºC. Assume an average overall heat transfer coefficient of 850 W/m2K and a design heat load of 6000 W. What area is required when using a shell and tube heat exchanger with the water making one shell pass and the brine making two tube passes. Compare the heat transfer area if the water is making two shell passes and brine making four tube passes. | CO2 | 20 |
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|  | | **Compulsory**: |  |  |
| 9. | a. | Emissivities of two large parallel plates maintained at 600ºC and 200ºC are 0.3 and 0.5 respectively. Find the net radiant heat exchange per square metre for these plates. | CO3 | 10 |
| b. | An open pan 20 cm in diameter and 8 cm deep contains water at 25 ºC and is exposed to dry atmospheric air. If the rate of diffusion of water vapour is 0.000854 kg/h, estimate the diffusion coefficient of water in air. | CO3 | 10 |