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



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

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| **Code :** | **17FP2010** | **Duration :** | **3hrs** |
| **Sub. Name :** | **HEAT AND MASS TRANSFER** | **Max. Marks :** | **100** |

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

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| ***Note: Usage of steam/water/ food materials properties table, Convection correlations data are permitted.*** | | | | |
| **Q. No.** | **Sub Div.** | **Questions** | **Course**  **Outcome** | **Marks** |
| 1. | a. | In an experiment to measure the thermal conductivity of meat, beef was formed into a square section block 5 cm × 5 cm and 1 cm thick. The edges of the block were insulated and heat was supplied continuously to one face of the block at a rate of 0.80 W. The temperatures of each face were measured with thermocouples and found to be 28.5 and 23.3ºC, respectively. What is the thermal conductivity of beef? | CO1 | 5 |
| b. | The maximum tolerable heat loss through a furnace wall is 1.3 kW/m2. A brick wall is constructed next to the furnace wall to insulate the heat loss. The temperature on either side of the wall is 200 °C and 40 °C. What should be the thickness of the brick wall if the thermal conductivity of the brick is 0.72 W/m°C? | CO1 | 5 |
| c. | State Fourier law and based on that, derive an expression for heat flow through cylindrical pipe in series. | CO2 | 10 |
| **(OR)** | | | | |
| 2. | a. | A cold storage room is maintained at -18 °C. The room is made out of 12 mm thick SS wall (k = 16.3 W/m °C). The metallic wall is followed by a 40 cm thick teflon layer (k = 0.94 W/m °C), which is supported by a 45 cm thick brick wall (k = 0.7 W/m °C). Calculate the heat transfer per m2 if the outside temperature is 30 °C. | CO3 | 10 |
| b. | Discuss in detail about the 1) Conduction 2) Convection and  3) Radiation heat transfer modes. | CO2 | 10 |
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| 3. | a. | In a fruit packaging house, oranges are washed, dried in a stream of high speed air at room temperature, waxed, and dried again in a hot air stream. Calculate the heat transfer coefficient on the surface of an orange if the air velocity is 10 m/s, the air temperature is 55°C, the orange surface temperature is 25°C, and the orange has a spherical shape with a diameter of 8 cm. | C03 | 10 |
| b. | Write down the applications of the following:  i) Reynold’s No ii) Nusselt No  iii) Prandtl No iv) Grashoff No | CO3 | 10 |
| **(OR)** | | | | |
| 4. | a. | A fruit juice is passing through a hot pipe of 7.5 cm diameter and 3.3 m long @ 60 lpm and the wall temperature is 120 °C. The juice is entering at 25 °C and is leaving at 75 °C. Find the heat transfer coefficient and Nusselt number if the fluid properties are assumed to be those of water. | CO3 | 10 |
|  | b. | A 2.5-cm inside diameter pipe is being used to convey a liquid food at 80° C. The inside convective heat transfer coefficient is 10 W/(m2 °C). The pipe (0.5 cm thick) is made of steel (thermal conductivity = 43 W/[m°C]). The outside ambient temperature is 20 °C. The outside convective heat-transfer coefficient is 100 W/(m2 °C). Calculate the overall heat transfer coefficient and the heat loss from 1 m length of the pipe. | CO3 | 10 |
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| 5. | a. | State the following laws of radiation and give their applications.  i) Stefan-Boltzmann law ii) Plank’s law  iii) Wien’s displacement law iv) Kirchoff’s law | CO5 | 10 |
| b. | Give the applications of radiation heat transfer food industries. | CO5 | 5 |
| c. | Compare and contrast Grey body with black body. | CO5 | 5 |
| **(OR)** | | | | |
| 6. | a. | In a process plant, steam line is drawn from the boiler to the process vessels. The steam line is covered with glass wool and is covered with polished aluminium sheets. The outside temperature of the pipeline is 38 °C. Calculate the heat energy emitted per unit area per unit time. | CO5 | 5 |
| b. | Wrie a note on emmisivity, absorptivity and transmissivity. | CO5 | 5 |
| c. | Consider a 20 cm diameter spherical ball at 527 °C suspended in air.  Assuming the ball closely approximates a blackbody, determine (a) the total blackbody emissive power, (b) the total amount of radiation emitted by the ball in 5 min. | CO4 | 10 |
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| 7. | a. | Illustrate with a neat diagram, the working of Plate Heat exchanger. | CO4 | 10 |
| b. | Describe with a neat sketch the construction and working of scraped surface heat exchanger. | CO4 | 10 |
| **(OR)** | | | | |
| 8. |  | A liquid food (specific heat 5 4.0 kJ/[kg°C]) flows in the inner pipe of a double-pipe heat exchanger. The liquid food enters the heat exchanger at 20°C and exits at 60°C . The flow rate of the liquid food is 0.5 kg/s. In the annular section , hot water at 90°C enters the heat exchanger and flows counter currently at a flow rate of 1 kg/s. The average specific heat of water is 4.18 kJ/(kg°C). Assume steady-state conditions.  i) Calculate the exit temperature of water.  ii) Calculate log-mean temperature difference.  iii) If the average overall heat transfer coefficient is  2000 W/(m2°C) and the diameter of the inner pipe is 5 cm,  calculate thelength of the heat exchanger.  iv) Repeat these calculations for parallel-flow configuration. | CO4 | 20 |
|  | | **Compulsory**: |  |  |
| 9. | a. | Decribe the principle and theory of continuous molecular diffusion. | CO6 | 15 |
| b. | Write down the applications of diffusion in food processing. | CO6 | 5 |