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



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

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| **Code :** | **14FP2005** | **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. | One face of a stainless-steel plate 1 cm thick is maintained at 110°C, and the other face is at 90°C. Assuming steady-state conditions, calculate the rate of heat transfer per unit area through the plate on the basis of thermal resistance. The thermal conductivity of stainless steel is 17 W/(m°C). | CO2 | 10 |
| b. | Derive an expression for heat transfer in conduction through composite wall rectangular wall in series. | CO1 | 10 |
| **(OR)** | | | | |
| 2. |  | State and explain the following:  i) Kirchhoff’s law  ii) Stefan-Boltzman law  iii) Lambert’s Beer’s law  iv) Wien’s displacement law  v) Plank’s law. | CO3 | 20 |
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| 3. | a. | A cold storage wall (3 m X 6 m) is constructed of 15 cm thick concrete (thermal conductivity 1.37 W/m°C). Insulation must be provided to maintain a heat transfer rate through the wall at or below 500 W. If the thermal conductivity of the insulation is 0.04 W/(m°C), compute the required thickness of the insulation. The outside surface temperature of the wall is 38°C, and the inside wall temperature is 5°C. | CO2 | 10 |
| b. | Explain the applications of dimensionless numbers in estimation of heat transfer coefficient. | CO3 | 10 |
| **(OR)** | | | | |
| 4. | a. | Water flowing at a rate of 0.2 kg/s is heated from 30 to 70°C in a horizontal pipe (inside diameter 2.5 cm). The inside pipe surface temperature is 90°C. Estimate the convective heat-transfer coefficient if the pipe is 5 m long. | CO1 | 10 |
| b. | What is the expected percent increase in convective heat-transfer coefficient if the velocity of a fluid is doubled while all other parameters are kept the same for turbulent flow in a pipe? | CO2 | 7 |
| c. | Enumerate the steps for calculation of convective heat transfer coefficients using empirical correlations. | CO1 | 3 |
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| 5. |  | Explain with a neat sketch, the construction and working of  i) Plate heat exchanger  ii) 1-2 Shell and tube heat exchanger. | CO2 | 20 |
| **(OR)** | | | | |
| 6. |  | 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 the length of the heat exchanger. | CO2 | 20 |
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| 7. | a. | A piece of meat carcase is kept in a deep freezer maintained at  -18°C. Calculate the radiative heat transfer if the meat carcase isat 25°C and has an average area of 0.045m2. The emissivity of carcase may be taken as 0.82. | CO1 | 8 |
| b. | Consider a 20 cm diameter spherical ball at 800 K suspended in air.  Assuming the ball closely approximates a blackbody, determine  i) the total blackbody emissive power,  ii) the total amount of radiation emitted by the ball in 5 min. | CO2 | 8 |
| c. | Write a note on application of radiation in food processing. | CO1 | 4 |
| **(OR)** | | | | |
| 8. | a. | Explain in detail the film theory of mass transfer. | CO2 | 15 |
| b. | Write a note on convective mass transfer coefficient. | CO3 | 5 |
|  | | **Compulsory**: |  |  |
| 9. | a. | Derive an expression for LMTD. | CO2 | 10 |
| b. | Describe with a neat sketch, the construction and working of scraped surface heat exchanger. | CO3 | 10 |