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Name of Examination : **Winter 2020** - (Preview)

Course Code & Course Name : **ME305U - Heat Transfer**

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Maximum Marks : **60**

Duration : **3 Hrs**

[Edit](#) [Print](#) [View Answer Key](#) [Close](#) **Answer Key Submission Type:** Marking scheme with model answers and solutions of numerical

Instructions:

1. All questions are compulsory.
2. Illustrate your answer with suitable figures/sketches wherever necessary.
3. Assume suitable additional data; if required.
4. Use of logarithmic table, drawing instruments and non programmable calculators is allowed.
5. Figures to the right indicate full marks.

1) Solve any two sub-questions

- a) With usual notations derive generalized heat conduction equation in Cartesian coordinates and reduce it to Fourier, Poisson and Laplace equations [6]
- b) The interior of refrigerator having inside dimensions of 0.5 m X 0.5 m base area and 1m height, is to be maintained at 6°C. The walls of refrigerator are constructed of two mild steel sheets 3mm thick ($k = 46.5 \text{ W/m-K}$) with 50mm of glass wool insulation ($k = 0.046 \text{ W/m-K}$) between them. The average heat transfer coefficient at inner and outer surface are $11.6 \text{ W/m}^2\text{K}$ and $14.5 \text{ W/m}^2\text{K}$ respectively. Determine: (i) The rate of heat transfer if kitchen temperature is 25°C (ii) Temperature of outer surface of metal sheet. [6]
- c) What is meant by 'Critical thickness of insulation', derive the expression of it for cylinder. [6]

2) Solve any two sub-questions

- a) A fin 5mm thick throughout and 45 mm long has its base on a plane plate which is maintained at 125°C. The ambient temperature is 25°C. The conductivity of fin material is 55 W/m-K and the heat transfer coefficient is $145 \text{ W/m}^2\text{K}$. Determine: i) Temperature at the tip of the fin. ii) Heat dissipated by the fin iii) Fin efficiency and effectiveness of fin.. [6]
- b) With usual notations derive expression for maximum temperature in a wire with internal heat generation [6]
- c) Determine the rate of heat flow through a spherical boiler wall which is 2m in diameter and 2 cm thick ($k=58 \text{ W/m-K}$). The outside surface of boiler wall is covered with asbestos ($k=0.116 \text{ W/m-K}$) 5 mm thick. The temperatures of outer surface and that of fluid inside are 50°C and 300°C respectively. Take inner film resistance as 0.0023 K/W . [6]

3) Solve any two sub-questions

- a) A hot vertical cylinder 1.5 m high and 180 mm in diameter is maintained at 100°C in an atmosphere of 20°C. Calculate average heat transfer coefficient and heat loss by free convection from the surface of the cylinder. Assume properties of air at mean temperature of 60°C as under:
 $\rho = 1.06 \text{ kg/m}^3$, $\gamma = 18.97 \times 10^{-6} \text{ m}^2/\text{s}$, $C_p = 1.004 \text{ kJ/kg-K}$ and $k = 0.1042 \text{ kJ/mh}^\circ\text{C}$ [6]
- b) Explain briefly the various regimes of saturated pool boiling with the help of boiling curve? What is boiling crisis? [6]
- c) Differentiate between the mechanism of [6]
 1. film wise and drop wise condensation
 2. natural convection and forced convection

4) All sub-questions are compulsory

- a) What do you understand by 'view factor'? State minimum eight properties of it [6]
- b) A black body emits radiation at 2000 K, find [6]
 1. Monochromatic emissive power at 1 micrometer wavelength by using Planck's law
 2. Wavelength at which monochromatic emissive power is maximum by Wien's law
 3. Maximum monochromatic emissive power

5) All sub-questions are compulsory

- a) Water is heated at the rate of 1.4 kg/s from 40 °C to 70 °C by an oil of specific heat 1.9 kJ/kg-K entering at 110 °C and leaving at 60 °C in a counter flow heat exchanger. If overall heat transfer coefficient is $350 \text{ W/m}^2\text{K}$. Determine the heat transfer area required by using LMTD approach. Using the same entering fluid temperatures and the same oil flow rates calculate the effectiveness of heat exchanger and exit temperature of water and oil when the water flow rate is halved. Use effectiveness-NTU method in this case. [6]
- b) With usual notations derive expression for LMTD of counter flow heat exchanger [6]

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