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

Course Code & Course Name : **ME305 - 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) The surface temperature of a central heating radiator is 60°C. What is the net black body radiation heat transfer unit surface area between the radiator and its surroundings at 20° cC?
Take $\sigma = 5.67 \times 10^{-8} \text{ W/m}^2 \cdot \text{K}^4$ [6]
- b) A spherical container with OD 0.4 m and surface temperature of -180°C is insulated by 8 cm thick layer of material with thermal conductivity $k = 0.028 (1 + 5 \times 10^{-3} T) \text{ W/m K}$ where T is in °C. If the outside surface is at 15°C, determine the heat flow in. [6]
- c) Prove that critical thickness of insulation for cylindrical surface is $r_c = k/h$ [6]

2) Solve any two sub questions

- a) If a thin and long fin, insulated at its tip is used, show that the heat transfer from the fin is given by [6]

$$Q_{fin} = \sqrt{hPkA} (T_0 - T_\infty) \tan h mL.$$
- b) A very long 25 mm diameter copper ($k = 380 \text{ W/m.K}$) rod extends from a surface at 120°C. The temperature of surrounding air is 25°C and the heat transfer coefficient over the rod is 10 W/m².K. Calculate: [6]
 - (i) Heat loss from the rod,
 - (ii) How long the rod should be in order to be considered infinite?
- c) A plane wall of thickness 0.1 m and thermal conductivity 25 W/m.K having uniform volumetric heat generation of 0.3 MW/m³, is insulated on one side, while other side is exposed to a fluid at 92°C. The convection heat transfer coefficient between plane wall and fluid is 500 W/m².K. Determine the maximum temperature in the plane wall. [6]

3) Solve any two sub questions

- a) What is the important quantity that is obtained from the analysis of hydrodynamic boundary layer? [6]
- b) Estimate the heat transfer rate from a 100 W incandescent bulb at 140°C to an ambient at 24°C. Approximate the bulb as 60 cm diameter sphere, Calculate the percentage of power lost by natural convection. Use following correlation and air properties; [6]

$$Nu = 0.60 (Gr Pr)^{1/4}$$
 The properties of air at 82°C are $v = 21.46 \times 10^{-6} \text{ m}^2/\text{s}$, $k_f = 30.38 \times 10^{-3} \text{ W/m.K}$, $Pr = 0.699$.
- c) Define Condensation and explain filmwise and dropwise condensation. [6]

4) a) Determine (a) the wavelength at which the spectral emissive power of a tungsten filament at 1400 K is maximum, (b) the spectral emissive power at that wavelength, and (c) the spectral emissive power at 5 μm. [6]

b) What is a radiation shield? Where is it used? [6]

5) a) Derive for parallel flow heat exchanger. [6]

$$\dot{e} = \frac{(1 - \exp[-NTU(1+C)])}{(1+C)} \text{ where } C = C_{min}/C_{max} = (mC_p)_{min} / (mC_p)_{max}$$

- b) Steam in a condenser of a steam power plant is to be condensed at a temperature of 30°C with cooling water from a nearby lake, which enters the tubes of condenser at 14°C and leaves at 22°C. The surface area of the tubes is 45 m² and overall heat transfer coefficient is 2100 W/m².K. Calculate the mass flow rate of cooling water needed and rate of steam condensation in the condenser [6]

Next question!

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