Total No. of printed pages = 6

ME 131601

Roll No. of candidate [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ]

2016

B. Tech 6th Semester End-Term Examination

HEAT TRANSFER - II

Full Marks–100 Pass Marks–35 Time–Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following briefly : (any *six*) $6 \times 2 = 12$

(i) State the Stefan-Boltzmann law.

(ii) What do you understand by the term 'black body' ?

(iii) Define the term effectiveness of a heat exchanger.

(iv) Distinguish between filmwise condensation and dropwise condensation.

(v) State the purpose of using radiation shield.

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(vi) What do you understand by the term spectral emissivity ?

(vii) What is the shape factor of a hemispherical bowl of diameter 'D' with respect to itself ?

2. Answer any *six* : 6×3=18

(i) Define absorptivity, reflectivity and transmissivity.

(ii) Explain the term overall heat transfer co-efficient of a heat exchanger.

(iii) State three characteristics of view factor.

(iv) Derive a relation between irradiation and radiosity for an opaque body.

(v) Sketch the temperature variation curves in parallel flow and counter flow heat exchangers.

(vi) Assuming the sun to be a black body emitting radiation with maximum intensity at wavelength $\lambda = 0.49\ \mu m$, calculate the surface temperature of the sun.

(vii) Briefly classify the heat exchangers.

3. Answer any *four* : 4×5=20

(i) What do you mean by LMTD and NTU methods ?

(ii) Compare parallel flow and counter flow heat exchangers.

(iii) Show that emissive power of a diffuse surface is equal to π-times the intensity of radiation.

(iv) The flow rates of hot and cold water streams running through a parallel flow heat exchanger are 0.2 kg/s and 0.5 kg/s respectively. The inlet temperatures on the hot and cold sides are 75°C and 20°C respectively. The exit temperature of hot water is 45°C. If the individual heat transfer co-efficient on both sides are $650 W/m^2 °C$, calculate the area of the heat exchanger.

(v) The net radiation from the surfaces of two parallel plates maintained at T_1 and T_2 is to be reduced by 99% as a result of placing radiation shields between the parallel plates. Calculate the number of radiation shields to be placed between the two surfaces to achieve this reduction in radiant heat exchange. Assume the emissivity of the radiation shields as 0.05 and that of the surface as 0.8.

4. Solve the following : (any *three*) $3 \times 10 = 30$

(i) Calculate the following for an industrial furnace in the form of a black body and emitting radiation at 2500°C :

(a) Monochromatic emissive power at 1.2 μm length.

(b) Wavelength at which the emission is maximum.

(c) Maximum emissive power.

(d) Total emissive power.

(e) Total emissive power of the furnace if it is assumed as a real surface with emissivity equal to 0.9.

(ii) In a shell and tube counter-flow heat exchanger water flows through a copper tube 20 mm ID (internal diameter) and 23 mm OD (outer diameter), while oil flows through the shell. Water enters at 20°C and comes out at 30°C, while oil enters at 75°C and comes out at 60°C. The water and oil side film co-efficients are 4500 W/m^2 °C and 1250 W/m^2 °C respectively. The thermal conductivity of the tube wall is 355 W/m°C. The fouling factors on the water and oil sides may

be taken to be 0.0004 and 0.001 respectively. If the length of the tube is 2.4m, calculate the following :

(a) The overall heat transfer co-efficient.

(b) The heat transfer rate.

(iii) A small sphere (outside diameter = 50 mm) with a surface temperature of 277°C is located at the geometric centre of a large sphere (inside diameter = 250 mm) with an inner surface temperature of 7°C. Calculate how much of emission percentage from the inner surface of the large sphere is incident upon the outer surface of the small sphere ; assume that both the sides approach black body behaviour. Also calculate what is the net radiant heat interchange between the two spheres.

(iv) Two large parallel plates, one at 1000 K with emissivity 0.8 and other is at 300 K having emissivity 0.6. A radiation shield is placed between them. The shield has emissivity as 0.1 on the side facing hot plate and 0.3 on the side facing cold plate. Calculate the percentage reduction in radiation heat transfer as a result of placing the radiation shield.

(v) With the help of boiling curve for water at 1 atm, explain briefly the boiling regimes.

5. Write short notes on any *five* : 5×4=20

(i) Kirchoff's law

(ii) Condenser

(iii) Gray body

(iv) Shape factor

(v) Fouling factor

(vi) Pressure drop and pumping power.