Total No. of printed pages = 6

ME 131601

Roll No. of candidate | | | | | | | | | | |

2017

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 any *six* of the following in brief : 6×2=12

   (a) What is reflectivity and transmissivity ?

   (b) What is shape factor ?

   (c) What are the values of emissivity and transmissivity for a black body ?

   (d) What would be the solid angle subtended by a complete hemisphere ?

[Turn over

(e) For a steel body, the absorptivity and reflectivity are specified as 0.3 and 0.5 respectively. What would be the transmissivity of the body ?

(f) If the temperature of a solid surface decreases from 527°C to 37°C, then what would be the decrease in the ratio of the emissive power of the body ?

(g) An enclosure consists of five surfaces, 1, 2, 3, 4 and 5. The shape factors for radiation heat transfer are $F_{11} = 0.1$, $F_{12} = 0.2$, $F_{13} = 0.15$, $F_{14} = 0.4$ (the subscripts 1, 2, 3, 4, 5 represents respective surfaces). The surface areas A_1, A_2, A_3, A_4 and A_5 are $4m^2$, $1m^2$, $2m^2$, $3m^2$ and $5m^2$ respectively. Find the value of the shape factor F_{51}.

2. Answer any *six* of the following : 6×3=18

(a) An opaque surface is at 50°C and its emissivity is 0.5. If the emissive power of the surface is 600 W/m^2 and is exposed to solar radiation at the rate of 1200 W/m^2, then what would be the radiosity of the surface ?

(b) Find the shape factor of a hemispherical body placed on a flat surface with respect to itself.

(c) A circular tube of equal length and diameter is shown below :

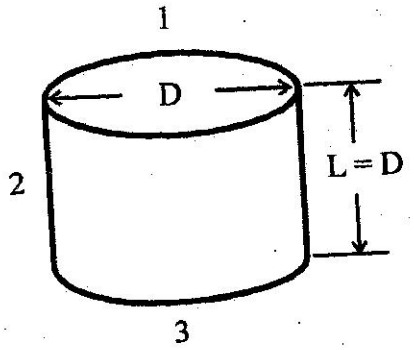

Figure-1

A circular tube of equal length and diameter

The tube consists of three surfaces, 1 is the top surface, 2 is the sidewall and 3 is the bottom surface. Find the value of shape factor F_{12} if F_{13} is 0.17.

(d) In a counter flow heat exchanger, air enters at 70°C and leaves at 40°C. Water enters 30°C and leaves at 50°C. Find the value of LMTD in °C.

(e) In a counter flow heat exchanger, water (c_p = 4.18 kJ/kgK) enters at 80°C with a mass flow rate of 0.5 kg/s. Air (c_p = 1 kJ/kgK) enters at 30°C with a mass flow rate of 2.009 kg/s. What would be the LMTD (in °C) of the heat exchanger if its effectiveness is 0.8 ?

(f) In a counter flow heat exchanger, if $\dot{m}_h c_h = \dot{m}_c c_c$ and the NTU is equal to 1, then what would be the effectiveness of the heat exchanger ?

(g) Would the heat exchanger be counter flow or parallel flow, if the hot fluid enters at 65°C and leaves at 40°C and the cold fluid enters at 18°C and leaves at 43°C ?

3. Answer any *two* of the following : 2×5=10

(a) Determine the net radiation per square metre between two very large parallel plates at temperatures 327°C and 127°C. The emissivities of the hot and cold plates are 0.75 and 0.65 respectively.
Stefan-Boltzmann constant is 5.67×10^{-8} W/m²K.

(b) Two long parallel surfaces have emissivity of 0.85 each. Determine the number of thin parallel shields, each of equal emissivity, required to reduce the net heat exchange by 80%.

(c) A counter flow heat exchanger is used to heat water with hot exhaust gas coming out from an engine. The water (c_p = 4180 J/kg°C) flows at a rate of 2 kg/s, while the exhaust gas (c_p = 1030 J/kg°C) flows at the rate of 5.25 kg/s. If the surface area of heat transfer is 32.5 m² and the overall heat transfer coefficient is 200 W/m² °C, what is the NTU for the heat exchanger ?

4. Answer any *three* of the following : 3×20=60

(a) A small sphere (outside radius = 30 mm) is maintained at a temperature of 300°C. It is placed at the geometric centre of a large sphere (inside radius = 180 mm) which is maintained at 15°C. Assuming both the surfaces to be black bodies, calculate the following :

(i) The fraction of emission from the large sphere, which is absorbed by the inner surface of the large sphere itself.

(ii) Net rate of heat exchange between the two spheres.

(b) 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 of the hot and cold fluids are 75°C and 20°C respectively. The exit temperature of hot water is 45°C. If the individual heat transfer coefficients on both sides are 650 $W/m^2°C$, calculate the area of the heat exchanger.

(c) Explain film condensation and dropwise condensation processes with the help of diagrams.

State any five assumptions of Nusselt theory of condensation.

(d) Write short notes on the following :

(i) Heat exchanger

(ii) Wien's displacement law

(iii) Solid angle

(iv) Irradiation and radiosity.