AE1352 – HEAT TRANSFER

C 3012

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2007.

Sixth Semester

Aeronautical Engineering

AE 1352 — HEAT TRANSFER

(Regulation 2004)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write about transient heat conduction.

2. Write expression for variation of thermal conductivity with temperature.

3. Distinguish between natural and forced convection.

4. Give the physical significance of Nusselt number and Prandtl number.

5. Define radiation intensity and radiation shape factor.

6. Define irradiation and radiosity.

7. Define overall heat transfer coefficient.

8. Define "LMTD".

9. How is ablation used for high speed cooling?

10. Define Transpiration Cooling?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Derive the expression of heat loss from the composite spherical wall surrounded by air on both sides. (8)

(ii) A copper slab (K = 372 w/m°C) in 3 mm thick. It is protected from corrosion by 2 mm thick layer of stainless steel (K = 17 w/m°C) on both sides. The temperatures of the two outer surface of steel are 400°C and 100°C. What is the temperature of the two interfaces? (8)

Or

(b) (i) What is meant by thermal contact resistance? Upon what parameters does this resistance depend? (6)

(ii) A wall 2 cm thick is to be constructed from material which has an average thermal conductivity of 1.3 W/mK. The wall is to be insulated with material having an average thermal conductivity of 0.35 W/mK, so that the heat loss per square meter will not exceed 1830 W. Assuming that the inner and outer surface temperatures of the insulated wall are 1300°C and 30°C, calculate the thickness of insulation required. (10)

12. (a) (i) Carry out the dimensional analysis for the forced convection through a long tube and obtain the following relationship $Nu = f(\text{NRe}, \text{Pr})$. (8)

(ii) Water flows over a flat heater 0.06 m in length at 300°C under high pressure. The free stream velocity is 2 m/s and the heater is held at 315°C. What is the average heat transfer coefficient and average heat flux? Given :

K = 0.520 W/m°C , Kinematic viscosity = 0.124×10^{-6} m²/s,

Local Nusselt number, $Nu_x = 0.332\ (\text{NRe}_x)^{0.5}$. (8)

Or

(b) (i) What is the physical significance of Grashof number? How is a modified Grashof number defined for a constant- heat flux condition on a vertical plate? (6)

(ii) A hot vertical plate is placed in a stagnant air inside a room. Draw the temperature and velocity profile in the thermal boundary layer generated due to heat transfer from the plate to the surrounding air. (10)

13. (a) Derive an expression for the heat transfer between two very large flat parallel plates. (16)

Or

(b) (i) What is Kirchoff' s law identity? When does it apply? (4)

(ii) Two parallel plates 0.5 by 1.0 m are spaced 0.5 apart. One plate is measured at 1000°C and the other at 500°C. The emissivities of the plates are 0.2 and 0.5, respectively. The plates are located in a very large room, the walls of which are maintained at 27°C. The plates exchange heat with each other and with the room, but only the plate surfaces racing each other are to be considered in the analysis. Find the net transfer to each plate and to the room. (12)

14. (a) (i) Define overall heat transfer coefficient? Write down the expression of overall heat transfer coefficient by including all the resistance involved in case of heat transfer through the tubes of an exchanger. (8)

(ii) Derive an expression for log mean temperature difference for a counter current flow double pipe heat exchanger (8)

Or

(b) (i) Define heat exchanger effectiveness. (6)

(ii) A shell and tube heat exchanger is to be constructed with 2.54 cm I.D tube. The cold fluid is flowing through the tubes at the rate of 18,000 Kg/hr. the inlet temperature is 35°C while outlet temperature of cold water is 65°C. The hot water flows outside the tube at the rate of 12,800 kg/hr and entering at 100°C. The average velocity of the cold water through the tube is 0.3 m/s and overall heat transfer coefficient is 1600 w/m^2 °C. Specific heat for both the water is 4.18 KJ/Kg°C. Determine the number of tubes and required length of the tubes for 1–1 shell and tube heat exchanger.

Given :

Density of water at 50°C = 988 kg /m^3

Surface area/unit length = 0.0798 m^2/m, per tube

Cross sectional area = 0.0003098 m^2 per tube. (10)

15. (a) (i) What is the main purpose of a gas turbine combustion chamber? Why the design of combustion chamber is rather difficult? (4)

(ii) What are the main requirements of a gas turbine combustion chamber? Are these requirements mutually compatible? (4)

(iii) Enumerate the various methods of fuel injection in combustion chamber of a gas turbine and discuss their advantages and disadvantages. (8)

Or

(b) (i) Explain the working principles of Rocket thrust Chambers. (8)

(ii) Describe in detail about the Aerodynamic heating. (8)