Code No. : 6345/N

FACULTY OF ENGINEERING

B.E. 3/4 (Mech.) II Semester (New) (Suppl.) Examination, December 2009

HEAT TRANSFER

Time: 3 Hours] [Max. Marks: 75

*Note : Answer **all** questions from Part **A**. Answer **any five** questions from Part – **B**. Use of "Heat Transfer Data Book" **permissible**.*

PART – A **(25 Marks)**

1. Define "thermal diffusivity" and explain its physical significance.
2. State Fourier's law of conduction heat transfer and give mathematically equivalent statement for it.
3. Explain the physical significance of "Fourier" and "Biot" numbers.
4. What is "fin parameter" (m) ? Explain its physical relevance in fin provision on an installation.
5. Explain (i) Reynolds number and (ii) Nusselt number as referred to forced correction problems.
6. Give the mathematical expressions given by Vonkarman in his integral solution of laminar forced convection boundary layer for (i) boundary layer thickness and (ii) local drag coefficient.
7. State and explain Wien's law for spectral emissive power of a black body.
8. Define "view factor" and explain its significance.
9. Define "NTU" and "Effectiveness" as referred to a heat exchanger.
10. Explain "burn-out" as referred to "pool boiling" as demonstrated by Nukiyama experimentally.

PART – B **(5×10=50 Marks)**

11. A 5 cm thick steel plate of thermal conductivity 20 W/m-K is subjected to a uniform heat flux of 600 W/m^2 on one of its surfaces and dissipates heat by convection with a heat transfer coefficient of 80 W/m^2-°C from the other surface into the ambient air at 25°C. Calculate the temperatures of (i) the surface subjected to uniform flux as well as (ii) the surface subjected to convection heat transfer.

12. A gas turbine blade, 63 mm in length, 4.6×10^{-4} m^2 in cross-sectional area and 0.12 m in perimeter, is exposed to hot gases at 870°C, with a convection heat transfer coefficient of 418.68 W/m^2-K. The temperature at the root is 480°C and the tip may be assumed to be insulated. The thermal conductivity of the blade material is 0.2326 W/m-K. Determine the rate of heat flow at the root of the blade, and also estimate the tip temperature.

13. A piece of aluminium, which is in the form of a sphere, is of mass 5.5 kg, and is initially at an uniform temperature of 290°C throughout. It is suddenly immersed in a fluid at a temperature of 15°C, with a correction heat transfer coefficient of 58 W/m^2-K. Estimate the time needed to cool the aluminium piece to a temperature of 90°C. Take properties of "aluminium" from tables in data book.

14. A single horizontal pipe of 10 cm outside diameter is maintained at 80°C in quiescent atmospheric air at 20°C. Determine the rate of heat loss by convection from a 2 m length of the above pipe into quiescent air.

15. Saturated steam, free from air and other non-condensabler, at a temperature of 90°C, condenser on the outside surface of a vertical tube of outside diameter 2.54 cm, and maintained at a uniform temperature of 70°C. Determine the length of the tube so as to condense 20 kg/h of steam.

16. Two equal, parallel black discs, each of diameter 0.5 m, are located 0.25 m apart, directly opposing each other. If the temperatures of the discs are, respectively, 200°C and 50°C, find out the net radiation heat transfer rate between the discs.

17. A 1S-1T counter-current heat exchanger is proposed to be used for heating 2.5 kg/s of water from 20°C to 80°C by making use of hot exhaust gases of specific heat 100 J/kg-K and entering at 220°C and leaving at 90°C. The overall heat transfer coefficient is 250 W/m^2-K. Find the heat transfer surface area required.
