Heat Transfer
(ME-303, Dec. 2005)

Time: 3 Hours Max. Marks: 60

Note: Question No. 1 is compulsory. Attempt any four questions from section B and two questions from section C.

Section-A

1. (a) Explain the difference between the subject of 'Heat transfer' and 'Thermodynamics'.
   (b) Define Thermal diffusivity and discuss its importance.
   (c) What are the parameters on which the effectiveness of a fin depends?
   (d)Is it necessary that adding insulation always reduces the heat transfer rate?
   (e)Define mean bulk temperature.
   (f) Write the formula for Grashof number and discuss its importance.
   (g) Define thermal boundary layer thickness.
   (h) Why heat transfer rate is higher in drop wise condensation as compared to film wise condensation?
   (i) What is pool boiling?
   (j) Define Gray body.

Section-B

2. An exterior wall of a house may be approximated by 10 cm layer of common brick (K=0.75 w/m-deg), followed by a 4 cm layer of gypsum plaster (K=0.5 w/m-deg). What thickness of loosely packed rock wool insulation (K=0.065 w/m-deg) should be added to reduce the heat loss or gain through the wall by 75%.
3. Derive the expression of heat dissipation from an infinitely long fun.
4. A black body of 0.2 m^2 area has an effective temperature of 800ºK. Calculate
   (a) The total rate of energy emission.
   (b) The energy of normal radiation
   (c) The intensity of radiation along a direction 60º to the normal and
   (d) The wavelength of maximum monochromatic emissive power.
5. A heat treated steel plate 3m x 1m and is initially at 30º C. It is cooled by blowing air parallel to 1 m edge at 9 km/hr. If the air is at 10ºC, Calculate the convective heat transfer from both sides of the plate. At mean film temperature of 20ºC, thermo physical properties of the air are as follows: $\upsilon = 15.06 \times 10^{-6}$ m^2/s, K=0.0259 w/m-deg, Pr = 0.703 and Nusselt number is given by the relation: $Nu = 0.664 (Re)^{0.5} (Pr)^{0.33}$.
6. Describe the different boiling regimes in case of pool boiling.

Section-C

7. Exhaust gases (C_P = 1.12 KJ/Kg-deg) flowing through a tubular heat exchanger at the rate of 1200 kg/hr are cooled from 400ºC to 120ºC. The cooling is affected by water (C_P = 4.18 KJ/Kg K) that enters the system at 10ºC at the rate of 1500 Kg/hr. If the overall heat transfer coefficient is 500 KJ/m^2-hr-deg. What heat exchanger area is required to handle the load for (a) parallel flow and (b) counter flow arrangement
8. A metal (K = 45 W/m – deg) steam pipe 5 cm internal diameter and 6.5 cm external diameter is logged with a 2.75 cm radial thickness of high temperature insulation having thermal conductivity of 1.1 W/m-deg. The surface heat transfer coefficients for the inside and outside are 4650 and 11.5 W/m^2-deg. If the steam temp. is 25ºC, make calculations for
   (a) Heat loss per meter length of pipe.
   (b) Temperature at the interfaces.
   (c) Overall coefficient of heat transfer referred to inside and outside surfaces.
9. Write short notes on any two of the following.
   (a) Thermal boundary layer
   (b) Radiation shields
   (c) Critical thickness of insulation.