B.E. (Aeronautical Engineering) Fifth Semester (C.B.S.)

Heat Transfer Paper - I

P. Pages : 4 **TKN/KS/16/7458**

Time : Three Hours Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Diagrams and chemical equations should be given whenever necessary.
11. Illustrate your answers whenever necessary with the help of neat sketches.
12. Use of non programmable calculator is permitted.
13 Use of heat transfer data hand book & steam table is permitted.

1. a) Define the followings : **6**

i) Temperature field.

ii) Thermal diffusivity.

iii) Laplace equation of heat flow.

iv) Transient heat conduction.

b) A composite wall consists of 10cm thick layer of building brick, k = 0.7 w/m-k & 3cm thick plaster, k = 0.5 w/m-k. An insulating material of k = 0.08 w/m-k is to be added to reduce the heat transfer through the wall by 40%. Find its thickness. **7**

OR

2. a) Derive the heat conduction equation in cylindrical co-ordinates using an elemental volume for a stationary isotropic solid. **7**

b) A 3cm OD steam pipe is to be covered with two layers of insulation each having a thickness of 2.5cm. The average thermal conductivity of one insulation is 5 times that of the other. Determine the percentage decrease in heat transfer if better insulation material is next to pipe than it is the outer layer. Assume that the outside and inside temperatures of composite insulation are fixed. **6**

3. a) Differentiate the following in detail : **3**

i) Forced & Natural convection.

ii) Rayleigh number and Grashof no.

b) A household oven door of 0.5m height and 0.7m width reaches an average surface temperature of 32ºC during operation. Estimate the heat loss to the room with ambient air at 22ºC. If the door has an emissivity of 1.0 and the surroundings are also at 22ºC. Comment on the heat loss by free convection relative to that by radiation. **10**

OR

4. a) Differentiate the following. **3**

i) Evaporation & boiling.

ii) Pool boiling & flow boiling.

iii) Subcooled & saturated boiling.

b) The bottom of a copper pan, 150mm in diameter, is maintained at 115ºC by the heating element of an electric range. Estimate the power required to boil the water in this pan. Determine the evaporation rate. What is the ratio of the surface heat flux to the critical heat flux ? What pan temperature is required to achieve the critical heat flux? **10**

5. a) Answer the following questions : **5**

i) What is the physical significance of Nusselt No.?

ii) How is thermal entry length defined for flow in a tube?

iii) In which mode of heat transfer is the heat transfer coefficient usually higher: - Natural convection or forced convection?

b) In a flow over a surface, velocity and temperature profiles are of the forms **8**

$u(y) = Ay + By^2 - Cy^3$ &

$T(y) = D + Ey + Fy^2 - Gy^3$

where the coefficients A through G are constants. Obtain expressions for friction coefficients 'C_f' and the convection coefficients 'h' in terms of u_∞, T_∞ and appropriate profile coefficients and fluid properties.

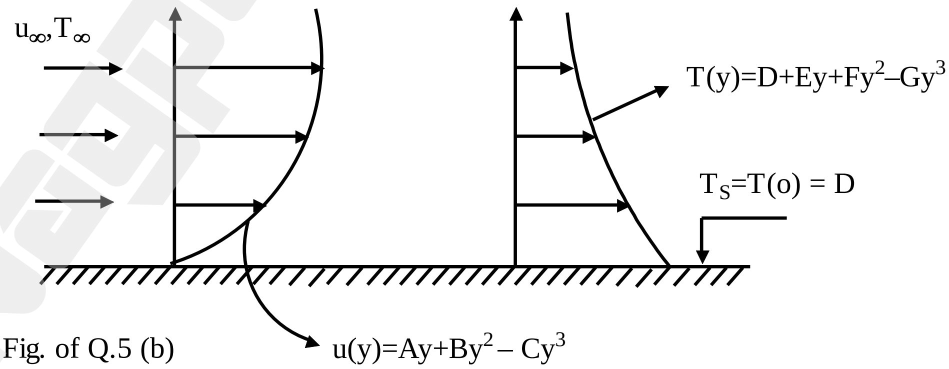

Fig. of Q.5 (b)

OR

6. a) Define hydrodynamic entry length for flow in a tube. Is the entry length longer in laminar or turbulent flow? **3**

b) Consider atmospheric air at 25ºC in parallel flow at 5m/s over both surfaces of 1m long flat plate maintained at 75ºC. Determine the boundary layer thickness, the surface shear stress, and the heat flux at the trailing edge. Determine the drag force on the plate and the total heat transfer from the plate, each per unit width of the plate. **10**

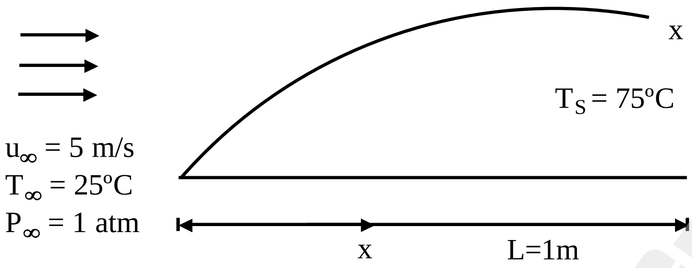

Fig. - Q.6 (b)

7. a) Calculate the following for an industrial furnace in the form of a black body and emitting radiation at 2500ºC. **8**

i) Monochromatic emissive power at 1.2 micrometer length.

ii) Wavelength at which the emission is maximum.

iii) Maximum emissive power.

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

b) Explain in detail the following. **5**

i) Specular and diffuse reflection

ii) Reciprocity rule and summation rule

OR

8. a) Define the followings : **6**

i) Radiation shield.

ii) Quantum theory

iii) Planck's distribution law.

iv) Irradiation.

b) Two very large parallel plates with emissivities 0.5 exchange heat. Determine the percentage reduction in the heat transfer rate if a polished aluminium radiation shield of c = 0.04 is placed in between the plates. **7**

9. a) When is a heat exchanger classified as compact? Can effectiveness be greater than one? **4**

b) An automobile radiator may be viewed as a cross flow heat exchanger with both fluids unmixed. Water, which has flow rate of 0.05 kg/s, enters the radiator at 400K and is to leave at 330K. The water is cooled by air which enters at 0.75 kg/s and 300 K. If the overall heat transfer coefficient is 200 w/m^2k, what is the required heat transfer surface area? **10**

OR

10. a) Can temperature of the hot fluid drop below the inlet temperature of the cold fluid at any location in a heat exchanger? Explain in detail. **5**

b) A concentric tube heat exchanger uses water, which is available at 15ºC, to cool ethylene glycol from 100ºC to 60ºC. The water and glycol flow rates are each 0.5kg/s. What are the maximum possible heat transfer rate and effectiveness of the exchanger? Which is preferred, a parallel flow or counter flow mode of operation? **9**

11. In a gas turbine plant air enters the compressor at 1 bar and 7ºC. It is compressed to 4 bar with an isentropic efficiency of 82%. The maximum temperature at the inlet to the turbine is 800ºC. The isentropic efficiency of the turbine is 85%. The calorific value of the flued used is 43.1 mJ/kg. The heat losses are 15% of the calorific value. **14**

Calculate the following:

i) Compressor work

ii) Heat supplied

iii) Turbine work

iv) Net work

v) Thermal efficiency

vi) A/F ratio

vii) Specific fuel consumption : Assume

$C_{p,a} = 1.005\,kJ/kg-k$; $\gamma_a = 1.4$;

$C_{p,g} = 1.147\,kJ/kg-k$; $\gamma_g = 1.33$

OR

12. a) Discuss the working of gas turbine engine with the help of the functional components. **7**

b) Write short notes on: **7**

i) Mass transfer

ii) Ablative Heat transfer

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