Registration no: | | | | | | | | | | |

Total Number of Pages: 03

M .TECH
HTPC202

2nd Semester Regular / Back Examination – 2015-16

ADVANCED HEAT TRANSFER-II

Q Code : W802

Time: 3 Hours

Max marks: 70

Answer Question No.1 which is compulsory and any five from the rest.

The figures in the right hand margin indicate marks.
(steam tables are allowed in the examination hall)

Q1 Answer the following questions: (2 x 10)

a) What do you mean by thermal boundary layer? How does δ/δ_t vary with prandtl number?.

b) Write down the N-S equations for incompressible viscous liquids and explain the terms in it.

c) Write down the energy equation for a fluid element. What is dissipation function?

d) Draw the temperature profile of fluid inside the pipe for constant heat flux and constant wall temperature case.

e) What do you understand by hydrodynamic and thermal entry length?

f) What do you mean by evaporative cooling?

g) Draw the velocity and temperature profile of natural convection for a vertical plate which is cold compared to the fluid.

h) What do you mean by fouling factor? What are the causes of fouling?

i) What is mass diffusivity? What is its dimension?

j) Differentiate between LMTD and NTU approaches in heat exchanger analysis.

Q2 a) What do you mean by Von Karman's integral method? How is it used in deriving heat transfer coefficient for flow over a flat plate? (5)

b) With the help of Buckingham π-theorem show that for forced convection heat transfer (5)

$$Nu = CRe_d^a pr^b$$

Q3 a) A fluid flows through a 10 cm ID pipe. Assume that the velocity is uniform over the cross section of the pipe but the temperature varies linearly from 100°C at the pipe wall to 0°C at the centre line. Calculate the heat transfer co-efficient based on the mean fluid temperature if the heat flow rate from the pipe wall is 117600 w/m2K. (5)

b) Air at 20°C and a pressure of 1 bar is flowing over a flat plate at a velocity of 3 m/s. If the plate is 250 mm wide and 56°C, estimnate the following quantities at x=250 mm, given properties of air at the bulk mean temperature of 38°C are ρ=1.137 kg/m3, k=0.027 W/mK, cp=1.005 kJ/kgK and v=16.768×10-6m2/s (5)

(i) Hydraulic and thermal Boundary layer thicknesses (ii) average friction coefficianct (iii) Average heat transfer coefficient (iv) Rate of heat transfer (v) Total mass flow rate.

Q4 a) Write down governing equations of forced convection with mass transfer over a flat plate laminar boundary layer (4)

b) Explain eddy viscosity of heat? How is it different from thermal diffusivity? (3)

c) Differentiate between Reynolds Analogy and Reynolds-Colburn Analogy (3)

Q5 a) How the principal dimensionless parameters of natural convection determined from the boundary layer equations concerning mass, momentum and energy? (6)

b) A horizontal cylinder has a diameter of D=5 cm and length L=50 cm. its surface is maintained at 35C while the surrounding air is 20C. Neglecting radiation calculate the rate of heat transfer from the cylindrical surface at the steady state. The properties of air are (4)

v=16×10-6 m2/s

kf=26×10-3 W/mK

Pr=0.707

$$Nu_d = 0.518\left[1+\left(\frac{0.6}{Pr}\right)^{0.6}\right]^{-5/12}\left(Gr_d\,Pr\right)^{1/4}$$

Q6 a) Derive the expression of finding LMTD for parallel flow type heat exchanger. (5)

b) Water is heated in a building from 20°C at rate of 84 kg/min by using inlet hot water at 110°C in a single pass counter flow heat exchanger. Find the heat transfer if hot water is 108 kg/min. Calculate the exit temperature of both the fluids. The overall heat transfer coefficient is 320 W/m2K and the heat transfer area is 20m2. The specific heat of water is 4.18 kJ/kgK. (5)

Q7 a) State physical interpretation of Eckert number, Grashoff number, Schmidt number and Lewis number. (6)

b) Explain Fick's law of diffusion. What is mass diffusivity? What is its dimension? (4)

Q8 Write short notes (any two) (5+5)

a) Flow pattern map in flow boiling

b) Evaporative cooling

c) Dropwise condensation