Registration no:

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M .TECH
HTPC202

Second Semester Examination 2013

ADVANCED HEAT TRANSFER-II

(CONVECTIVE HEAT & MASS TRANSFER)

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) Define laminar and turbulent flows. What is the Reynolds number.
b) What is displacement thickness?
c) What do you mean by thermal boundary layer?
d) What are the generally accepted values of critical Reynolds number for a) flow over a flat plate b) flow in a tube?
e) What is the difference between Nusselt number and Biot number?
f) What do you mean by subcooled boiling?
g) Draw the laminar and turbulent velocity boundary layer for natural convection on a vertical plate.
h) What is the magnitude of Nusselt number for laminar flow in a tube considering constant heat flux case? What is the value of constant wall temperature case?
i) Write the momentum and energy equation for a laminar boundary layer flow over a flat plate
j) What do you mean by fouling factor?

Q2 a) Experimental results for heat transfer over a flat plate with an extremely rough surface were found to be correlated by an expression of the form (5)

$$\mathrm{Nu}_x = 0.04\,\mathrm{Re}_x^{0.9}\,\mathrm{Pr}^{1/3}$$

Where Nu_x is the local value of the Nusselt number at a position x measured from the leading edge of the plate. Obtain an expression for the ratio of the average heat transfer coefficient between the leading edge and a location x to the local heat transfer coefficient at x.

b) A fan that can provide air speeds up to 50 m/s is to be used in a low speed wind tunnel with atmospheric air at 25°C. If one wishes to use the wind tunnel to study flat plate boundary layer behavior up to Reynolds numbers of 10^8, what is the minimum plate length? At what distance from the leading edge would transition occur, if the critical Reynolds number is 5×10^5? (5)

Q3 a) State the five methods which are available for evaluation of convection (4)

heat transfer coefficient.

b) How are the principal dimensionless parameters of natural convection determined from the boundary layer equations concerning continuity, momentum and energy? (6)

Q4 In an oil cooler, oil enters at 160°C. if the water entering at 35°C flows parallel to oil, the exit temperatures of oil and water are 90°C and 70°C respectively. Determine the exit temperatures of oil and water if the two fluids flow in opposite directions. Assume that the flow rates of the two fluids and U_o remain unaltered. What should be minimum temperatures to which oil could be cooled in parallel flow and counerflow operations? (10)

Q5 A vertical plate 300mm wide and 1.2 m high is maintained at 70°C and is exposed to saturated steam at 1 atm pressure. Calculate the heat transfer coefficient and the total mass of steam condensed per hour. What would be the heat transfer coefficient if the plate is inclined at 30° to the vertical. (10)

Q6 a) Give a comparison of Newton's law of viscosity, Fourier' s law of heat conduction and Fick's law of diffusion. How can you generalize them in terms of force and flux? (5)

b) Explain the physical significance of Schmidt number, Lewis number and Prandtl number. (5)

Q7 a) How is the mass transfer coefficient evaluated by dimensionless analysis. (5)

b) Air at 1 atm,25°C, containing small quantities of iodine flows with a velocity of 5.18 m/s inside a 3.048 cm diameter tube. Determine the mass transfer coefficient for iodine transfer from the gas stream to the wall surface. If Cm is the mean concentrate of iodine in kg mol/m^3. In the air stream, determine the rate of deposition of iodine on the tube surface wher the iodine concentration is zero. Take kinematic viscosity of air is 1.58×10^{-5} m^2/s and D for air-iodine system at 1 atm, 298K is 0.826×10^{-5} m^2/s. (5)

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

a) Regimes of boiling

b) Dropwise condensation and Filmwise condensation

c) LMTD and NTU method

d) Types of heat exchangers