a) Estimate the overall heat transfer coefficient u_i at the section where the water is at 40°C. Assume fully developed conditions.

b) Determine the length of the tube required to condense 0.05 kg/s of steam, assuming that the overall heat transfer coefficient determined in part (a) is uniform.

5. a) What is plank's distribution for monochromatic emissive power?

b) Define a grey surface?

c) What is the relation between radiosity and emissive power of a black surface?

d) State reciprocity relation for view factors.

e) State Kirchoff's law?

OR

Write short notes on following :

a) Regimes of Pool Boiling

b) Film wise and drop wise condensation.

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ME - 605

B.E. VI Semester

Examination, June 2013

Heat and Mass Transfer

Time : Three Hours

Maximum Marks : 70/100

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Note: Solve all the questions, internal choice is given with all the questions, missing data is to be assummed suitably.

1. Saturated steam at 200°C flows inside a 5cm O.D. Carbon steel tube with a wall thickness of 3mm. The tube surface is insulated with 5cm thick fiberglass. The surface heat transfer coefficient on the steam and air sides are 8000 w/m² °C and 10w/m² °C respectively. If the temperature of the outside air is 25°C.

   Determine :

   a) Heat transfer rate per meter length of the tube

   b) The temperature of the outer surface of the insulation.

   c) The rate of condensation of steam per meter length of the tube.

   OR

   Consider two long, hollow cylinders of an insulating material of the same axial length. Cylinder 1 has on ID of 25mm and OD of 50mm. Cylinder 2 has an ID of 100mm and an OD of 175mm. For the same inner and outer surface temperatures in both cases, find the ratio of heat transfer rates q_1/q_2.

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2. Coffee, initially at 80°C, is served in a silver cup which is modeled as a 6cm diameter, 5cm high cylinder. Assuming that the properties of the coffee are the same as those of water and the heat capacity of the cup (the product of the mass of the cup and its specific heat) is negligible compared with the heat capacity of the coffee. Estimate the temperature of the coffee 10 minutes later if the surface heat transfer coefficient (on all surface including the top) is 6 w/m² °C . Air at 20°C. Surrounds the entire cup and that the effect of evaporation from the top surface is 0 accounted for in the value of the surface heat transfer coefficient.

OR

Stainless steel balls of 4mm diameter, initially at 30°C, are heated for 1min with air at 95°C with a surface heat transfer coefficient of 40 w/m²°C and then cooled in 20°C with a surface heat transfer coefficient of 20 w/m²°C for 1 min. What is the temperature of the balls when they are removed from the cool air.

3. An experimental apparatus consists of a flat plate, 1m long in the diversion of flow 0.6m wide, and 4mm thick maintained at 40°C. The water at 20°C flows parallel to the plate with a free stream velocity of 3m/s. Estimate the heat fluxes at a distance of 1cm and 50 cm from the leading edge and the total Heat transfer rate from one surface. Take the properties of water at mean film temperature of 30°C as below:-

ρ = 995.6kg/m³
Cp = 4183 J/kg°C
K = 0.6154 w/m°C
μ = 797.7 x 10^{-6} N-s/m²
Pr = 5.422

OR

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A room heater is modeled as a series of 40 vertical plates, each 400mm high, 150mm wide and 15mm thick. If the temperature of the surface of the plates and air are 60°C and 10°C respectively, estimate the heat transfer rate to the air by natural convection from the vertical surfaces. The properties of air at mean film temperature of 35°C are as below :

ρ = 1.146kg/m³
Cp = 1007 J/kg°K
K = 0.02625 w/m°K
μ = 1.895 x 10^{-5} N-s/m²
Pr = 0.7268 and
β = 3.532 x 10^{-3}/°K

4. In an oil cooler for a diesel engine 0.1kg/s of oil (specific heat = 2131J/kg°C) is to be cooled from 120°C to 60°C in a double pipe heat exchanger with 0.1 kg/s of water available at 10°C. The over all heat transfer coefficient is 400 w/m² °C. Determine the heat transfer surface area if the flow is

i) Parallel
ii) Counter flow

OR

Dry saturated steam at 100°C enters the annulus of a double pipe, horizontal heat exchanger with negligible velocity. It is condensed on the outer surface of the 3mm thick, 25mm outside diameter type 316 stainless steel tube. Water at 30°C enters the tube with a mass flow rate of 0.6 kg/s.

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