Birla Institute of Technology & Science, Pilani.
I Semester 2014-15.
BITS F311 Heat Transfer
Comprehensive Examinations. 11/12/2015

Closed Book **Time: 180 Minutes.**
Total Marks:80 **Weightage: 40%**
Remarks: a) Answer the questions in the same order as they appear in the question paper b) Use of heat transfer date hand book permitted c) Make suitable assumptions if required.

Part: A **(10x2=20Marks)**

Q1) Find the change in current carrying capacity of a bare wire exposed to convective atmosphere if HTC increases from X to 5X. Assume other parameters remain the same. **[2]**

Q2) Deduce an expression for the nodal temperature of a corner node for 2D steady state conduction assuming the surfaces are exposed to convective atmosphere. **[2]**

Q3) Find the dimensionless temperature ratio at 0.6R of a sphere undergoing transient conduction in a convective atmosphere after time "t" of immersion resulting in Fo=2 and Bi=1. (R=Maximum radius of the sphere). **[2]**

Q4) What is adiabatic mixing cup temperature? Explain with suitable diagram. **[2]**

Q5) What is flow separation for the flow across the cylinder? Explain the effect of Laminar and Turbulent flow on the angle of flow separation. **[2]**

Q6) Deduce an expression for the shape factor of a cylindrical blind hole within itself having diameter= height. Consider the entire inside surface area of the cylinder for the analysis. **[2]**

Q7) Two circular discs of equal diameter are coaxially kept parallel to each other. The distance of separation "x" =Diameter of the disc. Find the change in faction radiation exchange between these surfaces if the distance is reduced to D/4. **[2]**

Q8) Draw the temperature variation of the fluids along a counter flow heat exchanger for C=1 and C=α. **[2]**

Q9) Under which circumstance the effectiveness of parallel flow and counter flow exchangers will be equal. Prove this using appropriate relations. **[2]**

Q10) Explain briefly the role of phase change heat transfer in compact sizing of heat transfer equipment with proper justification. **[2]**

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Part B **(15x4=60 Marks)**

Q11a) A plane wall is a composite of two materials, A and B. The wall of material "A" has uniform heat generation of $1.5x10^6 W/m^3$, K_A =75W/mK having thickness 50mm.The wall of material "B" has no heat generation with K_B= 150W/mK. having thickness of 20mm.The inner surface of the material "A" is well insulated while the outer surface of "B" is cooled by water stream having temperature of 30^OC and $h=1000W/m^2K$. Draw the temperature distribution in the composite slab. Also find the temperatures at i) insulated surface ii)interface and iii0 surface of the composite wall. **[10]**

11b) A very long rod is firmly attached to the surface of a billet and is exposed to surrounding fluid at 400^OC. The temperatures measured at a distances of 25mm and 120mm from the billet along the rod are 325^OC and 375^OC respectively. Find the surface temperature of the billet. **[5]**

Q12a) Inside temperature of an air conditioned bus having dimension of 10m length x3m width and 2m height is maintained at 25^OC. It is moving at an average speed of 80kmph. The ambient temperature is 49^OC. Find the total heat gained by the bus from the side walls and roof. Also find out the Tonnage of refrigeration (TR) needed to maintain the temperature at 25^OC. Also find the diesel consumption (kg/h) and fuel cost (Rs/h) to operate the air conditioner assuming COP of AC as 2 and brake specific fuel consumption of the engine as 0.2kg/kWh. **[10]**

12b) A bucket of water to be maintained at 15^OC, but it is heated by immersion rod of length 30cm and diameter 4cm.The temperature of the rod is maintained at 85^OC. Will you suggest to keep the rod vertical or horizontal to minimise the heat gain by the water? Also find the heat gain in both the cases. **[5]**

Q13a) A cylindrical flask of 3cm diameter is used to store ice at 0^OC the thickness of the flask is negligible. Outer surface of the cylinder is having emissivity of 0.1.It is surrounded by another hollow cylinder of diameter 6cm having inside emissivity of 0.1.The temperature of outside cylinder is 30^OC. Find the time required to completely melt the ice. (You may not required the length of cylinder). To make the flask more effective a cylindrical shield having diameter 4.5cm is inserted between the two cylinders. The emissivity of both the surfaces of the shield is 0.05. Find the change in melting time of the ice. **[10]**

13b) A vertical plate of length 1m and width 1m is maintained at 100^OC.The plate is exposed to surrounding air at 30^OC. Estimate the total heat loss from the surface of the plate by convection and radiation. Also find the faction of heat loss by convection and radiation. Do you suggest ignoring the radiation mode in such case? **[5]**

Q14a) Deduce an expression for the LMTD of a counter flow heat exchanger. **[5]**

14b) A steam condenser consists of a square array of 400 tubes kept in horizontal direction. The diameter of the tube is 6mm.The tubes are exposed to saturated steam at 15.76kPa and the tube temperature is maintained at 25^OC. Find the rate of condensation of steam per meter length of the tube. **[10]**

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