R09

Code No: C2103

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH I - SEMESTER EXAMINATIONS, APRIL/MAY-2012
ADVANCED HEAT AND MASS TRANSFER
(THERMAL ENGINEERING)

Time: 3hours **Max. Marks: 60**

Answer any five questions
All questions carry equal marks

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1.a) Explain how the three thermal boundary conditions be produced in laboratory. Explain the physical significance of boundary condition of the third kind.

b) A steel plate of thickness of 5cm and thermal conductivity k = 20W/m K is subjected to a uniform heat flux of $600 W/m^2$ on one of its surfaces and dissipates heat by convection with a heat transfer coefficient of $80 W/m^2$ ^{0}C from the other surface into the ambient air at $28^0 C$. What is the temperature of the surface dissipating heat by convection?

2. An electrical transmission line made of 1cm diameter annealed copper (k=399W/m K) cable carriers 70amps and has a resistance of 0.0104 ohms per meter of length. On a breezy day the convective heat transfer coefficient between the cable and the air is $228 W/m^2 K$. Determine the surface and centerline temperature of the cable. Consider one-meter length and the air temperature to be $28^0 C$.

3.a) Explain why and when extended surfaces are used to transfer heat.

b) A thermometer well mounted through the wall of a steam pipe is a steel tube with a 0.10cm wall thickness, 1.25cm OD, 5cm length and k =W/m K. The steam flow produces an average heat transfer coefficient of $100 W/m^2$ on the thermometer well. If the thermometer reads 149C and the temperature of the steam pipe is 65C, estimate the average steam temperature. Derive the relevant equation used.

4.a) Explain the concept of boundary layer.

b) Atmospheric air at 15m/s and at 15^0C is in parallel flow over a flat heater surface that is to be maintained at a temperature of 140^0C. The heater surface area is $0.25 m^2$ and the airflow is known to induce a drag force of 0.25 N on the heater. What is the electrical power needed to maintain the prescribed surface temperature?

5.a) Show the temperature and velocity profiles under free convection from a vertical plate.

b) Calculate the total heat loss by convection and radiation from an unplugged horizontal steam pipe, 6cm outside diameter at $115^0 C$ to air at $25^0 C$. Assume the emissivity of the surface $\in = 0.9$.

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6. In a power controlled pool – bring experiment, a horizontal cylindrical heater is immersed in saturated water at atmospheric pressure. The peak heat flux is $10^6\ W/m^2$. The power is increased slightly above this level and the nucleate boiling regime is replaced abruptly by film boiling. Estimate the excess temperature in this new regime by assuming that radiation is the dominant mode of heat transfer across the film. Assume any missing data.

7.a) What are radiation shields? Give their applications.

b) Dry air at 30^0C flows over a flat plate at 30C which is covered with a water film. The velocity of flow of air is 6 m/s. The plate is 1 m long. Determine the average convection mass transfer coefficient and also the mass of water evaporated per second. Given diffusion, $D_{AB} = 2.6\times10^{-6}$, Sc = 0.615, Density of water vapor at $30^0 C$ is $P_w = 0.03 kg/m^3$.

8. Write short notes on
   a) Variable thermal conductivity
   b) Transient heat conduction
   c) Types of condensation
   d) Fick's law of diffusion.

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