**R13**

**Code No: 114CF**

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD**

**B.Tech II Year II Semester Examinations, May - 2016**

**HEAT AND MASS TRANSFER**

**(Agriculture Engineering)**

**Time: 3 Hours** **Max. Marks: 75**

**Note:** This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A.
Part B consists of 5 Units. Answer any one full question from each unit.
Each question carries 10 marks and may have a, b, c as sub questions.

**PART - A** **(25 Marks)**

1.a) Explain the concept of critical radius of insulation and its significance. [2]
b) Explain the heat transfer applications in dairy applications. [3]
c) Explain hydrodynamic and thermal entry lengths and its significance. [2]
d) Explain the significance of NTU method. [3]
e) Explain gas radiation and radiation from flames briefly. [2]
f) Write all three types of fins and their heat transfer equations. [3]
g) Explain the performance of heat exchangers. [2]
h) Give the electrical analogy to three composite materials. [3]
i) Explain Fick's law used for mass transfer. [2]
j) Explain the concept of molecular diffusion in fluids. [3]

**PART - B** **(50 Marks)**

2.a) Derive an expression for general heat conduction equation in cylindrical co-ordinate System.
b) A long Cylindrical rod of radius 5 cm and K=10w/mk, contains radioactive material which generates heat uniformly within the cylinder at a constant rate of 3 mw/m$^{3}$. The rod is cooled by convection from its cylindrical surface into ambient air at 50$^{0}$C with heat transfer coefficient 60 W/m$^{2}$k. Calculate the temperature at the centre and outer surface of the cylindrical rod. [5+5]

**OR**

3.a) A metal plate of 4 mm thickness (k = 95.5 W/m $^{0}$C) is exposed to vapour a 100 $^{0}$C on one side and cooling water at 25$^{0}$C on the opposite side. The heat transfer coefficients on vapour side and water side are 14500 W/m$^{2}$ $^{0}$C and 2250 W/m$^{2}$ $^{0}$C respectively. Determine:
i) The rate of heat transfer,
ii) The overall heat transfer coefficient, and
iii) Temperature drop at each side of heat transfer.
b) Derive an equation for heat transfer through composite cylinder with three layers. [5+5]

4.a) Define thermal conductivity, thermal resistance and thermal conductance.

b) A steel pipe is carrying steam at a pressure of 30 bar its outside diameter is 90 mm and is lagged with a layer of material 45 mm thick (K = 0.05 W/m-K). The ambient temperature is $20^0$C and the surface of the lagging has a heat transfer coefficient of 8.4 W/m-K. Neglecting resistance due to pipe material and due to steam film on the inside of steam pipe, find the thickness of lagging (K = 0.07 W/m-K) which must be added to reduce the steam condensation rate by 50 percent if the surface coefficient remains unchanged. [5+5]

**OR**

5.a) Derive an equation for heat transfer for a short fin and temperature distribution.

b) One end of a long rod 38 mm in diameter is inserted in to a furnace with the other end projecting in the outside air. After the steady state is reached temperature of the rod is measured at two points 175 mm apart and found to be $182^0$C and $138^0$C. If the ambient air is $24^0$C and Heat transfer co-efficient is 59 W/m$^2$K, calculate the thermal conductivity of the rod. [5+5]

6.a) Using dimensional analysis establishes a relation between Nusselt, Prandtle and Grashoff numbers.

b) A plate of size 20 cm × 30 cm is used as water heater in a process plant. The temperature of water is $20^0$C while the heater plate is maintained at a temperature of $120^0$C. Determine the heat transfer rate by convection when 20 cm side of the heater is kept vertical. [5+5]

**OR**

7. a) Derive the equation for Reynolds colburn analogy.

b) Air at 1.2 bar and $22^0$C is flowing over a flat plate at a velocity of 4 m/s. If the plate is 30 cm wide and at a temperature of $60^0$C, calculate at x=0.3 m.
(i) Hydrodynamic and thermal boundary layer thickness.
(ii) Local and average friction coefficients.
(iii) Local and average heat transfer coefficients.
(iv) Total drag force on the plate and mass flow rate over the plate. [5+5]

8.a) A counter flow double pipe heat exchanger is to heat water from $25^0$C to $85^0$C at a rate of 1.5 kg/sec. The heating is accomplished by geothermal water available at $160^0$C at a flow rate of 2 kg/sec. The inner tube is thin walled and has a diameter of 1.5 cm. If the overall heat transfer coefficient is 650 W/m$^2$ $^0$C determine the length of the heat exchanger.

b) Derive an expression for the effectiveness of (i) parallel flow and (ii) counter flow heat exchanger when the heat capacity rates of both the fluids are equal. [5+5]

**OR**

9.a) Derive the relation for intensity of radiation and emissive power of a black body.

b) Two parallel circular discs of radius 0.5 m are separated 0.5 m apart. One plate is maintained at 1000 K and the second plate is at 2000 K. The plates are located in a large room which is maintained at 300 K. The circular discs exchange heat with each other and also with the room, but only the circular discs facing each other are to be considered. The emissivities of the discs are 0.2 and 0.5 respectively. Find the net heat transfer to each disc end to the room. [5+5]

10.a) Differentiate between diffusion and convective mass transfer.

b) Pure water at $20^0$C flows at a velocity of 2 m/s over a slab of salt. If the concentration of salt at the interface is 380 kg/$m^3$, determine the average mass transfer coefficient and rate of diffusion of salt into water. Take area of the salt slab as 1×1 $m^2$. [5+5]

**OR**

11.a) How is mass diffusion analogous to conduction heat transfer?

b) Dry air at $30^0$C flows at a velocity of 6m/s over a plate 1 m along and 0.5wide. If the plate is maintained at $30^0$C and its entire surface is covered with a water film, determine the average convective mass transfer coefficient and also the mass of water evaporated per second. [5+5]

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