



KERALA AGRICULTURAL UNIVERSITY

B.Tech.(Agri. Engg) 2016 Admission

IV Semester Final Examination-July 2018

Fape.2203

Heat and Mass Transfer (2+0)

Marks: 50

Time: 2 hours

1 A Fill in the blanks. (10x1=10)

- 1 Free convection is the result of motion of fluid due to .....
- 2 .....is highest thermal conductive material.
- 3 Conductive heat transfer thermal resistance in case of cylindrical surface can be obtained using the relation.....
- 4 The unit of diffusion coefficient is .....
- 5 The incident radiation distributed uniformly in all direction is called.....

B State True/False

- 6 Radiation heat transfer cannot take place in the presence of any medium
- 7 Thermal conductivity of gas increases with the increase of temperature
- 8 Transmissivity of opaque body is unity
- 9 The value of LMTD for counter flow heat exchanger is higher than parallel flow heat exchanger
- 10 Effectiveness of heat exchanger can be greater than one ( $\epsilon > 1$ )

II Write short notes on ANY FIVE (5x2=10)

- 1 Significance of thermal diffusivity in heat transfer?
- 2 Effect of contact resistance in conductive heat transfer?
- 3 Why it is advisable to use log mean temperature difference instead of arithmetic mean temperature difference to evaluate the performance of a heat exchanger?
- 4 Importance of fouling factor in design of a heat exchanger?
- 5 Why critical thickness of insulation is relevant only for curved surfaces? Why not for plane wall?
- 6 What is the difference in emissivity of black, gray and real bodies?
- 7 Define Wien's displacement law.

P.T.O

**III Answer any FIVE of the following.**

(5x4=20)

- 1 Estimate the diffusion coefficient for ammonia in air at 25°C temperature and one atmospheric pressure. Consider molecular weights as 17, 29 and molecular volumes as 25.81 cm<sup>3</sup>/gm mole, 29.89 cm<sup>3</sup>/gm mole, respectively for ammonia and air.
- 2 What do you understand by the term Thermal Boundary Layer? How Prandtl number affects thermal and hydraulic boundary layer for a hot surface?
- 3 Define radiosity and irradiation. Also derive the relation between radiosity and irradiation for a non black opaque surface.
- 4 Consider atmospheric air at 25°C in parallel flow at 5 m/s over both side of 1m long flat plate maintained at 75°C. Determine the boundary layer thickness and heat flux at the trailing edge. Consider for Air :  $\rho = 1.085 \text{ kg/m}^3$ ,  $\nu = 18.2 \times 10^{-6} \text{ m}^2/\text{s}$ ,  $k = 0.028 \text{ W/m.K}$ ,  $Pr = 0.707$  and  $Nu = 0.332 Re^{1/2} Pr^{1/3}$ .
- 5 Determine whether it is safe to store a radioactive waste that generating 0.5 MW of energy per unit volume in a hollow spherical vessel of Lead having 0.50 m inner and 0.60 m outer diameter. The lead vessel is further covered with another spherical vessel of Steel having 0.62 m diameter. The whole vessel is surrounded by a fluid of 10 °C temperature having convective heat transfer coefficient as 500 W/m<sup>2</sup> K. Assume, melting point of Lead as 330 °C, thermal conductivity of lead and steel as 35.3 W/m K and 15.1 W/m K respectively.
- 6 Determine the overall heat transfer coefficient for liquid to liquid heat transfer through a 0.003 m thick steel plate [ $k = 50 \text{ W/ m.K}$ ] for given fouling factor and heat transfer coefficient as  $h_i = 2.5 \text{ kW/m}^2$ ,  $h_o = 1.8 \text{ kW/m}^2$ ,  $R_{fi} = 0.0002 \text{ m}^2.\text{K/ W}$ .
- 7 A very long copper rod 20 mm in diameter extends horizontally from a plane heated wall maintained at 100 °C. The surface of the rod is exposed to an air environment at 20 °C with convective heat transfer coefficient of 8.5 W/m<sup>2</sup>-deg. Workout the heat loss if the thermal conductivity of copper is 400 W/m-deg. Also estimate how long the rod be in order to be considered as of infinite length.

**IV Answer any ONE of the following**

(1x10=10)

- 1 Derive the expression for effectiveness of a counter flow heat exchanger in terms of capacity ratio (C) and NTU. Also enumerate the assumptions made for this derivation and draw a plot between effectiveness and NTU .
- 2 Explain Fourier's Law. Derive the three dimensional Fourier Conduction Equation.

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