KERALA AGRICULTURAL UNIVERSITY
B.Tech.(Food Engg) 2017 Admission
II Semester Final Examination-July 2018

Fden.1202 **Heat and Mass transfer (1+1)**

Marks: 50
Time: 2 hours

I **Fill up the blanks** **(10x1=10)**

1 The rate equation for convection is known as .....
2 The unit of thermal diffusivity is .....
3 Heat transfer in liquids and gases is essentially due to .....
4 The value of Stefan –Boltzmann constant is .....

State True or False

5 Thermal conductivity of gases decreases with increase in temperature .
6 The Nusselt number in forced convection is a function of Reynolds number and Grashof's number.
7 The effectiveness of counter-flow heat exchanger is greater than parallel- flow heat exchanger.
8 The automobile radiator is a cross-flow heat exchanger .

Define

9 Kirchhoff's law of radiation.
10 Fick's law of diffusion.

II **Write Short notes on any FIVE of the following** **(5x2=10)**

1 Critical radius of insulation
2 Logarithmic mean temperature difference
3 Planks law of radiation
4 Condensation heat transfer
5 Emissivity
6 Mechanism of conduction in solids
7 Convective mass transfer

III **Answer any FIVE of the following.** **(5x4=20)**

1 An electrical wire 2 m long and 0.3 cm diameter extends across a room at 15°C. Heat is generated in the wire as a result of resistance heating and the surface temperature of the wire is measured to be152°C in steady state operation. Also the voltage drop and the current through the wire are measured to be 60 V and 1.5 A respectively. Disregarding the heat transfer by radiation, determine the convective heat transfer coefficient.

P.T.O

2 A horizontal steel pipe having a diameter of 5 cm is maintained at a temperature of 60°C in a large room where the air and wall temperature are at 20°C. The surface emissivity of the steel may be taken as 0.8. Calculate the total heat lost per unit length by convection and radiation. Take convective heat transfer coefficient = 7 W/m^2K.

3 Draw the hydrodynamic boundary layer over a flat plate indicating all the regimes of the flow. Also sketch the velocity profile in the laminar and turbulent region.

4 Explain Equimolar counter diffusion.

5 Hot oil with a capacity rate of 2500 W/K flows through a double pipe heat exchanger. It enters at 360°Cand leaves at 300°C. Cold fluid enters at 30°C and leaves at 200°C. If the overall heat transfer coefficient is 800 W/m^2 K, determine the heat exchanger area required for (a) parallel-flow and (b) counter-flow.

6 Explain the analogy between heat, mass and momentum transfer.

7 Derive an expression for the steady state heat transfer through a cylinder.

IV Answer any ONE of the following (1x10=10)

1 A steel pipe line (k= 50 W/mK) of inner diameter 100 mm and outer diameter 110 mm is to be covered with two layers of insulation each having a thickness of 50 mm. The thermal conductivity of the first insulation material is 0.06 W/mKand that of the second is 0.12 W/mK. Calculate the loss of heat per meter length of pipe and the inner surface temperature between the two layers of insulation when the temperature of the inside tube is 250°Cand that of the outside surface of the insulation is 50°C. If the order of insulation material for the steel pipe were reversed, that is the insulation with a higher value of thermal conductivity was put first, calculate the change in heat loss with all other conditions remaining unchanged. Comment also on the result.

2 Engine oil at 20°C is forced over a 20 cm square plate at a velocity of 1.2 m/s. The plate is heated to a uniform temperature of 60°C. Calculate the heat lost by the plate. The properties of engine oil are

Density = 900 kg/m^3, kinematic viscosity = 0.00024 m^2/s, conductivity = 0.144 W/mK, Prandtl number = 2870.

Use the following correlation for heat transfer coefficient.

$$Nu_x = 0.332\ Re_x^{0.5} Pr^{0.333}$$

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