KERALA AGRICULTURAL UNIVERSITY
B.Tech.(Food Engg.)
II Semester Re- Examination-October 2021
2019 Admission

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

Marks: 50
Time: 2 hours

I **State whether True or False** **(10x1=10)**

1. Natural Convection can take place only in the presence of gravity
2. Effectiveness of a counter flow heat exchanger is greater than a parallel flow heat exchanger
3. Thermal conductivity is a property of material
4. The physical mechanism associated with cooking in a microwave oven is convection
5. Emissivity is a surface property

Name the following

6. Define an isotropic material
7. State Kirchoff's law for radiation

Fill in the blanks

8. The rate of heat transfer is expressed in .....
9. The unit of thermal resistance is .....
10. The emissivity of a black body is .....

II **Write short notes on ANY FIVE of the following** **(5x2=10)**

1. Heat exchanger effectiveness
2. LMTD
3. Fick's law of diffusion
4. Irradiation
5. Grey body
6. Plank's Law of radiation
7. Overall heat transfer coefficient

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

1. A wire of radius 3mm and 1.25m length is to be maintained at 60 degree C by insulating it by a material of thermal conductivity of 0.175 W/mK. The temperature of surrounding air is 20 degree C with heat transfer coefficient 8.5 W/m^2 K. For maximum heat dissipation, determine
   a. Minimum thickness of insulation and the heat loss
   b. Percentage increase in heat loss due to insulation with bare wire
2. A pipe with a surface temperature of 480K is kept within a large enclosure whose walls are at 380K. Persuming the pipe surface to be black, calculate the coefficient of radiant heat transfer. If the heat transfer coefficient including the effect of radiation and convection is 34.9 W/m^2K, find the convective heat transfer coefficient.
3. In a food processing plant, brine solution is heated from -12 degree C to -6.5 degree C in a double pipe parallel flow heat exchanger by water entering at 35 degree C and leaving at 20.5 degree C at the rate of 9 kg/min. Determine the heat exchanger area if overall heat transfer coefficient of 860 W/m^2K. For water Cp =$4.186x10^3$ J/kg K

4. Represent on a neat sketch of velocity and thermal boundary layer for a fluid with Prandtl number Pr>1
5. What are the different types of heat exchangers? How are they classified?
6. Establish a relation for the shape factor of a cavity with respect to itself. The cavity is closed on its outer surface with a flat surface
7. A plastic membrane of 0.25mm thick has hydrogen gas maintained at pressures of 2.5 bar and 1 bar on its opposite sides. The binary diffusion coefficient of hydrogen in the plastic is 8.5×10^{-8} m^2/s and the solubility of hydrogen in the membrane is 1.5×10^{-3} kg-mol/m^2 – bar. Under uniform temperature conditions of 25 degree C workout
   a. Molar concentration of Hydrogen at the opposite faces of the membrane
   b. Molar and mass diffusion flux of hydrogen through the membrane

IV **Write an essay on ANY ONE of the following** **(1x10=10)**

1. Derive an equation for the Logarithmic Mean Temperature Difference (LMTD) in a counter flow concentric pipe heat exchanger.
2. A spherical tank of 3m internal diameter and made of 2cm thick stainless steel (k=15 W/m deg C) is used to store ice water at 0 degree C. The tank loses heat to the surrounding at 25 degree C by natural convection and radiation with a combined heat transfer coefficient of 15.5 W/m^2 deg C. If the convective coefficient at the inner surface of the tank is 80 W/m^2 deg C, determine;
   a. The rate of heat transfer to the iced water in the tank and
   b. The amount of ice that melts during a period of 24 hours (latent heat of ice=334 kJ/kg)

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