KERALA AGRICULTURAL UNIVERSITY

B.Tech (Food Engg.) 2011 Admission

II[nd] Semester Final Examination, July/August 2012

Cat. No Fden.1202 **Marks: 80**

Title: Heat and Mass Transfer (2+1) **Time: 3hours**

I. Answer the following questions: **5 x 1 = 5**

A. Choose the correct answer:

1. Q= KAdt/dx is known as
   a) Laplace law b) Plank's law
   c) Navier – Stokes equation d) Fourier's law

2. The heat transfer is constant when
   a) temperature decreases with time
   b) temperature remains constant with time
   c) temperature increases with time

3. _____ needs no medium for heat transfer.
   a) Conduction b) Convection
   c) Radiation d) None
4. Log mean temperature difference in case of parallel flow compared to counter flow is
   a) More b) Less c) Same d) None of the above
5. The gases have poor
   a) transmissivity b) absorptive
   c) reflectivity d) All the above

B. Fill in the blanks: **5 x 1 = 5**

1. The value of Stefan-Boltzman's constant is _____ W/m^2K^4.
2. _____ is the process of heat transfer which occurs due to movement of the fluid particles by density changes associated with temperature differential in a fluid.
3. The unit of overall heat transfer coefficient in SI units is _____.
4. The energy radiated by a body is proportional to the fourth power of its _____.
5. The condensation process is the _____ process

II. Answer any *TEN* of the following: **10 x 3 = 30**

1. State Fourier's law, Kirchoff's law and Stefan-Boltzman's Law.
2. Define emissivity of an object and shape factor.
3. Derive an expression for conduction heat transfer through a hollow cylinder.
4. Differentiate between parallel, counter and cross flow heat exchanger with a neat sketch.
5. Explain the analogy between heat, mass and momentum transfer.
6. Define absorptivity, reflectivity and transmittivity.
7. What are the modes of heat transfer and explain briefly?

8. Derive an expression for the shape factor in case of radiation exchange between two surfaces.
9. Define boundary layer thickness, displacement thickness and momentum thickness.
10. Derive an energy equation for thermal boundary layer over a flat plate.
11. Explain the different modes of mass transfer.
12. What is insulation? Explain briefly about critical thickness of insulation.

III. Answer any *SIX* questions: **6 x 5 = 30**

1. Explain in brief about the plate heat exchanger with a neat sketch.
2. A 5 m high and 12 m long composite wall of a cold storage is made of 100 mm thick brick wall as the outside wall. The inner wall surface is of fibre glass of 60 mm thick. In between the two walls an insulating board of 20 mm thick is placed. The coefficient of thermal conductivity for the three layers are given below:
   Brick wall= 1.15 W/m-K, Fiber glass = 0.04 W/m-K, Insulating board =0.06 W/m-K. If the outside atmospheric temperature is 27 °C and cold room temperature is 8 °C. calculate the heat loss per hour through the wall. Also determine the interface temperatures.
3. Derive an expression for the Log Mean Temperature Difference (LMTD) in a single pass double-pipe counter flow heat exchanger.
4. Derive an expression for conduction heat transfer through a composite wall.
5. What is Fick's law of diffusion? Explain steady state equimolar counter diffusion.
6. (a) State and explain Wien's Displacement law. Show that $E_{b\lambda}$ will be maximum when $\lambda_{max} T = 2900\ \mu K$.
   (b) Assuming sun as black body radiating the heat at 5000 K, find the maximum monochromatic emissive power of the sun's surface.
7. A heavy hydrocarbon oil which has C_p= 2.3 kJ/kgK is being cooled in a counter flow heat exchanger from 372 to 350 K. The oil flows inside the tube at a rate of 3630 kg/hr and water enters at 289 K for cooling and flows outside the tube. Assume C_p= 4.187 kJ/kgK for water. Calculate the water outlet temperature and heat transfer area, if the overall heat transfer coefficient U = 340 W/m^{2}K.
8. Define mass transfer? Write its application of mass transfer phenomenon in food processing?

IV. Write short note on any *ONE* of the following **1x 10 =10**

1. a. Explain in brief about the Scraper surface heat exchanger with a neat sketch.
   b. Derive expression on effectiveness of heat exchanger and NTU

2. a. Derive momentum equation for hydrodynamic boundary layer over a flat plate.
   b. Explain briefly about condensation heat transfer mechanism.

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