B. TECH
(SEM IV) THEORY EXAMINATION 2018-19
HEAT AND MASS TRANSFER

[Time: 3 Hours]   *[Total Marks: 70]*
Note: Attempt all questions.

SECTION-A

1. Attempt **all** parts of the following: [2*7=14]

   a. What is Fick's law of diffusion?
   b. Define bound and unbound moisture content.
   c. Differentiate b/w free and forced convection.
   d. Differentiate b/w molecular diffusion and eddy diffusion.
   e. State the Newtons law of cooling.
   f. Discuss the thermal conductivity of material.
   g. Explain the Dirt factor.

SECTION-B

2. Attempt any **three** part of the following: [7*3=21]
   a. Explain the critical thickness of insulation. Show that in case of a cylinder, the critical radius of insulation is given by $r_{cr} = k/h$, where k is thermal conductivity and h is the air film heat transfer coefficient.
   b. A flat furnace wall is constructed of 114 mm layer of Sil-o-cel brick, with a thermal conductivity of 0.138 W/m-K backed by a 229 mm layer of common brick, of conductivity 1.38 W/m-K. The temperature of inner face of the wall is 760 ^{0}C, and that of the outer face is 76.6 ^{0}C (i) what is the heat loss through the wall? (ii) What is the temperature of the interface between refractory brick and the common brick?
   c. Explain the difference between a double pipe heat exchanger and a shell and tube heat exchanger. Also draw a neat sketch of a 2-4 shell and tube heat exchanger showing its operation.
   d. What is the steam economy of an evaporator? And also discuss the various methods of feed in a triple effect evaporator.
   e. Write short notes on the following-
       (i) Equilibrium yield of crystallization
       (ii) Film theory of mass transfer

SECTION-C

3. Attempt any **one** part of the following: [7x1=7]
   a. Discuss various regimes of boiling phenomenon and show the effect of ΔT on heat flux for different regimes. What is critical heat flux?
   b. What is the mass transfer coefficient? Derive the relationship between overall mass-transfer coefficient and individual phase mass-transfer coefficient.

4. Attempt any **one** part of the following: [7x1=7]

   a. Discuss the analogy between heat and mass transfer.
   b. A single effect evaporator operates at an absolute pressure of 0.1 kg/cm^2 and is used to concentrate 5000kg/hr of a solution from 10% to 40%. Saturated is used in the steam chest at a pressure of 1.5 kg/cm^2 gauge. The overall heat transfer coefficient is 1000kcal/h m^2 ^{0}C. Calculate the heat transfer area: Feed temperature = 25^{0}C, Heat capacity of feed = 0.9 kcal/kg ^{0}C, heat capacity of product = 0.8 kcal/kg ^{0}C, boiling point rise = 15 ^{0}C.

5. Attempt any **one** part of the following: [7x1=7]

   a. A steel tube with ID of 200 mm, OD of 220 mm and a thermal conductivity 40 kcal/(m hr ^{0}C) is covered with two layers of two different insulating materials. The thickness of the first layer is 50 mm and that of the second layer is 80 mm while the thermal conductivities are 0.172 W/m K and 0.96 J/m hr ^{0}C. The temperature of inner surface is 327 ^{0}C and that of the outer surface insulation is 45 ^{0}C. Determine the heat loss through a length of 1 m of the pipe line and also the interface temperatures between the individual layers.
   b. Discuss the moisture content on wet basis, dry basis, equilibrium moisture and free moisture. A wet solid is to be dried from 80 to 5 % moisture on wet basis. Calculate the moisture to be evaporated per 1000 kg of dried product.

6. Attempt any **one** part of the following: [7x1=7]

   a. Explain the typical rate of drying curve and explain various regions in it. Also explain any one dryer equipment with neat sketch.
   c. Why LMTD is used in designing of double pipe heat exchanger? Develop an expression for evaluation of LMTD in true counter-current heat exchanger.

7. Attempt any **one** part of the following: [7x1=7]
   a. Show that the diffusion coefficients D_{AB} nad D_{BA} are equal for a binary mixture (A-B) with constant molar density.
   b. Discuss the classification of different types of crystallizers and discuss any one of them.