Code No: 07A62303 **R07** **Set No. 2**

III B.Tech II Semester Examinations,APRIL 2011
HEAT TRANSFER IN BIOPROCESSES
Bio-Technology

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Discuss how the geometric parameter of the pipe, physical properties of the fluid and its velocity influence the heat transfer coefficient in the fluid flow in a pipe . [16]

2. What are the various modes of heat transfer through solids, liquids and gases? Explain in detail. [16]

3. Obtain an expression for the quantity of heat flow through a flat slab with a neat sketch. [16]

4. A square plate, 40 cm x 60 cm, is at 140°Cand is exposed to air at 20°C . Find the heat loss from the plate if
   (a) the plate is kept vertical.
   (b) the plate is placed horizontally. Find the percentage change in heat flow due to the change in position. [8+8]

5. 1.5 kg/s of a solution containing 1.0 wt% solids is fed to a single effect evaporator at 303K. It is to be concentrated to a solution of 1.5 wt% of solids. Evaporation takes place at atmospheric pressure. Saturated steam is supplied at 205 kN/m^2 for heating. If the overall heat transfer coefficient is 3000 W/m^{2}K, what is the surface area required?. Suitable assumptions may be made, if necessary. Saturation temperature of steam at 205 kN/m2 = 125^0C . Latent heat of vaporization = 2200 kJ/kg. [16]

6. (a) In a parallel flow double pipe heat exchanger, the hot fluid enters the heat exchanger at 90 ^0C and leaves at 50 ^0C , while the cold fluid enters the heat exchanger at 20^0C and leaves at 40^0C . Calculate the LMTD.
   (b) In a counter current double pipe heat exchanger, the hot fluid enters at 200^0C and leaves at 100 ^0C , while the cold fluid enters the heat exchanger at 20^0C and leaves at 80 ^0C . Calculate the LMTD. [8+8]

7. Estimate the heat flux which would occur in nucleate boiling of saturated water at 477^{0}k upon platinum wire as submerged heating surface (491^{0}k). Thermal properties of water
   P = 968 kg/m^3
   k = 0.58 w/m^{0}C
   Cp = 4180 j/kg^{0}C
   μ= 1.14x10^{-6}N.sec/m^2 [16]

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8. A fermentation medium contains initial spores concentration of $8.5X10^{10}$.The medium is sterilized chemically at 120^0C, and the spore density was noted with the progress of time. the data are as follows.

Time(min)	0	5	10	15	20	30
Spore density(m^{-3})	$8.5X10^{10}$	$4.23x10^9$	$6.2X10^7$	$1.8X10^6$	$4.5X10^4$	32.5

a) Find the thermal death kinetics

b) With the above data, calculate the inactivation factor at 40 min [16]

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Code No: 07A62303 **R07** **Set No. 4**

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Bio-Technology

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Derive Colburn analogy and State its significance and Sketch temperature and velocity profile of free convection of vertical wall. [16]

2. (a) Condensing equipments are always designed for film-wise condensation - why?
   (b) Discuss the regimes of boiling heat transfer with the help of a boiling curve. Why are heat transfer coefficients lowered in film boiling as compared to nucleate boiling? [8+8]

3. What do you understand by black body and grey body? Explain. [16]

4. What is dimensional analysis? Explain any one method of dimensional analysis? [16]

5. How evaporation different from other unit operations like drying, crystallization and distillation? Explain in detail. [16]

6. A cylindrical tube has inner diameter of 20 mm and outer diameter of 30mm. find out the rate of heat flow from tube of length 5 m if inner surface is at 373 K (100^0C) and outer surface is at 308 K (35^0 C). Take the thermal conductivity of tube material as 0.291 W/(m.K). [16]

7. Calculate the heat transfer area required for a 1-1 shell and tube heat exchanger which is used to cool 55000 kg/hr of alcohol from $66\,^0C$ to $40\,^0C$ using 40,000 kg/hr of water entering at 5^0 C. U = 580 W/m^2 K, consider
   (a) counter flow
   (b) parallel flow.
   C_P water = 4.18 X 10^3 J/kg K
   C_P alcohol = 3.76 X10^3 J/kg K. [16]

8. The thermal death kinetic data of bacillus stearothermophilus are as follows at three different temperatures.

Temp,^0C	115	120	125
Kd,min^{-1}	0.035	0.112	0.347

   (a) Calculate the activation energy and Arhenius constant for sterilization
   (b) Find Kd at 130^0C. [16]

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Code No: 07A62303 **R07** **Set No. 1**

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HEAT TRANSFER IN BIOPROCESSES
Bio-Technology

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Derive an expression for the temperature profile in a thick walled cylinder during heat transfer by conduction under steady state. [16]

2. (a) What is Sieder Tate equation and why is it used?
   (b) What is the significance of jH factor? [8+8]

3. Derive an expression for determining the rate of heat transfer through the thick wall of a hollow cylinder. Also, find the temperature profile and its nature. State your assumptions clearly. [16]

4. Describe how effective is plate heat exchanger for continuous sterilization of medium.Is plate heat exchanger useful for Batch sterilization explain? [16]

5. Show that the Heat transfer coefficient for film type condensation over a vertical plate is $h = 0.943 \left[\frac{k_f^3 p^2 f g \lambda}{\Delta T_0 L \mu_f}\right]^{1/4}$ [16]

6. Draw a neat sketch of backward feed multiple effect evaporation system and discuss the salient features. When is backward feed operation preferred over forward feed? [16]

7. Determine the rate of heat loss from a 300 mm diameter steam pipe placed horizontally in ambient air at 30°C The length of the pipe is 5m and wall temperature, Tw = 120°C Use the following empirical expression:
   Nu=0.53 $(GrxPr)^{1/4}$
   Properties of air at 100°C are as following
   β =1/373 K^{-1} ?= 23.13 x 10^{-6} m^2 /sec
   K= 0.0325 W/m.K
   Pr = 0.7
   Nu = 114. [16]

8. A light oil with 20^0C inlet temperature flows at the rate of 500 Kg/minute through 5cm inner diameter pipe which is enclosed by a jacket containing condensing steam at 150^0C. If the pipe is 10 meter long, find the outlet temperature of the oil. [16]

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Code No: 07A62303 **R07** **Set No. 3**

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HEAT TRANSFER IN BIOPROCESSES
Bio-Technology

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. How the local and average convection coefficients for flow past a flat plate are related? Derive the relationship. [16]
2. Explain the Batch sterilization process with neat sketch. [16]
3. (a) What is the effect of liquid pressure on boiling?
   (b) Write a short notes on pool boiling of saturated liquid. [8+8]
4. A heat exchanger heats 25,000 kg/hr of water entering at 30°C while cooling 20,000 kg/hr of water from 100°C to 80°C. Determine the area necessary for
   (a) Parallel flow
   (b) Counter flow arrangement. [8+8]
5. Classify various types of evaporators with industrial applications. [16]
6. A plane brick wall, 25 cm thick, is faced with 5 cm thick concrete layer. If the temperature of the exposed brick face is 70°C and that of the concrete is 25^0C, , find out the heat lost per hour through a wall of 15 m x10 m. Also, determine the interface temperature. Thermal conductivity of the brick and concrete are 0.7 W/m.K and 0.95 W/m.K respectively. [16]
7. A long hollow cylinder has its inner and outer surfaces maintained at temperatures T_b and T_a respectively. The inner and outer radii are b and a respectively. Calculate the temperature profile in the solid section of the cylinder and determine the flux at both surfaces. Assume steady state condition. [16]
8. Determine the rate of heat loss from a 100 mm diameter steam pipe placed horizontally in ambient air at 30°C . The length of the pipe is 4 m and wall temperature, Tw = 170°C.
   Use the following empirical expression:
   $Nu=0.53\ (GrPr)^{1/4}$
   Properties of air at 100°C are as following
   $\beta= 1/373K^{-1}$ $\gamma= 23.13x10^{-6}m^2/sec$
   K= 0.0425 W/m.K
   Pr = 0.8
   Nu = 110. [16]

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