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

III B.Tech II Semester Examinations,December 2010
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. Write detailed notes on extended surface equipment with suitable examples. [16]

2. (a) Explain the phenomenon of heat transfer by free convection.
   (b) What forces control the fluid motion?
   (c) Can free convection occur in space vehicles with a Zero's 'g' trajectory? [16]

3. Using dimensional analysis, prove that the heat transfer during forced convection can be represented by the following relationship $N_{Nu} = f(N_{Re}, N_{Pr})$ where N_{Nu}, N_{Re}, N_{Pr} represent Nusselt, Reynolds and Prandtl number respectively. [16]

4. Determine the heat transfer rate through a spherical copper shell of thermal conductivity 386 W/mK, inner radius of 2- mm and outer radius of 60 mm. The inner surface and outer surface temperatures are 200^0 C and 100^0 C respectively. [16]

5. What are various objectives of evaporation explain? [16]

6. Describe graphically how does the number of spores vary with time in batch sterilization ? [16]

7. Estimate the heat flux which would occur in nucleate boiling of saturated water at 477^0k upon platinum wire as submerged heating surface (491^0k). Thermal properties of water
   $P = 968$ kg/m^3
   $k = 0.58$ w/m^{0}C
   $Cp = 4180$ j/kg^{0}C
   $\mu = 1.14 \times 10^{-6}$ N.sec/m^2 [16]

8. Determine the heat flux across 15.2 cm thick slab when one face is kept at 500 K and the other face at 280K
   The thermal conductivity of the slab material varies linearly with temperature in accordance with the equation $k = k_o(1 + BT)$ where $k_o = 0.0346$ W/m.K and $B = 3.6 \times 10^{-3o}K^{-1}$.. [16]

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

III B.Tech II Semester Examinations,December 2010
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. Briefly discuss about the influence of boundary layer on heat transfer with neat sketches. [16]

3. Draw the boiling curve and identify the burn out point on the curve. Explain how burnout is caused. Why is the burn out point avoided in the design of boilers. [16]

4. A vertical plate is at 96°C in an atmosphere of air at 20°C. Estimate the local heat transfer co-efficient at a distance of 20 m from the lower edge and the average value over the 20 cm length [16]

5. Classify various types of evaporators with industrial applications. [16]

6. Write notes on fin efficiency and types of extended surfaces. [16]

7. 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]

8. State and explain the following laws relating to thermal radiation and temperature of a radiating body:

   (a) Plank's law
   (b) Stefan Boltzman law
   (c) Wien's displacement law. [16]

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

III B.Tech II Semester Examinations,December 2010
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 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]

2. Classify heat exchangers. Draw a neat diagram of 1-2 shell and tube heat exchanger and explain its various parts and their functions. [16]

3. Explain the various types of evaporators used in biotech industry. Give figures wherever possible. [16]

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

5. Derive an expression for the efficiency of fibrous filter for sterilizing air. Calculate the filter depth for 90% efficiency of removal of spores from the air(X90)when filter constant(k) is 0.42 cm−1. [16]

6. Discuss briefly the effect of turbulence on boundary layers. Under forced flow conditions, how does Prandtl number affect the relative thickness of thermal and hydrodynamic boundary layers? [16]

7. An insulated wall is to be constructed of common brick 20 cm thick, and metal lathe with plaster 2.5 cm thick, with intermediate layer of loosely packed rock wool. The outer surfaces of the brick and plaster are to be at a temperature of 600^o C and 50^o C respectively. Calculate the thickness of insulation required in order that the heat loss per square meter shall not exceed 600 kcal/hr. The conductivity of brick, rock-wool and metal lathe with plaster are 0.32, 0.045 and 0.7 k cal/m.hr.oC respectively. [16]

8. A horizontal cylinder 0.025 m diameter and 0.5 m long is suspended in water at 20^{o}C Calculate the rate of heat transfer if the cylinder surface is at 60^{o}C Use the following correlation:
   Nu = 0.53 $(\mathrm{GrPr})^{0.25}$
   The relevant physical properties of water at the mean film temperature 40^{o}Care:
   Thermal conductivity is 0.63 W/(m.K) Viscosity is 2.35 kg/h.m
   Density is 992 kg/m^3
   Pr is 4.3. [16]

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

III B.Tech II Semester Examinations,December 2010
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. Obtain an expression for the quantity of heat flow through a sphere with a neat sketch. [16]

2. What do you mean by fouling factor? What are the causes of fouling in heat exchangers. [16]

3. Using dimensional analysis show that nusselt number is a function of Reynolds number and prandlt number. [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. Describe how effective is plate heat exchanger for continuous sterilization of medium.Is plate heat exchanger useful for Batch sterilization explain? [16]

6. The two faces of a slab at x = 0 and x = L are kept at $t_1$andt_2°C respectively. The 'k' of the material is given by as a temperature dependent value by $k = k_o(t^2 - t_0^2)$ where t_0 and k_0 are constants. Deduce the expression for
   (a) heat flow/unit area and
   (b) k_{av} for this material. [16]

7. Nucleate boiling of saturated water at 4.825 M Pa is being conducted by means of a submerged brass heater producing a heat flux of 2050 kW/M^2 . Estimate the surface temperature of the heater. Thermal properties of water
   p = 968kg/m^3
   k = 0.58w/m°C
   Cp = 4180j/kg°C
   μ= 1.14x10^{-6}N.sec/m^2 [16]

8. Explain the effects of boiling point elevation and hydrostatic head on evaporator capacity. [16]

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