Roll No.

Paper Code: BT-12

Pre-PhD
FIRST SEMESTER EXAMINATION, 2016-2017
PRINCIPLES OF BIOPROCESS ENGINEERING

[Time: 3 Hours]   [Total Marks: 100]

Note: Attempt *ALL* questions. Assume suitable data, if required. All question carry equal marks.

1.   Attempt any *TWO* parts of the following: -   **(10x2)**

   (a) Justify the statement with the help of suitable examples that "Bioprocess development is an interdisciplinary challenge".
   (b) A 150 m^3 bioreactor is operated at 35°C to produce fungal biomass from glucose. The rate of oxygen uptake by the culture is 1.5 kg $m^{-3}h^{-1}$; the agitator dissipates heat at a rate of 1 kWm^{-3}. 60 m^3h^{-1} cooling water available from a nearby river at 10°C is passed through an internal coil in the fermentation tank. If the system operates at steady state and 460 kJ heat is released for each gmol oxygen consumed, what is the exit temperature of the cooling water?
   (c)   Enumerate the different system information required for scale up in bioprocess. Also discuss the various scale up criterion for microbial cell process.

2.   Attempt any *TWO* parts of the following: -   **(10x2)**

   (a)   Discuss the process of 'Kinetics of cell death'. Also justify with mathematical   expressions, that the MM Kinetics is the combination of zero order and first order reaction kinetics.
   (b)   Corn-steep liquor contains 2.5% invert sugars and 50% water; the rest can be considered solids. Beet molasses containing 50% sucrose, 1% invert sugars, 18% water and the remainder solids, is mixed with corn-steep liquor in a mixing tank. Water is added to produce a diluted sugar mixture containing 2% (w/w) invert sugars. 125 kg corn-steep liquor and 45 kg molasses are fed into the tank.
   (i) How much water is required?
   (ii) What is the concentration of sucrose in the final mixture?
   (c) Discuss in detail the method of sterilization that involves the removal of micro organism rather than their destruction with the help of their temperature & time profile.

3.   Attempt any *TWO* parts of the following: -   **(10x2)**

   (a)   A strain of *Azotobacter vinelandii* is cultured in a 15 m^3 stirred fermenter for   alginate production. Under current operating conditions k_La is 0.17 s^{-1}. Oxygen   solubility in the broth is approximately $8x10^{-3}$ kg m^{-3}. What is the maximum possible cell concentration (x_{max})? While the specific rate of oxygen   uptake is 12.5 mmol$g^{-1}h^{-1}$.
   (b)   Explain the *'Dynamic method'* for the measurement of k_La in mass transfer operation with the help of suitable diagram and mathematical expression.
   (c)   What are dimensionless groups? Discuss the dimensional homogeneity in an equation with the help of suitable examples.

4.   Attempt any ***TWO*** parts of the following:-   **(10x2)**

a) Define Log mean temperature difference (LMTD) A liquid stream is cooled from 70°C to 32°C in a double pipe heat exchanger. Fluid flowing counter-   currently with this stream is heated from 20°C to 44°C. Calculate the log mean temperature difference.

b) Differentiate between homogeneous and heterogeneous reactions. Discuss the   steady state shell mass balance with the help of suitable examples.

c) Heat is transferred from one fluid to a second fluid across a metal wall. The film coefficients are 1.2 and 1.7 $kWm^{-2}K^{-1}$. The metal is 6mm thick and has a thermal conductivity of 19 $Wm^{-1}K^{-1}$. On one side of the wall there is a scale deposit with a fouling factor estimated at 830 $Wm^{-2}K^{-1}$. What is the overall heat-transfer coefficient?

5.   Attempt any ***FOUR*** parts of the following:-   **(5x4)**

(a) Chemostat and Turbidostat

(b) Half life Period

(c) Shell & tube heat exchanger

(d) Batch Cell growth

(e) Newtonian & Non- Newtonian fluids

(f) Mass Transfer Coefficient