Registration No. :

Total number of printed pages – 2

B. Tech

PCBT 4402

Seventh Semester Examination – 2011

BIOREACTOR DESIGN AND ANALYSIS

Full Marks – 70

Time : 3 - Hours

*Answer Question No. 1 which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the following questions :   2×10

   (a)   Write down the rate equation with example.

   (b)   What are the reasons for non-ideality in the flow pattern of bioreactors ?

   (c)   What is space time and space velocity ?

   (d)   Write down the mass balance equation for plug flow reactor.

   (e)   What is the critical dilution rate ? Write down the mathematical expression for it.

   (f)   In a typical aerobic fermentation process, the diffusivity coefficient for oxygen into the fermentation broth is $8 \times 10^{-10} m^2/s$. The stagnant liquid film thickness was calculated to be 6 microns. Find the mass transfer coefficient for oxygen based on film theory.

   (g)   Differentiate between plug flow reactor (PFR) and continuous stirred tank reactor (CSTR).

   (h)   What is the function of sparger in a bioreactor ?

   (i)   Write down the relation between Q_{OUR} and Q_{SOD}.

   (j)   What is aspect ratio of a fermenter ?

P.T.O.

2. What is meant by residence time distribution (RTD) ? Describe RTD studies of ideal non-ideal flow bioreactor. 4+6

3. A 10m³ fermenter is operated continuously with feed substrate concentration $50 \, kgm^{-3}$. The microorganism cultivated in the reactor has the following characteristics : $\mu_{max} = 0.56h^{-1}$, $K_s = 0.75 \, kg/m^3$, $Y_{xs} = 0.5 \, kg \, kg^{-1}$. Maintenance requirement and product formation are negligible. 5+5

   (i) What feed flow rate is required to achieve 90% substrate conversion ?

   (ii) How does the biomass productivity at 92% substrate conversion compare with the maximum possible biomass productivity ?

4. What is plug flow reactor ? Describe the basic design principles and kinetics of PFR. 2+8

5. Write short notes on the following : 5+5

   (i) Air lift fermenter

   (ii) Programmed Reactor

6. Describe briefly the concept of design of a fermenter. What factor do you consider as essential for a successful design and operation of a fermenter ?
   μ
   4+6

7. Write short notes on the following : 5+5

   (a) Reactor stability

   (b) Biosensors

8. In a fed-batch culture operating with intermittent addition of glucose solution, values of the following parameters are given at time $t = 2h$, when the system is at quasi-steady state : 2.5×4

Culture volume (V)	= 1000 ml
Substrate concentration (S_0)	= 100 gm glucose / liter
Limiting rate constant (Ks)	= 0.1gm glucose / liter
Initial amount of biomass in the reactor (X_t^0)	= 30 gm