M.TECH/BT/3RD SEM/BIOT 6131/2020

MODELLING AND SIMULATION IN BIOPROCESS
(BIOT 6131)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Two compartment model is
(a) A type of structured model
(b) Where G component corresponds to cellular enzymes
(c) Overtly simplistic
(d) All the above

(ii) Michaelis-Menten is
(a) a deterministic model (b) a probabilistic model
(c) an empirical model (d) None of the above

(iii) Which of the following is used to grow bacterial cultures continuously?
(a) Haemostat
(b) Chemostat
(c) Bacteria cannot be grown in continuous culture
(d) Thermostat

(iv) The Modified Euler's formula is the same as
(a) Runge-Kutta formula of the first order
(b) Runge-Kutta formula of the second order with b=1
(c) Runge-Kutta formula of the second order with b= ½
(d) None of the above.

(v) Errors may occur in performing numerical computation on the computer due to
(a) rounding errors (b) power fluctuation
(c) operator fatigue (d) All of these

(vi) Which of the following is not a cell growth model?
(a) Tessier model (b) Moser model
(c) Monod model (d) Michaelis Menten model

(vii) Stochastic model takes a
(a) discrete unit perspective (b) holistic perspective
(c) deterministic perspective (d) None of the above

(viii) Continuous sterilization model is a type of
(a) unstructured model (b) deterministic model
(c) segregated model (d) probabilistic model

(ix) Penicillin is produced in _____ phase of growth
(a) lag phase (b) log phase (c) stationary phase (d) death phase

(x) Which is **not** related to the continuous culture?
(a) Substrate concentration and other conditions remain constant
(b) Cells grow at a constant fully acclimatized exponential rate
(c) It has four phase, these are lag, log, stationary and death phase
(d) All of the above.

Group – B

2. Establish a mechanistic model for action of an enzyme on a substrate in the cellular system with suitable premises.

12

3. (a) What do you understand by terms modelling and simulation?

(b) What are compartment models?

(c) Describe a three compartment model.

4 + 2 + 6 = 12

Group – C

4. In cultivation of baker's yeast in a stirred and aerated tank, lethal agents are added to the fermentation medium to kill the organisms immediately. Increase in dissolved oxygen (DO) concentration upon addition of lethal agents is followed with the aid of a DO analyzer and a recorder. Using the following data, determine the oxygen transfer coefficient ($k_l a$) for the reactor. Saturation DO concentration is C* = 9mg/L.

Time(min)	1	2	2.5	3	4	5
DO(mg/L)	1	3	4	5	6.5	7.2

12

5. A value of $k_l a = 30 h^{-1}$ has been determined for a fermenter at its maximum practical agitator rotational speed and with air being sparged at 0.5L gas/L reactor volume.min. *E. coli* with a q_{02} of 10mmol O_2/g X.h are to be cultured. The critical dissolved O_2 concentration is 0.2mg/L. The solubility of oxygen from air in the fermentation broth is 7.3mg/L at 30°C.
(i) What maximum concentration of *E.coli* can be sustained in this fermenter under aerobic conditions?
(ii) What concentration could be maintained if pure oxygen was used to sparge the reactor?

6 + 6 = 12

Group – D

6. Ethanol is being fermented in a batch reactor using *S. cerevisiae*. What will be the substrate concentration (glucose) after 12 hours of operation?
Data given,
So=100 gm/lit
Ethanol concentration after 12 hours =70gm/lit
Yx/s=0.6, Ks=2 gm/lit, Kp=97 gm/lit
Assume, ethanol is an inhibitory product and inhibits growth in non-competitive manner

12

7. In a chemostat with recycle, the feed flow rate and the culture volumes are F= 100 ml/hr and V= 1000 ml, respectively. The system is operated under glucose limitation, and yield coefficient Yx/s is 0.5 gdw cells/ gm substrate. Glucose concentration in the feed is So=10 g glucose /l. The kinetic constant of the organisms are μ_m=0.2 hr^{-1}, Ks= 1 gm glucose /l. The value of C (the ratio of cell concentration in the recycle stream to the cell concentration in the reactor effluent) is1.5. The recycle ratio α = 0.7. The system is at steady state.
(i) Find the substrate concentration in the recycle stream (s).
(ii) Find the specific growth rate (μ_{net})of the organism.
(iii) Find the cell (biomass) concentration in the recycle stream.

4 + 4 + 4 = 12

Group – E

8. Find out the value of y at x = 3 for the following differential equation using Euler's formula:
$(dy/dx) + 0.4y = 3e^{-x}$
Initial value given as y(0)=5
Use step size=1

12

9. Rate of propagation of infectious disease is given by
dx/dt=r(1-x)x
where r= rate constant for spread of infection
x= fraction of population that is infected
(1-x)=fraction of population that is uninfected.
r
Assume, Infected + Normal----------→ 2 Infected
If r=0.5, and X(0)=0.1
Find out, how much fraction of population will get infected after 15 days.
(Use Euler method with step size=3).

12

Department & Section	Submission Link
BT	https://classroom.google.com/c/MTI3MzU2MDc2MzI3/a/Mjc1NTI3NTMyNjc1/details