M.TECH/BT/3RD SEM/BIOT 6131/2021

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) Structured and segregated model solicits
(a) Multicomponent average cell description
(b) Single component heterogeneous individual cell
(c) Multicomponent, heterogeneous cell description
(d) Average cell description

(ii) What is the basic assumption in Briggs- Haldane model of enzyme substrate reaction?
(a) Rapid equilibrium
(b) Quasi steady state
(c) Substrate and inhibitor should be structurally similar
(d) None of the above.

(iii) 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

(iv) Monod model is
(a) a deterministic model (b) a probabilistic model
(c) an empirical model (d) None of the above

(v) In sterilization process, spore of which of the following organism is considered as control?
(a) Aspergillus niger (b) Bacillus subtilis
(c) Clostridium botulinum (d) Bacillus stearothermophilus

(vi) A completely mixed continuous stirred-tank reactor for the cultivation of cells is called?
(a) Turbidostat (b) Chemostat
(c) Haemostat (d) Thermostat

(vii) The chemostat and turbidostat are the types of bioreactors that are used in which of the following culture?
(a) Batch culture (b) Continuous culture
(c) Fed-Batch culture (d) Solid State culture

(viii) Which of the following equation describes the relationship between μ and residual growth limiting substrate?
(a) Eyring equation (b) Van't Hoff equation
(c) Arrhenius equation (d) Monod equation

(ix) The Iterative formula for Newton Raphson method is given by _____
(a) $x_1 = x_0 - f(x_0)/f'(x_0)$ (b) $x_0 = x_1 - f(x_0)/f'(x_0)$
(c) $x_0 = x_1 + f(x_0)/f'(x_0)$ (d) $x_1 = x_0 + f(x_0)/f'(x_0)$

(x) What do you mean by the low Ks value?
(a) Low affinity for the limiting substrate
(b) Medium affinity for the limiting substrate
(c) High affinity for the limiting substrate
(d) No affinity for the limiting substrate

Group- B

2. Derive an unstructured, non segregated model in a bioprocess. [(CO2) (Understand/LOCQ)] **12**

3. Differentiate between:- **(4 × 3) = 12**
(i) Two compartment model and three compartment model
(ii) Deterministic and stochastic models
(iii) Modelling and simulation. [(CO1,CO2) (Understand/LOCQ)]

Group - C

4. An autoclave malfunctions, and the temperature reaches only 119.5˚C. The sterilization time at the maximum temperature was 20min. The jar contains 10L of complex medium that has 10^{-5} spores/L. At121˚C k_d =1.0min $^{-1}$ and E_{0d} = 90kCal/gmol. What is the probability that the medium was sterile? [(CO3)(Analyze/IOCQ)] **12**

5. Derive a probabilistic model for a bioprocess. [(CO3)(Analyze/IOCQ)] **12**

Group - D

6. Derive a model equation relating specific growth rate of an organism with flow and cell recycle ratio and dilution rate. Is it possible that a chemostat with recycle can be operated at dilution rate higher than μ. [(CO4) (Derive/IOCQ)]

(10 + 2) = 12

7. Write and explain all the factors of the following growth models: **(6 × 2) = 12**
   i) Blackman model
   ii) Teisser model
   iii) Moser model
   iv) Contois model
   v) Logistic model
   vi) Haldane model. [(CO4) (Analyse/IOCQ)]

Group - E

8. An organism growing in a batch reactor following Monod growth model. If the cell concentration at the time of addition of inoculum is 0.1 gm/lit, then find out the cell concentration after 20 hrs of operation. Use Euler method to solve the problem. $\mu_{max} = 0.7\ hr^{-1}$, Ks = 200 gm/lit, S=100gm/lit. [(CO6) (Evaluate/HOCQ)]

12

9. Biological treatment of phenolic wastewater shows substrate inhibition governed by following equation: $\mu = \mu_{max}/(Ks + S + S^2/K_i)$ If, $\mu = 0.2\ hr^{-1}$, $\mu max = 0.7\ hr^{-1}$, Ks = 150 mg/L, Ki = 250 mg/L, then find out S by Newton -Raphson method with initial assumption of S= 45 mg/L. [(CO5) (Critique/HOCQ)]

12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	25%	50%	25%

Course Outcome (CO):

After the completion of the course students will be able to

1. Understand the basic concepts of modeling and simulation
2. Differentiate between modeling and simulation
3. Classify mathematical models into deterministic and stochastic, structured and unstructured, segregated and non-segregated models
4. Derive mathematical models for various processes in the biological system
5. Apply different numerical techniques towards simulation of bioprocesses
6. Develop mathematical models for a given bioprocess

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

Department & Section	Submission Link
BT	https://classroom.google.com/c/NDU0OTAyODgxNzc5/a/NDU0OTAyODgxODEx/details