Ref. No.: PG/FTBE/T/112A/17/2018

M.TECH (F.T.B.E) EXAMINATION, 2018

(1st Year -1st Semester)

Advanced Biochemical Engineering

Time: 3 hrs. Full Marks : 100

Part-I [Answer any three questions, Marks 50]

1. Draw a neat diagram of an industrial fermenter showing all of its essential parts and specify their individual function. What are the important features a good fermenter should have for better yield of product ? Name the various types of bioreactors which are used for industrial production of products. (16)

2. (a) Write down the equation which is followed to evaluate the death of microbial cell (kinetic equation for cell death) during sterilization. What is the importance for evaluating the activation energy from Arheneus Equation ?

   (b) The initial cell count pre sterilization is 10^4 cells / ml and the media volume is 10,000 liters. The heating from 100 to 121^{0}C (the holding temperature) takes 15 mins and cooling down to 100^{0}C takes 20 mins. Calculate the holding time. N_f is chosen typically as 0.0001 which implies that the probability of one cell surviving post sterilization is 1/10000 (one cell will survive the sterilization process) (refer table below)

   (4 + 12)

3. Write short notes on (any two): (8 x 2)

   i) Media design and its importance in fermentation industries

   ii) Fermentative production of glutamic acid

   iii) Operation and working principle of a Chemostat

   iv) Electrodialysis – its working principle and capability for purification of biomolecules

4. (a) Define the men generation time of an organism. How will you determine the length of the lag phase of the growth of a microbial culture

   (b) A glucose ammonium salt medium was inoculated with $5x10^5$ cells of *E.coli*. After 300 minutes the culture was still in exponential growth phase with a population of $35x10^6$ cells. the mean generation time of the organism of the medium is 40 mins. Determine whether or not a lag phase was manifested and if so , its duration in minutes. (8 + 8)

5. State how immobilized enzymes are prepared and show with the help of diagram how they are used as biocatalyst to transform reactants to products. State with diagram how enzymes are purified using molecular sieve technique. Compare native and immobilized enzyme stating advantages and disadvantages with respect to their activities. (16)

6. (a) Derive Michaelis –Menten equation for an enzyme catalyzed reaction. What was the modification suggested in Lineweaver-Burk plot for calculating k_m value more accurately.

   (b) The D-Serine-dehydratase of *Neurospora crassa* has been shown to require pyridoxal phosphate as co-enzyme.

   The enzyme catalyzes the reaction : $CH_2OH.CHNH_2.COOH \rightarrow CH_3.CO.COOH + NH_3$

Contnd...P/2

The following figure was obtained in an experiment to determine the pyridoxal phosphate saturation curve of the enzyme:

Micromole pyruvic acid produced in 20 mins	**pyridoxal phosphate conc. x 10^5 (M)**
0.150	0.0
0.200	0.2
0.275	0.85
0.315	1.25
0.340	1.70
0.350	2.00
0.360	8.00

Using these data determine the apparent Michaelis constant for the serine dehydratase with respect to pyridoxal phosphate. (8+8)

Refer: Q no. 2 (b)

Table

T(°C)	k (min.⁻¹)	$\nabla_{heating/cooling}$
100	0.019	—
101	0.025	0.044
102	0.032	0.076
103	0.040	0.116
104	0.051	0.168
105	0.065	0.233
106	0.083	0.316
107	0.105	0.420
108	0.133	0.553
109	0.168	0.720
110	0.212	0.932
111	0.267	1.199
112	0.336	1.535
113	0.423	1.957
114	0.531	2.488
115	0.666	3.154
116	0.835	3.989
117	1.045	5.034
118	1.307	6.341
119	1.633	7.973
120	2.037	10.010
121	2.538	12.549
122	3.160	15.708
123	3.929	19.638
124	4.881	24.518
125	6.056	30.574
126	7.506	38.080
127	9.293	47.373
128	11.494	58.867
129	14.200	73.067
130	17.524	90.591

Ref. No.: Ex/PG/FTBE/T/112A/2018

M.TECH. FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING FIRST YEAR FIRST SEMESTER – 2018

Subject: ADVANCED BIOCHEMICAL ENGG

Time: 3hours **Full Marks: 100**

Part-II

Use Separate Answer scripts for each Group

Answer any one question from Group A and any two from Group B **10+20×2 = 50**

Group-A

1. (a) Classify microbial products depending on the growth association.
   (b) A strain of mold was grown in a batch culture on glucose and the following data were obtained:

Time (h)	0	9	16	23	30	34	36	40
Cell concentration (g/l)	1.25	2.45	5.1	10.5	22	33	37.5	41
Glucose concentration (g/l)	100	97	90.4	76.9	48.1	20.6	9.38	0.63

   (a) Calculate the maximum net specific growth rate
   (b) Calculate the apparent growth yield
   (c) What maximum cell concentration could one expect if 150g of glucose were used with the same size inoculums? 3+7 = 10

2. (a) Briefly describe different structured and unstructured growth models.
   (b) In a chemostate with cell recycle, the feed flow rate and culture volume are F = 100ml/h and V = 1000ml, respectively. The system is operated under glucose limitation and the yield coefficient $Y_{X/S}$ is 0.5 gdw cells /g substrate. Glucose concentration in the feed is S_0 = 10 g glucose/l. The kinetic constants of the organisms are $\mu_m = 0.2h^{-1}$, K_s = 1.0 g glucose/l. The value of C is 1.5 and the recycle ration is α= 0.7. The system is at stead state.
   (i) Find the substrate concentration in the recycle stream (ii) Find the specific growth rate of the microorganism (iii) Find the cell mass concentration in the recycle stream (iv) Find the cell concentration in the centrifuge effluent. 4+6 = 10

Group-B

3. (a) Briefly describe the time temperature profile and design calculation for batch media sterilization.

   (b) A medium in a fermentor is sterilized batchwise at 120^0C. The temperature time profile observed with a recorder attached to the fermentor is as follows:

t (min)	0	10	30	36	43	50	55	58	63	70	102	120	140
T (^{0}C)	30	50	90	100	110	120	120	110	100	90	60	44	30

   Assuming that the specific denaturation rate of contaminating bacterial spores, $k = 7.94 \times 10^{38} \exp\left(-\frac{68.7\times10^3}{RT}\right) min^{-1}$ and the initial number of spores, $N_0 = 6 \times 10^{12}$, calculate the sterility level after sterilization. 8+12 = 20

4. (a) Briefly describe the aerosol particles collection mechanism by fibrous media.

   (b) Air at 20^0C will be assumed to contain 10^4 particles (1μ in size) / m^3. This dilute aerosol is to be filtered through a bed of glass fibers (d_r=19μ and α=0.033) at an air velocity, v_s = 5cm/sec. Calculate the relation between bed length, L, and overall collection efficiency, η of the filter. (Given: $\eta_0 N_R N_{Pe} = 15$ and air velocity is far less than critical velocity). 5+15= 20

5. (a) The flowing data is given for an activated sewage treatment plant:

   Flow rate of raw sewage, F = 320,000 m3/day; Flow rate of excess sludge. F_{ex} = 6700 m^3/day; Working volume of the aeration tank, V = 68000m^3; Recycle ration, ώ = 0.197; Concentration of microorganism, X = 21,000 / ml; concentration of microbe in effluent from separator, X_0 = 52 /ml.

   Estimate the value of specific growth rate.

   (b) Present the mass balance equations in a series of reactor under steady state condition.

   10+10 = 20