

B.E. CHEMICAL ENGINEERING FOURTH YEAR SECOND SEMESTER EXAM 2024
BIOENERGETICS & BIOPROCESS ENGINEERING

Time: 3 hours

Full Marks: 100

Answer all questions

Q. No.	CO No.		Marks																											
1.	1.	<p>a) Derive the rate equation for a homogeneous enzyme-catalysed reaction using Briggs-Halden theory. What is its basic difference with Michaelian concept?</p> <p>b) Briefly describe the uncompetitive inhibition kinetics.</p> <p>c) The following data have been obtained from an enzyme catalyzed reaction using enzyme concentration ($[E_0] = 0.00875 \text{ g/l}$).</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Substrate concentration, $[s](\text{g/l})$</td> <td>30</td> <td>20</td> <td>10.7</td> <td>8.0</td> <td>5.0</td> </tr> <tr> <td>Rate of reaction, $\gamma[\text{g}/(\text{l}\cdot\text{min})]$</td> <td>0.87</td> <td>0.71</td> <td>0.51</td> <td>0.41</td> <td>0.30</td> </tr> </table> <p>Estimate using Hanes-Woolf plot: 1) Forward reaction velocity (V_m), 2) Michaelis-Menten constant (K_m), and 3) Rate constant (k_2).</p>	Substrate concentration, $[s](\text{g/l})$	30	20	10.7	8.0	5.0	Rate of reaction, $\gamma[\text{g}/(\text{l}\cdot\text{min})]$	0.87	0.71	0.51	0.41	0.30	5+5+5=15															
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2.	2.	<p>a) What are the advantages and disadvantages of enzyme immobilization?</p> <p>b) Derive Thiele modulus using diffusional effects in enzymes immobilized in a porous matrix.</p> <p>c) Write the definitions and significances of the Thiele modulus and Effectiveness Factor and plot the graphs of Effectiveness Factor vs Thiele modulus and particle radius.</p>	3+7+5=15																											
3.	3.	<p>a) Describe briefly with the help of a neat sketch the various section of cell growth curve.</p> <p>b) In his (Monod) thesis which was published Monod was proposed equation with his name. As experimental support for this equation from his presented results from 4 batch reactor run on the growth of a pure bacteria culture in a lactose solution. One of his runs produced:</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>Time(hr)</td> <td>0</td> <td>0.54</td> <td>0.90</td> <td>1.23</td> <td>1.58</td> <td>1.95</td> <td>2.33</td> <td>2.70</td> </tr> <tr> <td>$C_A(\text{mg}\cdot\text{L}^{-1})$</td> <td>147</td> <td>125</td> <td>104</td> <td>70</td> <td>38</td> <td>18</td> <td>3</td> <td>1</td> </tr> <tr> <td>$C_C(\text{mg}\cdot\text{L}^{-1})$</td> <td>15.5</td> <td>23</td> <td>30</td> <td>38.8</td> <td>48.5</td> <td>68.3</td> <td>61.3</td> <td>62.5</td> </tr> </table> <p>Fit the Monod equation to this data.</p>	Time(hr)	0	0.54	0.90	1.23	1.58	1.95	2.33	2.70	$C_A(\text{mg}\cdot\text{L}^{-1})$	147	125	104	70	38	18	3	1	$C_C(\text{mg}\cdot\text{L}^{-1})$	15.5	23	30	38.8	48.5	68.3	61.3	62.5	10+5=15
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P.T.O.

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4.	4.	<p>a) Derive unstructured logistic model equation for batch growth of cells.</p> <p>b) Derive the optimum cell concentration using MFR, $C_{C,opt} = Y_{C/A} [C_{A0} - \frac{C_{A0}}{1+N}]$, where $N = \sqrt{1 + \frac{C_{A0}}{K_S}}$, and $Y_{C/A}$ = Yield of cell concentration.</p>	5+10=15
5.	5.	<p>a) Describe the mechanical and non-mechanical methods of cell disruption.</p> <p>b) E-coli lives and grows on manitol (Carbon-source) with the following kinetics. $r_c = \frac{1.2 C_A C_C}{2+C_A} \text{g cell. m}^{-3} \cdot \text{h}^{-1}$ with $Y_{C_C/C_A} = 0.1 \text{ g cell/g manitol}$.</p> <p>Find the outlet concentration of cells produced when 2.5 m³/h of manitol solution ($C_{A0} = 5 \text{ g/m}^3$) is fed directly to a MFR of volume 0.75 m³. And draw the reactor scheme if the reactor volume is 0.85 m³.</p>	10+5=15
6.	6.	<p>a) What is a chemostat?</p> <p>b) Derive the performance equation of batch reactor in terms of cell formation.</p> <p>c) Briefly explain the sterilization of the reactors.</p> <p>d) Briefly write the design and operation of a typical aseptic, aerobic fermentation process.</p> <p>e) How cell grows?</p> <p>f) Write the Monod equation with the meanings of all symbols?</p>	2+3+3+5+1 +1=15
7.		<p>a) What do you mean by allosteric binding of enzyme?</p> <p>b) What is the cross-linking of enzyme?</p> <p>c) What is the microencapsulation of enzyme?</p> <p>d) Why commercial fermentation vessels are usually constructed from stainless steel?</p>	4+2+2+2 =10