

## B.E. CHEMICAL ENGINEERING FOURTH YEAR SECOND SEMESTER

## SUPPLEMENTARY EXAM 2024

## BIOENERGETICS &amp; 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-catalyzed reaction using the rapid equilibrium assumption.</p> <p>c) The following data have been obtained from an enzyme catalyzed reaction using enzyme concentration (<math>[E_0] = 0.00875 \text{ g/l}</math>).</p> <table border="1"> <tr> <td>Substrate concentration, <math>[s](\text{g/l})</math></td> <td>40</td> <td>30</td> <td>20.7</td> <td>18.0</td> <td>15.0</td> </tr> <tr> <td>Rate of reaction, <math>\gamma[\text{g}/(\text{l}\cdot\text{min})]</math></td> <td>0.97</td> <td>0.81</td> <td>0.61</td> <td>0.51</td> <td>0.40</td> </tr> </table> <p>Estimate using the Lineweaver-Burk plot plot: 1) Forward reaction velocity (<math>V_m</math>), 2) Michaelis-Menten constant (<math>K_m</math>), and 3) Rate constant (<math>k_2</math>).</p>	Substrate concentration, $[s](\text{g/l})$	40	30	20.7	18.0	15.0	Rate of reaction, $\gamma[\text{g}/(\text{l}\cdot\text{min})]$	0.97	0.81	0.61	0.51	0.40	10+5=15															
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Rate of reaction, $\gamma[\text{g}/(\text{l}\cdot\text{min})]$	0.97	0.81	0.61	0.51	0.40																									
2.	2.	<p>a) Explain the different methods of enzyme immobilization?</p> <p>b) Briefly describe the competitive inhibition kinetics.</p>	10+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"> <tr> <td>Time (h)</td> <td>0</td> <td>0.64</td> <td>0.95</td> <td>1.33</td> <td>1.68</td> <td>1.95</td> <td>2.43</td> <td>2.80</td> </tr> <tr> <td><math>C_A(\text{mg}\cdot\text{L}^{-1})</math></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><math>C_C(\text{mg}\cdot\text{L}^{-1})</math></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 (h)	0	0.64	0.95	1.33	1.68	1.95	2.43	2.80	$C_A(\text{mg}\cdot\text{L}^{-1})$	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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4.	4.	<p>a) Derive the optimum cell concentration using MFR,</p> $C_{C,opt} = Y_{C/A} [C_{A0} - \frac{C_{A0}}{1+N}], \text{ where } N = \sqrt{1 + \frac{C_{A0}}{K_S}}, \text{ and } Y_{C/A} =$ <p>Yield of cell concentration.</p> <p>b) E-coli lives and grows on manitol with following kinetics,</p> $r_c = 1.5 \frac{C_A C_C}{2 + C_A}$ <p>where, <math>C_A =</math> g manitol / <math>m^3</math> and <math>Y_{C/A} = 0.15</math> g cell / g manitol. Find the outlet concentration of cells produced when 2 <math>m^3/h</math> of manitol solution (<math>C_{A0} = 6</math> g / <math>m^3</math>) is fed directly to a MFR of volume 0.95 <math>m^3</math>. Draw the reactor scheme if the reactor volume is 0.95 <math>m^3</math> instead of 5.0 <math>m^3</math>.</p>	15+10=25
5.	5.	<p>a) Describe the non-mechanical methods of cell disruption.</p> <p>a) Explain electrical cell quantification?</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) Explain the fermentation process with schematic diagram.</p> <p>d) Briefly explain the sterilization of the reactors.</p>	2+5+5+3=15