Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

IISEMESTER M.TECH (INDUSTRIAL BIOTECHNOLOGY)

END SEMESTER EXAMINATIONS, MAY 2016 (REGULAR)

BIO502- BIOREACTOR DESIGN AND ANALYSIS

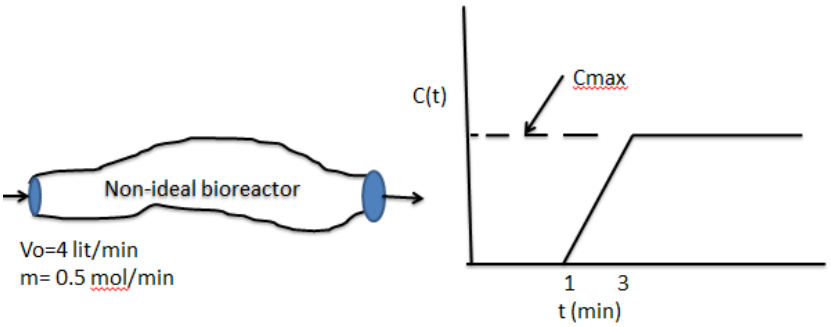
Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** the questions.
- Missing data may be suitable assumed.

1A.	Write on the physical significance of various dimensionless numbers that are used in estimating (i) External Mass transfer effects (ii) Internal mass effects (ii) Simultaneous internal and external mass transfer effects.	**5**
1B.	Isomerization of Glucose to Fructose by immobilized glucose isomerase was carried out in a fixed bed bioreactor. The enzyme was immobilized on non-porous glass beads of 2mm diameter. The substrate (S_0=2 M) is pumped from the bottom of the reactor at volumetric flow rate of 8ml/min. At this flow rate Damkholar number obtained as 1.25. The intrinsic rate without mass transfer resistance is obtained as 0.085 M/min. Find the film effectiveness factor in the above reaction system. Data: Vmax=0.0281 M/min, Km=0.231 M	**5**
2A.	What do you mean by constant feed policy in continuous reactors? Develop a mathematical model for predicting time course profiles of conversion for enzyme immobilized in non-porous glass beads with M-M kinetics in CSTR. Explain how this model is industrially useful.	**6**
2B.	What are the advantages of Recycle in a Chemostat. Prove that recycle reactor can be operated at higher dilution rate without fear of washout	**4**

<table>
<tr><td>3A.</td><td>The data Shown below are the fractional conversions of substrate(X) obtained for the hydrolysis of benzoyl-arginine ethyl ester (BAEE) by the enzyme ficin immobilized to CM-.cellulose. The immobilized enzyme was packed in a column (plug-flow) reactor, and the data were obtained for different flow rates (V_0) through the column, and substrate concentrations (So). Estimate the Michaelis constant for the hydrolysis of BAEE. State any assumptions you must make, and explain the trend shown by the three sets of data.
<table>
<tr><td>V_0 (ml/hr)</td><td colspan="5">Substrate Concentration ,So (mM)</td></tr>
<tr><td></td><td>2.0</td><td>6.0</td><td>20.0</td><td>33.0</td><td>55.0</td></tr>
<tr><td>40</td><td>X=0.36</td><td>0.33</td><td>0.26</td><td>0.22</td><td>0.16</td></tr>
<tr><td>80</td><td>X=0.30</td><td>0.27</td><td>0.17</td><td>0.13</td><td>0.095</td></tr>
<tr><td>140</td><td>X=0.27</td><td>0.22</td><td>0.12</td><td>0.087</td><td>0.061</td></tr>
</table></td><td>6</td></tr>
<tr><td>3B</td><td>Consider a 1000 liter Chemostat in which biomass is being produced with glucose as the substrate. The microbial system follows a Monod relationship with μ_m = 0.4 h^{-1}, K_S = 1.5 g/l, and the yield factor $Y_{x/s}$=0.5. If normal operation is with a sterile feed containing 10 g/l glucose at a rate of 100 liter/h: What is the specific biomass production rate (g/l-h) at steady state? If recycle is used with a recycle stream of 10 l/h and a recycle biomass concentration five times as large as that in the reactor exit, what would be the new specific biomass production rate?</td><td>4</td></tr>
<tr><td>4A.</td><td>Write the controllability matrix for Chemostat reactor system with cell cultures? Describe the designing of P-controller for Turbidostat operation? Derive the expression for steady state gain and discuss the effect of dilution rate on gain?</td><td>5</td></tr>
<tr><td>4B.</td><td>Consider that you have been working with Chemostat system where cell growth follows the substrate inhibition kinetics. Write the conditions for obtaining positive and negative real parts of Eigen values. Explain how to construct operating diagram which distinguishes between stable and unstable regions for substrate inhibition kinetics.</td><td>5</td></tr>
<tr><td>5A.</td><td>Write the possible input, out, Manipulated variables during the controlling of Biological waste water treatment process (Activated sludge). Write the various steps that are to be followed while designing the controller for above process.</td><td>4</td></tr>
<tr><td>5B.</td><td>A step input to a non-ideal bioreactor gives the results shown the following fig. If the data is consistent determine: (i)Bioreactor volume (V) (ii) Mean residence time (iii) F-curve (iv) E-curve</td><td>6</td></tr>
</table>

		
6A.	Differential between E & F -curves? Describe the various input tracer signals used in RTD experiment. Write the desirable characteristics of RTD tracer materials	**5**
6B	Write on following operating issues that affects the designing of bioreactor i. Foaming. ii. Cleaning and sterility.	**5**