

**M.TECH FOOD TECHNOLOGY AND BIO-CHEMICAL ENGINEERING**  
**FIRST YEAR FIRST SEMESTER EXAM 2025**  
**FERMENTER DESIGN, CONTROL AND OPTIMIZATION**

Time: 3 hrs

Full Marks: 100

**Part-1**  
**Group-A**

Answer any one question

1×10 = 10

1. Write the material balance equations for cell mass, substrate concentration and product in a series of CSTR.
2. Write short note on  $k_{La}$  measurement process by dynamic method. What are the different resistances of oxygen transfer in fermentation broth?

**Group-B**

Answer any two questions

2×20 = 40

3. (a) Write the effect of different parameters on  $k_{La}$  values.  
 (b) In cultivation of Bakers yeast in a stirred and aerated tank, lethal agents are added to the fermentation medium to kill the organisms immediately. Increase in DO concentration upon addition of lethal agents is followed with the aid of a DO analyzer and a recorder. Using the following data, determine the oxygen transfer coefficient for the reactor. Saturated DO concentration is 9 mg/l.

|            |   |   |     |   |     |     |
|------------|---|---|-----|---|-----|-----|
| Time (min) | 1 | 2 | 2.5 | 3 | 4   | 5   |
| DO (mg/l)  | 1 | 3 | 4   | 5 | 6.5 | 7.2 |

8+12 = 20

4. (a) Define power number and aeration number. How power number is related with Reynolds number.  
 (b) Dimensions of a fermentor equipped with two sets of standard flat blade turbines and four baffle plates are:  
 Fermentor diameter = 3m  
 Impeller diameter = 1.5m  
 Baffle plate width = 0.3m  
 Liquid depth = 5m  
 The viscosity and the density of the broth are 1200 kg/m<sup>3</sup> and 0.02 kg /m.sec  
 Rotation speed of impellers and aeration rate are 60 rpm and 0.4vvm respectively.  
 Calculate power required for ungassed system and power required for aerated system.

8+12 = 20

5. (a) What are the different scale up criterion of fermenter?  
 (b) A stirred tank reactor is to be scaled down from 10m<sup>3</sup> to 0.1 m<sup>3</sup>. The dimensions of the large tank are:  $D_t = 2m$ ;  $D_i = 0.5m$ ;  $N = 100$  rpm.

[ Turn over

- (iii) Determine the dimensions of the small tank ( $D_t$ ,  $D_i$ ,  $H$ ) by using geometric similarity.
- (iv) What would be the required rotational speed of the impeller in the small tank if the following criteria were used?
- Constant tip speed
  - Constant impeller Re number.
- 8+12 = 20

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**Part – II**[Answer any four questions,  $12.5 \times 4 = 50$  ]]

1. What are the materials of construction used for fabrication of fermenter tubings. What do you mean by 'set point' and 'deadband' in reference to pH controller? Name the acid and alkali which are generally recommended for pH control in a fermentation. How would you sterilize inlet air for a fermenter having capacity less than 5lit? Name two types of DO sensors. What are 'thermistors' and 'RTD'? 2+2.5+2+2+1+3
2. Name different types of sparger, commonly used in fermenters. With a neat sketch show the design of any one type of agitator commonly used in fermenters. Why baffles are used in fermentation vessel? What do you mean by 'vvm' ? What do you mean by 'CIP'? What is the function of condenser used with fermenters? 2+3+2+2+2+1.5
3. With the help of neat sketch explain the function of pH controller . Why foam is generated during fermentation and why do we require to control it? Name one chemical anti-foaming agent. Explain the principle of action of any one type of DO controller. 4+3+1+4.5
4. What is 'LDO sensor'? Write short note on : fluidized bed bioreactor Mention applications of membrane bioreactor . What is 'draft tube' ? Give example of applications of each of packed bed bioreactor , photobioreactor 2+3.5+2+2+3
5. Write the advantages and disadvantages of air lift bioreactors . Mention some applications of Air Lift Bioreactor. With neat sketch explain the mechanism of action in a bubble column bioreactor. What are 'down comer' and 'riser' in air lift bioreactor? 3+2+4.5+3