**Printed page: 03….** **Subject Code: AMTBT0102**

**Roll No:** | | | | | | | | | | | | | |

**NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA**

**(An Autonomous Institute Affiliated to AKTU, Lucknow)**

**MASTER OF TECHNOLOGY (M. Tech)**

**(SEM: First, Theory Examination (2020-2021)**

**SUBJECT NAME: BIOPROCESS ENGINEERING & TECHNOLOGY**

**Time: 3 Hours** **Max. Marks:70**

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**General Instructions:**

- All questions are compulsory. Answers should be brief and to the point.
- This Question paper consists of ...03.....pages & ...8.....questions.
- It comprises of three Sections, A, B, and C. You are to attempt all the sections.
- Section A -Question No- 1 is objective type questions carrying 1 mark each, Question No- 2 is very short answer type carrying 2 mark each. You are expected to answer them as directed.
- Section B - Question No-3 is Long answer type -I questions with external choice carrying 4marks each. You need to attempt any five out of seven questions given.
- Section C - Question No. 4-8 are Long answer type –II (within unit choice) questions carrying 7 marks each. You need to attempt any one part *a* or *b.*
- Students are instructed to cross the blank sheets before handing over the answer sheet to the invigilator.
- No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.

**SECTION – A**

**1. Answer all the parts-** **[5x1=5]** **CO**

**a.** During fluid mixing in bioreactors, which of the following is considered as the slowest step? **(1)** **CO1**

i. Diffusion
ii. Dispersion
iii. Distribution
iv. Eddy formation

**b.** For a microbial culture, if the doubling time is 0.231h, the maximum growth rate will be (assume the endogenous metabolism is negligible): **(1)** **CO2**

i. 3.0 $h^{-1}$
ii. 2.5 $h^{-1}$
iii. 1.0 $h^{-1}$
iv. 0.3 $h^{-1}$

**c.** Levels of the primary metabolites in the cells are regulated by **(1)** **CO3**

i. Feedback Inhibition
ii. feedback repression
iii. Energy charge
iv. All the above

| | | | |
|---|---|---|---|
| **d.** | Suppose the fermentation broth contains more than one component. Then for successful extraction operation, the selectivity coefficient should be:<br>i. 0<br>ii. 1<br>iii. <1<br>iv. >1 | **(1)** | **CO4** |
| **e.** | Which of the following methods of cell disruption would be suitable for recovery of extracellular products?<br>i. Ultrasonication<br>ii. Ball mill<br>iii. Enzymatic<br>iv. None of the above | **(1)** | **CO5** |

**2. Answer <u>all</u> the parts-** **[5×2=10]** **CO**

| | | | |
|---|---|---|---|
| **a.** | What is cryptic growth? | **(2)** | **CO1** |
| **b.** | Define apparent growth yield coefficient for bacteria. | **(2)** | **CO2** |
| **c.** | List the steps involved in transfer of $O_2$ from gas bubble to the cell in fermenter. | **(2)** | **CO3** |
| **d.** | Define the role of "filter aids" in filtration of fermentation broth | **(2)** | **CO4** |
| **e.** | Differentiate simultaneous and sequential product formation. | **(2)** | **CO5** |

## SECTION – B

**3. Answer any <u>five</u> of the following-** **[5x4=20]** **CO**

| | | | |
|---|---|---|---|
| **a.** | What are the component parts of the fermentation process? Discuss briefly with proper schematic of a bioreactor. | **(4)** | **CO1** |
| **b.** | Backer yeast biomass is dried from 14% total solids to 93% total solids. What is the product yield from each 1000 kg of raw yeast biomass assuming that 8% by weight of the original potatoes is lost in peeling? | **(4)** | **CO2** |
| **c.** | Define bioenergetics. What is the role of bioenergetics in biochemical engineering? | **(4)** | **CO2** |
| **d.** | A fermentation broth with viscosity $10^{-2}$ *Pas* and density 1000 $kg\ m^{-3}$ is agitated in a 2.7 $m^3$ baffled tank using a Rushton turbine with diameter 0.5 m and stirred speed 1 $s^{-1}$. Estimate the mixing time. | **(4)** | **CO3** |
| **e.** | Write general mass and energy balance equations for a system. Discuss the steps involved in solving simple mass balance problems in bioprocess. | **(4)** | **CO3** |
| **f.** | Discuss (i) aerobic and (ii) anaerobic fermentation in details. List the major differences in aerobic and anaerobic fermentation. | **(4)** | **CO4** |
| **g.** | What is the principle of chromatography? Define the Scaling-up chromatography. | **(4)** | **CO4** |

## SECTION – C

**4 Answer any one of the following-** **[5×7=35]** **CO**

**a.** Discuss any two methods of $K_La$ estimation in bioreactors, in details. **(7)** **CO1**

**b.** Discuss some of the commonly used bioreactors in fermentation industry. Also, differentiate solid state and submerged fermentation. **(7)** **CO1**

**5. Answer any one of the following-**

**a.** Assume that experimental measurements for a certain organism have shown that cells can convert two-thirds (wt/wt) of the substrate carbon (alkane) to biomass. The biological reaction is given below: **(7)** **CO2**

Hexadecane: $C_{16}H_{34} + a\ O_2 + b\ NH_3 \longrightarrow c(C_{4.4}H_{7.3}N_{0.86}O_{1.2}) + d\ H_2O + e\ CO_2$

(i) Calculate the stoichiometric coefficients
(ii) Calculate RQ
(iii) Calculate the yield coefficients YX/S (g dw cell/g substrate), YX/O2 (g dw cell/g O2) for above reaction.

**b.** Corn-steep liquor contains 2.5% invert sugars and 50% water; the rest can be considered solids. Beet molasses containing 50% sucrose, 1% invert sugars, 18% water and the remainder solids, is mixed with corn-steep liquor in a mixing tank. Water is added to produce a diluted sugar mixture containing 2% (w/w) invert sugars. 125 kg corn-steep liquor and 45 kg molasses are fed into the tank. **(7)** **CO2**

(i) How much water is required?
(ii) What is the concentration of sucrose in the final mixture?

**6. Answer any one of the following-**

**a.** What do you understand by the term "contamination in bioprocess?" What are the possible sites and consequences of contamination in a fermenter? List the various steps require for avoiding contamination. Expand the terms SIP and CIP. **(7)** **CO3**

**b.** Discuss the process for industrial production of backer's yeast in details. Also, represent the entire process in process flow/block diagram. **(7)** **CO3**

**7. Answer any one of the following-**

**a.** What are the critical parameters that are to be controlled for industrial production of metabolites through suspended fermentation? Discuss is details with schematic diagram(s). **(7)** **CO4**

**b.** Recombinant *E. coli* was used for industrial production of intercellular metabolite (Protein). Discuss the methodology used for recovery and purification of the desired protein from fermentation broth. **(7)** **CO4**

**8. Answer any one of the following-**

**a.** Discuss the theory of filtration of fermentation broth. What are rotatory vacuum filters? Discuss the mechanism of filtration for rotatory vacuum filters. **(7)** **CO5**

**b.** Discuss the process of adsorption and its operations in detail. **(7)** **CO5**