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| <b>B.E / B.TECH. DEGREI</b>  | E EX   | XAM1   | INA   | TI   | ON  | , M  | AY  | 202  | 23   |   |  |   |
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|  |  |  | • 4 1   |  |   |  | c   |  |  | MA  | KK   | 5: 100  |
| <ol> <li>Examine the factors involved in oxygen m</li> <li>Apply selection criteria with respect to bio</li> <li>Interpret the stoichiometry and energetics</li> </ol> | ass troisection  | ansfer<br>or con   | in bio<br>sidera<br>orma  | orea<br>ation<br>tion  | ctors<br>in e<br>mec  | s<br>enzy<br>liate   | me s<br>d by  | yste<br>cell   | ems<br>grov  |   | s  |   |
| PART- A  | (10 x  | 2 = 20   | ) Ma  | rks)   | )   |  |   |  |  |   |  |   |
| (Answ  | er all   | Quest  | ions)   |  |   |  |   |  |  |   |  |   |
|  |  |  |   |  |   |  |   |  |  | CO  |  | RBT<br>LEVEL  |
| Comment on the rheological properties of fe  | erme   | ntatior  | med   | lium   | l <b>.</b>  |  |   |  |  | 1   |  | 2   |
| During the operations of a microbial fer   | ment   | ations   | a p   | rote   | inac  | eou  | s m   | ater   | ial  | 1   |  | 2   |
| released into the medium by the cells forming  | ng fr  | oth. He  | ow do   | o yo   | u co  | ntro   | l the   | e foa  | ım   |   |  |   |
| formation?   |  |  |   |  |   |  |   |  |  |   |  |   |
| Deduce the equation for studying specific g  | rowt   | n rate o   | of mi   | crob   | oial o  | cells  |   |  |  | 2   |  | 3   |
| Calculate the respiratory quotient for the give  | ven e  | quatio   | n:  |  |   |  |   |  |  | 2   |  | 5   |
| $C_6H_{12} O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$   |  |  |   |  |   |  |   |  |  |   |  |   |
| List out the design considerations for the flu   | iidise   | ed bed   | react   | or.  |   |  |   |  |  | 3   |  | 3   |
| Outline the sterilization design criterion: De   | el fac   | tor.   |   |  |   |  |   |  |  | 3   |  | 4   |
| List the agitation parameter which acts as so important?   | cale ı   | ip fact  | ors ai  | nd w   | v <b>hy</b> i   | is thi   | is  |  |  | 4   |  | 2   |
| Rate of oxygen consumption by the cells of   | leter  | nines  | the ra  | ate o  | of o  | xyge   | en tr   | ansf   | fer  | 4   |  | 2   |
| from gas to broth. Mention few factors wl aerobic fermentation process.  | nich   | influer  | ices t  | he c   | oxyg  | gen o  | lem   | and  | in   |   |  |   |
| acrobic refinentation process.   |  |  |   |  |   |  |   |  |  |   |  |   |
|  | <b>B.E / B.TECH. DEGREI</b><br>Fif<br><b>BT18501- BIOPR</b><br>( <i>Bia</i><br><b>CReg</b><br><b>ME: 3 HOURS</b><br>1 Select different operation modes according<br>Examine the factors involved in oxygen m<br>3 Apply selection criteria with respect to bio<br>4 Interpret the stoichiometry and energetics<br>5 Accomplish knowledge about the fundame<br><b>PART-A</b><br>(Answer<br>Comment on the rheological properties of for<br>During the operations of a microbial fer<br>released into the medium by the cells formin<br>formation?<br>Deduce the equation for studying specific g<br>Calculate the respiratory quotient for the giv<br>$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$<br>List out the design considerations for the flu<br>Outline the sterilization design criterion: De<br>List the agitation parameter which acts as so<br>important?<br>Rate of oxygen consumption by the cells of<br>from gas to broth. Mention few factors with | <b>B.E. / B.TECH. DEGREE EX</b><br>Fifth Se<br><b>BT18501- BIOPROC</b><br>( <i>Biotech</i><br>( <b>Regulati</b> )<br><b>ME: 3 HOURS</b><br>1 Select different operation modes according to ap<br>2 Examine the factors involved in oxygen mass tr<br>3 Apply selection criteria with respect to bioreact<br>4 Interpret the stoichiometry and energetics of pro<br>5 Accomplish knowledge about the fundamentals<br><b>PART- A (10 x</b><br>(Answer all)<br>Comment on the rheological properties of ferment<br>released into the medium by the cells forming fro<br>formation?<br>Deduce the equation for studying specific growth<br>Calculate the respiratory quotient for the given e<br>$C_{6}H_{12} O_{6} + 6O_{2} \rightarrow 6CO_{2} + 6H_{2}O$<br>List out the design considerations for the fluidised<br>Outline the sterilization design criterion: Del fac<br>List the agitation parameter which acts as scale w<br>important?<br>Rate of oxygen consumption by the cells detern<br>from gas to broth. Mention few factors which i | <b>BE / B.TECH. DEGREE EXAMI</b><br>Fifth Semester<br><b>BT18501- BIOPROCESS F</b><br><i>(Biotechnology,</i><br><b>(Regulation 20)</b><br><b>ME: 3 HOURS</b><br>1 Select different operation modes according to appropri-<br>2 Examine the factors involved in oxygen mass transfer<br>3 Apply selection criteria with respect to bioreactor conse<br>4 Interpret the stoichiometry and energetics of product ff<br>5 Accomplish knowledge about the fundamentals of mo<br><b>PART- A (10 x 2 = 20)</b><br>(Answer all Quest<br>Comment on the rheological properties of fermentations,<br>released into the medium by the cells forming froth. Ho<br>formation?<br>Deduce the equation for studying specific growth rate of<br>Calculate the respiratory quotient for the given equation<br>$C_6H_{12} O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$<br>List out the design considerations for the fluidised bed<br>Outline the sterilization design criterion: Del factor.<br>List the agitation parameter which acts as scale up facto<br>important?<br>Rate of oxygen consumption by the cells determines of<br>from gas to broth. Mention few factors which influent | <b>B.E</b> / <b>B.TECH. DEGREE EXAMILA</b><br>Fifth Semester<br><b>BT18501- BIOPROCESS ENG</b><br>( <i>Biotechnology</i> )<br><b>(Regulation 2018)</b><br><b>ME: 3 HOURS</b><br>1 Select different operation modes according to appropriate b<br>2 Examine the factors involved in oxygen mass transfer in bio<br>3 Apply selection criteria with respect to bioreactor considera<br>4 Interpret the stoichiometry and energetics of product forma<br>5 Accomplish knowledge about the fundamentals of modelin<br><b>PART- A (10 x 2 = 20 Ma</b><br>(Answer all Questions)<br>Comment on the rheological properties of fermentation med<br>During the operations of a microbial fermentations, a p<br>released into the medium by the cells forming froth. How de<br>formation?<br>Deduce the equation for studying specific growth rate of mi<br>Calculate the respiratory quotient for the given equation:<br>$C_{6}H_{12} O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$<br>List out the design considerations for the fluidised bed react<br>Outline the sterilization design criterion: Del factor.<br>List the agitation parameter which acts as scale up factors an<br>important?<br>Rate of oxygen consumption by the cells determines the ra<br>from gas to broth. Mention few factors which influences to | <b>B.E / B.TECH. DEGREE EXAMINATION</b><br>Fifth Semester<br><b>BT18501- BIOPROCESS ENGINI</b><br><i>(Biotechnology)</i><br><b>(Regulation 2018)</b><br><b>ME: 3 HOURS</b><br>1 Select different operation modes according to appropriate biore<br>2 Examine the factors involved in oxygen mass transfer in biorea<br>3 Apply selection criteria with respect to bioreactor consideration<br>4 Interpret the stoichiometry and energetics of product formation<br>5 Accomplish knowledge about the fundamentals of modeling an<br><b>PART- A (10 x 2 = 20 Marks)</b><br>(Answer all Questions)<br>Comment on the rheological properties of fermentation medium<br>During the operations of a microbial fermentations, a protereleased into the medium by the cells forming froth. How do yor<br>formation?<br>Deduce the equation for studying specific growth rate of microbic<br>Calculate the respiratory quotient for the given equation:<br>$C_6H_{12} O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$<br>List out the design considerations for the fluidised bed reactor.<br>Outline the sterilization design criterion: Del factor.<br>List the agitation parameter which acts as scale up factors and w<br>important?<br>Rate of oxygen consumption by the cells determines the rate of<br>from gas to broth. Mention few factors which influences the of<br>the sterilization few factors which influences the of<br>t | <b>BE / B.TECH. DEGREE EXAMINATION</b><br>Fifth Semester<br><b>BT18501- BIOPROCESS ENGINEEI</b><br><i>(Biotechnology)</i><br><b>(Regulation 2018)</b><br><b>WE: 3 HOURS</b><br>1 Select different operation modes according to appropriate bioreactor<br>2 Examine the factors involved in oxygen mass transfer in bioreactors<br>3 Apply selection criteria with respect to bioreactor consideration in ed<br>4 Interpret the stoichiometry and energetics of product formation med<br>5 Accomplish knowledge about the fundamentals of modeling and sin<br><b>PART-A (10 x 2 = 20 Marks)</b><br>(Answer all Questions)<br>Comment on the rheological properties of fermentation medium.<br>During the operations of a microbial fermentations, a proteinator<br>released into the medium by the cells forming froth. How do you conformation?<br>Deduce the equation for studying specific growth rate of microbial formation?<br>Deduce the espiratory quotient for the given equation:<br>$C_6H_{12} O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$<br>List out the design considerations for the fluidised bed reactor.<br>Outline the sterilization design criterion: Del factor.<br>List the agitation parameter which acts as scale up factors and why i<br>important?<br>Rate of oxygen consumption by the cells determines the rate of ox<br>from gas to broth. Mention few factors which influences the oxygen<br>form gas to broth. Mention few factors which influences the oxygen<br>form gas to broth. Mention few factors which influences the oxygen<br>form gas to broth. Mention few factors which influences the oxygen<br>form gas to broth. Mention few factors which influences the oxygen<br>form gas to broth. Mention few factors which influences the oxygen<br>form gas to broth. Mention few factors which influences the oxygen<br>form gas to broth. Mention few factors which influences the oxygen<br>form gas to broth. Mention few factors which influences the oxygen<br>form gas to broth. | <b>B.E. / B.TECH. DEGREE EXAMINATION, M.</b><br>Fifth Semester<br><b>BT18501- BIOPROCESS ENGINEERIN</b><br><i>(Biotechnology)</i><br><b>(Regulation 2018)</b><br><b>ME: 3 HOURS</b><br>1 Select different operation modes according to appropriate bioreactor con<br>2 Examine the factors involved in oxygen mass transfer in bioreactors<br>3 Apply selection criteria with respect to bioreactor consideration in enzyge<br>4 Interpret the stoichiometry and energetics of product formation mediate<br>5 Accomplish knowledge about the fundamentals of modeling and simula<br><b>PART- A (10 x 2 = 20 Marks)</b><br>(Answer all Questions)<br>Comment on the rheological properties of fermentation medium.<br>During the operations of a microbial fermentations, a proteinaceous<br>released into the medium by the cells forming froth. How do you contro<br>formation?<br>Deduce the equation for studying specific growth rate of microbial cells<br>Calculate the respiratory quotient for the given equation:<br>$C_{6}H_{12} O_{6} + 6O_{2} \rightarrow 6CO_{2} + 6H_{2}O$<br>List out the design considerations for the fluidised bed reactor.<br>Outline the sterilization design criterion: Del factor.<br>List the agitation parameter which acts as scale up factors and why is the<br>important?<br>Rate of oxygen consumption by the cells determines the rate of oxygen<br>from gas to broth. Mention few factors which influences the oxygen of the main formation for the story shich influences the oxygen of the main factor shich influences the oxygen form gas to broth. Mention few factors which influences the oxygen of the main factor shich inf | <b>BE / B.TECH. DEGREE EXAMIINATION, MAY</b><br>Fifth Semester<br><b>BT18501- BIOPROCESS ENGINEERING</b><br><i>(Biotechnology)</i><br><b>(Regulation 2018)</b><br><b>ME: 3 HOURS</b><br>Select different operation modes according to appropriate bioreactor configue<br>Examine the factors involved in oxygen mass transfer in bioreactors<br>Apply selection criteria with respect to bioreactor consideration in enzyme statistic development of product formation mediated by<br>Accomplish knowledge about the fundamentals of modeling and simulations<br><b>PART- A (10 x 2 = 20 Marks)</b><br>(Answer all Questions)<br>Comment on the rheological properties of fermentation medium.<br>During the operations of a microbial fermentations, a proteinaceous me<br>released into the medium by the cells forming froth. How do you control the<br>formation?<br>Deduce the equation for studying specific growth rate of microbial cells<br>Calculate the respiratory quotient for the given equation:<br>$C_6H_{12} O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$<br>List out the design considerations for the fluidised bed reactor.<br>Outline the sterilization design criterion: Del factor.<br>List the agitation parameter which acts as scale up factors and why is this<br>important?<br>Rate of oxygen consumption by the cells determines the rate of oxygen tra-<br>form gas to broth. Mention few factors which influences the oxygen demi- | <b>B.E</b> / <b>B.TECH. DEGREE EXAMINATION, MAY 207</b><br>Fifth Semester<br><b>BT18501- BIOPROCESS ENGINEERING</b><br><i>(Biotechnology)</i><br><b>(Regulation 2018)</b><br><b>ME: 3 HORS M</b><br>1 Select different operation modes according to appropriate bioreactor configurati<br>2 Examine the factors involved in oxygen mass transfer in bioreactor configurati<br>3 Apply selection criteria with respect to bioreactor consideration in enzyme syste<br>4 Interpret the stoichiometry and energetics of product formation mediated by cell<br>5 Accomplish knowledge about the fundamentals of modeling and simulations of<br><b>PART- A (10 x 2 = 20 Marks)</b><br>(Answer all Questions)<br>Comment on the rheological properties of fermentation medium.<br>During the operations of a microbial fermentations, a proteinaceous mater<br>released into the medium by the cells forming froth. How do you control the foat<br>formation?<br>Deduce the equation for studying specific growth rate of microbial cells<br>Calculate the respiratory quotient for the given equation:<br>$C_6H_{12} O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$<br>List out the design considerations for the fluidised bed reactor.<br>Outline the sterilization design criterion: Del factor.<br>List the agitation parameter which acts as scale up factors and why is this<br>important?<br>Rate of oxygen consumption by the cells determines the rate of oxygen transal<br>from gas to broth. Mention few factors which influences the oxygen demand | Reg. No.       Image: A transmission of the standard | Reg. No.       Image: Contract of the second | B.E / B.TECH. DEGREE EXAMIINATION, MAY 2023         Fifth Semester         BI18501- BIOPROCESS ENGINEERING         (Biotechnology)         (Regulation 2018)         ME: 3 HORS       MAX. MARKS         1 Select different operation modes according to appropriate bioreactor configurations         2 Examine the factors involved in oxygen mass transfer in bioreactors         3 Apply selection criteria with respect to bioreactor consideration in enzyme systems         4 Interpret the stoichinometry and energetics of product formation mediated by cell growth         5 Accomplish knowledge about the fundamentals of modeling and simulations of bioprocess         PART- A (10 x 2 = 20 Marks)         (Answer all Questions)         Co         Comment on the rheological properties of fermentation medium.         1 released into the medium by the cells forming froth. How do you control the foam formation?         Deduce the equation for studying specific growth rate of microbial cells       2         CoH12 O <sub>6</sub> + 6O <sub>2</sub> $\rightarrow$ 6CO <sub>2</sub> + 6H2O       2         List out the design considerations for the fluidised bed reactor.       3         Outline the sterilization design criterion: Del factor.       3         List he agitation parameter which acts as scale up factors and why is this       4         important?       3         List be orosumption by the cells determines the rat |

Illustrate the model which helps to study the inhibition constants 10. 5

## **PART- B (5 x 14 = 70 Marks)**

- (i) A continuous culture system is being con 11. (a) is of 50000 L in size and the residence tin medium contains spores and the sterilization 4 weeks in continuous mode. The level o reactor has to reduce to 10-fold from sterilization procedure and categorize viability temperature range.
  - (ii) Interpret the above process in terms of d expression for thermal cell death rate kin (OR
  - (i) In the food industry, it is important to re **(b)** in products to ensure proper food safety. processing and finding ways to reduce product. How long it would take to redu 90% at a given state of the killing agen Outline the various phases of microorgan of cell number.
    - (ii) Deduce the constants for exponential ind death of microorganisms.
- 12. (a) (i) A genetically engineered strain is culture production of heterologous protein. The of the oxygen in the medium is monitore Give a detailed description about the ste from the culture medium to the cells if approximately at 1 atm pressure.
  - (ii) Enlist different methods for the determin (OR)

|   | Marks | CO | RBT        |
|---|-------|----|------------|
| nstructed and fermentation tank<br>ime is of 2 hrs. The unsterilized<br>zation process is carried out for<br>of microorganism present in the<br>its initial level. Describe the<br>the organisms based on their | (7)   | 1  | LEVEL<br>3 |
| design equations and derive the inetics using graphical plots.<br><b>R</b> )  | (7)   | 1  | 3          |
| reduce the number of microbes<br>This is usually done by thermal<br>the number of bacteria in the<br>fuce the bacterial population by<br>ent. To predict the above case:<br>anisms and its changes in terms     | (7)   | 1  | 3          |
| ncrease in growth and the rapid   | (7)   | 1  | 3          |
| red in the reactor at 30°C for the<br>e oxygen requirement, solubility<br>ed regularly during the process.<br>eps for the mass transfer of gas<br>f the reactor is sparged with air                             | (7)   | 2  | 4          |
| nation of KLa.  | (7)   | 2  | 4          |

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- (i) During aerobic bioprocess, the oxygen is transferred from a rising gas (7) (b) bubble into a liquid phase and ultimately to the site of oxidative phosphorylation inside the cell. Explain the concept using film theory and justify the importance of oxygen in the bioprocesses.
  - (ii) What are the major resistances in oxygen transfer to the cells during the 2 (7) process?
- It is a semi-batch operation in which nutrients are fed either 3 13. (a) (i) (7) intermittently or continuously during the course of otherwise batch operation. The culture broth is harvested only at the end of the operational period (full volume), either fully or partially. Derive the balance equation for the above process assume it occurs at quasi steady state conditions.
  - (ii) Derive the product formation kinetic equation for the above-mentioned (7) 3 process.

## (**OR**)

- After a batch fermentation process, the system is dismantled and 3 (7) **(b)** (i) approximately half of the cell mass suspended in the liquid phase (2L) is attached to the walls of the reactor as a thick film. The target product is associated with each such cell fractions. If the reactor is scaled up to 20000 L, what are the problems associated with it? (a)What would be the required conditions of the reactors based on oxygen transfer.
  - What would be the required conditions of the reactors based on power (ii) (7) 3 consumption and impeller tip speed.
- Anaerobic digestion of volatile acids by methane bacteria is represented by 14. (a) (14) the equation

 $CH_3COOH + NH_3 \rightarrow Biomass + CO_2 + H_2O + CH_4$ 

The composition of methane bacteria is approximated by the empirical formula CH<sub>1.4</sub> O <sub>0.40</sub> N <sub>0.20</sub>. For each kg acetic acid consumed 0.67 kg CO<sub>2</sub> is evolved. How does the yield of methane under these conditions compare with the maximum possible yield?

(**OR**)

- Production of recombinant protein by a genetically-engineered strain of (14) (b) *Escherichia coli* is proportional to cell growth. Ammonia is used as nitrogen source for aerobic respiration of glucose. The recombinant protein has an overall formula CH<sub>1.55</sub> O <sub>0.31</sub>N <sub>0.25</sub>. The yield of biomass from glucose is measured at 0.48 gg<sup>-1</sup>; the yield of recombinant protein from glucose is about 20% that for cells (a) How much ammonia is required? (b) What is the oxygen demand?
- Derive the equation for identifying the substrate utilization rate and (14) 15. (a) saturation rate in the continuous stirred tank reactor using unstructured model.

## (**OR**)

It is a 'closed system', whereby the substrate and producing microorganism (14) **(b)** are added to the system at time zero and are not removed until the fermentation is complete. Explain the above concept using logistic models based on leudeking piret equation.

# **PART-** C (1 x 10 = 10 Marks)

(Q.No.16 is compulsory)

16. A researcher was carrying out the lipas *niger* using shea butter cake as the main subs parameters which influence the lipase produc and more manageable set of components, as component affects the overall response. What method she can adopt in order to evaluate the

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|                                   | Marks | CO | RBT   |
|-----------------------------------|-------|----|-------|
|                                   |       |    | LEVEL |
| se production by Aspergillus      | (10)  | 5  | 5     |
| strate. She tries to identify the |       |    |       |
| ction so as to generate reliable  |       |    |       |
| s well as indicating how each     |       |    |       |
| at type of model optimization     |       |    |       |
| parameters.                       |       |    |       |
|                                   |       |    |       |