U/K/TY

Reg. No:

Final Assessment Test – November 2025

VIT
Vellore Institute of Technology

Course: TBIT302L - Bioprocess Engineering

Class NBR(s): 1026 / 1029 Slot: C1+TC1

Time: Three Hours Max. Marks: 100

- **KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE**
- **DON'T WRITE ANYTHING ON THE QUESTION PAPER**

COs	CO Statements
CO1	Analyze media design and optimization process.
CO2	Evaluate oxygen transfer rate in bioreactors and mode of sterilization process.
CO3	Create mathematical models for microbial growth.
CO4	Apply mass transfer principles to solve biological problems.
CO5	Relate importance of metabolic stoichiometry in microbial growth and product formation

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions
(10 X 10 = 100 Marks)

1.	Provide a clear and well-labelled diagram of a mixed flow bioreactor, along with a detailed explanation of its benefits and drawbacks.	CO1	BL1
2.	Describe with a well-labelled diagram of photobioreactors, accompanied by a detailed description of their strength and weaknesses.	CO1	BL1
3.	Explain the working principle of a fed-batch bioreactor, including its concentration profile, and discuss its merits and demerits.	CO1	BL1
4.	Outline the classical and statistical approaches used in media optimization, highlighting their principles and comparative advantages	CO3	BL2
5.	Explain the process of continuous heat sterilization of liquids, highlighting its operational principles and equipment involved.	CO2	BL1
6.	Illustrate the various phases of cell growth in batch cultures with respect to the specific growth rate.	CO3	BL2
7.	Explain the Luedeking-Piret model for microbial product formation, including its mathematical formulation and significance in bioprocess engineering.	CO5	BL2
8.	Using the Monod kinetics framework, explain the methods employed to determine μ_{max} and K_s.	CO3	BL2

9.a) Medium at a flow rate of 2 m^3/h is to be sterilized by heat exchange with stream in a continuous sterilizer. The liquid contains bacterial spores at concentration of $5X10^{12}$ m^{-3}; the activation energy and Arrhenius constant for thermal destruction of these contaminants are 283 kJ/gmol and 5.7 $X10^{39}$ h^{-1} respectively. A contamination risk of one organism surviving every 60 days operation is considered acceptable. The sterilizer pipe has a inner diameter of 0.1 m; the length of the holding section is 24 m. The density of the medium is 1000 kg/m^3 and the viscosity is 3.6 kg/ (m h). Find ratio of N2/N1, Peclet number, specific death constant (Kd), What sterilizing temperature is required. CO4 BL3

Data: Value for Dz/uD=0.65, Damkohler number (Da) is 42 from graph.

OR

9.b) A 45 L stirred fermenter containing *B.thuringiensis* culture at 30°C is used for the production of microbial insecticide, find K_la using a dynamic method. Airflow shuts off for a few minutes and dissolved oxygen levels drop; the air supply is reconnected. When a steady state is reached, the dissolved oxygen concentration is 78% air saturation. The following results are obtained. CO4 BL3

Time (s)	5	15
Oxygen conc (% air saturation)	50	66

10.a) Production of a single cell protein from hexadecane by the following reaction equation: CO5 BL3

$C_{16}H_{34}+aO_2 + bNH_3 \rightarrow c\ CH_{1.66}N_{0.27}O_{0.20} + dCO_2 + eH_2O$

Where $CH_{1.66}N_{0.27}O_{0.20}$ represent the biomass. IF RQ = 0.43, determine the stoichiometric coefficients.

OR

10.b) *Klebsiella aerogenes* ($CH_{1.75}O_{0.43}N_{0.22}$) is produced from glycerol in aerobic culture with ammonia as nitrogen source. The biomass contains 8% ash, 0.40 g biomass is produced for each g glycerol consumed, and no major metabolic products are formed. What is the oxygen requirement for this culture in mass terms? The stoichiometry equation for anaerobic growth of *Klebsiella aerogenes* is given by CO5 BL3

$C_3H_8O_3+a\ O_2+ b\ NH_3 \rightarrow cCH_{1.75}O_{0.43}N_{0.22})+dCO_2+eH_2O$

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