JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATION- 2024

B.Tech-V Semester (BT/BI)

COURSE CODE (CREDITS): 18B11BT511 MAX. MARKS: 35

COURSE NAME: Bioprocess Engineering

COURSE INSTRUCTORS: Dr. Saurabh Bansal MAX. TIME: 2 Hours

Note: *(a) All questions are compulsory.*

(b) The candidate is allowed to make Suitable numeric assumptions wherever required for solving problems

(c) The candidate is allowed to bring a formula sheet (1 page) signed by me during the exam.

Q. No.	Question	CO	Marks
Q1a	What is a chemostat? How is it different from a turbidostat?	I	2
Q1b	Draw a graph (OD vs t) representing the growth curve of an organism during a chemostat.	I	2
Q2	How do bubble size and sparger design influence mass transfer rates in bioreactors?	II	2
Q3	What types of tubes are available for adding neutralizing agents, and what are the respective advantages and limitations of each type?	II	3
Q4a	What is the primary advantage of using fed-batch culture over batch culture in microbial growth kinetics?	III	2
Q4b	Given a 20-liter fermenter with a nutrient broth flow rate of 20 liters per hour, what is the dilution rate in the fermenter?	III	1
Q5	A fermentation broth with a viscosity of 10^{-2} Pa s and density of 1000 kg m^{-3} is agitated in a 50 m^3 baffled tank using a marine propeller 1.3 m in diameter. The power number for the impeller is 0.35. Calculate the power required for a stirrer speed of 4 s^{-1}.	IV	2
Q6	*Serratia marcescens* bacteria are utilized in the production of threonine. In batch culture, the maximum specific oxygen uptake rate of *S. marcescens* is 5 mmol O_2 g^{-1} h^{-1}. These bacteria are cultivated in a stirred fermenter at a cell density of 40 g l^{-1}, with a k_La of 0.15 s^{-1} under the given conditions. At the operating temperature and pressure of the fermenter, the solubility of oxygen in the culture liquid is 8 x 10^{-3} kg m^{-3}. Is the cell metabolism rate restricted by mass-transfer limitations, or is it solely governed by metabolic kinetics?	IV	2

Q7	A microbial strain is cultured in a 200 L stirred fermenter for secondary metabolite production. If the specific rate of oxygen uptake is 0.6 h^{-1} and the oxygen solubility in the broth is 10 mg/L. Calculate the volumetric mass transfer coefficient (K_La) (in s^{-1}) of oxygen required to achieve a maximum cell concentration of 12 g/L.	IV	2
Q8a	What is headspace volume in a fermenter, and why is it significant in the fermentation process?	V	2
Q8b	Draw the schematic diagrams of Airlift bioreactors representing all their important parts.	V	2
Q9a	What are the major advantages of the Fluidized Bed Bioreactor over the Fixed bed Bioreactor?	V	2
Q9b	Which of the following bioreactors is better and why: Airlift Bioreactor with internal loop and Airlift Bioreactor with external loop?	V	2
Q10	What are the advantages of using scale-down models in process development?	VI	2
Q11	The dimensions and operating conditions of a lab-scale fermenter are as follows: Volume = 1 L, Diameter = 20 cm, Agitator speed = 600 rpm, Ratio of impeller diameter to fermenter diameter = 0.3. This fermenter needs to be scaled up to 8,000 L for a large-scale industrial application. If the scale-up is based on constant impeller tip speed, what will the speed (rpm) of the agitator be in the larger reactor?	VI	2
Q12a	A stirred-tank reactor is to be scaled down from 10 m^3 to 0.1 m^3. The dimensions of the large tank are Dt = 2 m; Di = 0.5 m; N = 100 rpm. Determine the dimensions of the small tank (Dt, Di, H) by using geometric similarity.	VI	3
Q12b	What would be the required rotational speed of the impeller in the small tank if the impeller Re number (N_{Re}) was used as a scale-up criterion?	VI	2