

SOSC -

KATHMANDU UNIVERSITY
End Semester Examination
March, 2025

Marks Scored:

Level : B.Tech.

Course : BIOT 209

Year : II

Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date 24 MAR 2025

SECTION "A"

[10 Q. × 1 = 10 marks]

Choose and encircle the most appropriate option from each set of choices

- Which of the following is a substantial variable?
a. Temperature b. Pressure c. Mass d. Density
- Which condition is necessary for a system to be in a steady state?
a. Constant temperature and pressure b. Net accumulation of mass equals zero
c. No heat exchange with surroundings d. Zero velocity of all particles
- Which of the following is an intensive property?
a. Mass b. Volume c. Temperature d. Energy
- Enthalpy is defined as $H = U + PV$, Where U is:
a. Work done b. Internal energy c. Heat supplied d. Volume
- Non-Newtonian fluids exhibit viscosity that depends on:
a. Pressure only b. Temperature only c. Shear rate d. None of the above
- In cone and plate viscometers, the cone is placed at:
a. A 90° angle to the plate b. A very small angle to the plate
c. Parallel to the plate d. Perpendicular to the plate
- Which of the following is commonly used as mixing equipment in agitated tanks?
a. Rushton turbine b. Paddlewheel c. Screw conveyor d. Tray dryer
- Mixing time is defined as the time required to:
a. Completely dissolve a solid b. Achieve uniform composition in the tank
c. Rotate the impeller once d. Reach a specific viscosity
- According to the Arrhenius equation, the reaction rate increases with:
a. Increasing temperature b. Decreasing activation energy
c. Both a and b d. None of the above
- Which type of kinetics is characterized by a constant reaction rate, independent of substrate concentration?
a. Zero-order kinetics b. First-order kinetics
c. Second-order kinetics d. Michaelis-Menten kinetics

SECTION "B"
[10 Q. × 1 = 10 marks]

Fill in the blanks.

11. _____ ensures that equations have consistent units across all terms.
12. The general material balance equation is: Input - Output + _____ - Consumption = Accumulation.
13. The energy-balance equation considers internal, potential, and _____ energy changes.
14. Newtonian fluids have a constant viscosity regardless of the applied _____ rate.
15. The viscosity of fermentation broths depends on factors such as microbial _____ and extracellular polymers.
16. The _____ number determines the flow regime in a mixing tank.
17. In high-viscosity systems, specialized impellers such as _____ ribbons are used for effective mixing.
18. Batch growth typically includes lag, exponential, stationary, and _____ phases.
19. The effect of substrate concentration on cell growth kinetics is described by the _____ equation.
20. First-order kinetics implies that the reaction rate is directly proportional to the _____ concentration.

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4 MAR 2025

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SECTION "C"

[3 Q. × 8 = 24 marks]

Attempt *ANY THREE* questions:

1. The following reaction equation describes the production of single-cell protein from hexadecane:
 $C_{16}H_{34} + aO_2 + bNH_3 \rightarrow cCH_{1.66}O_{0.27}N_{0.20} + dCO_2 + eH_2O$
where $cCH_{1.66}O_{0.27}N_{0.20}$ represents the biomass. If RQ = 0.43, determine the value of stoichiometric coefficients. [8]
2. What is enthalpy? Why enthalpy is called a state function? Show and explain that enthalpy is independent of a path with an illustration. Fifty grams of benzaldehyde vapor is condensed at 179 °C. What is the enthalpy of the liquid relative to the vapor? Given that the standard heat of vaporization is 38.40 kJ/mol, the Molar mass of benzaldehyde = 106.12 g/mol. [1+1+3+3]
3. Explain the working principle of cone and plate viscometer with a well-labeled diagram and derive the formula to calculate viscosity. [8]
4. Explain the different types of reaction yield with respect to bioprocess technology. [8]

SECTION "D"

[5 Q. × 4 = 20 marks]

Attempt *ANY FIVE* questions

5. What is measurement convection? Describe the key aspects of measurement convections. [1+3]
6. The equation below represents a macroscopic view of cell growth:
 $C_wH_xO_yN_z + aO_2 + bH_gO_hN_i \rightarrow cCH_\alpha O_\beta N_\delta + dCO_2 + eH_2O$
Write the elemental balance for carbon, hydrogen, oxygen, and nitrogen. [1+1+1+1]
7. Below is a general mass balance equation with six input and output streams. [1+3]

$$\sum_{input\ streams} 6 M_i (h + e_k + e_p) - \sum_{output\ streams} 6 M_o (h + e_k + e_p) - Q + W_s = \Delta E$$

input *output*
sreams *streams*

- a. What are h, e_k , e_p , Q, W_s , and ΔE in the above equation?
- b. Rewrite the equation for different special cases.

P.T.O.

8. Show that mixing time (t_m) = 4 t_c , where t_c is the circulation time, with a well-labeled graph. [1=3]
9. Show a typical configuration of a stirring tank. Write the function and characteristics of each unit. [1+3]
10. What are the factors that affect the cell growth kinetics?

SECTION "E"

[11 marks]

11. Write short notes (**ANY FOUR**) [4Q × 2 = 8 marks]
- System, boundary, and process
 - Degree of reduction
 - Shear thickening and shear thinning
 - Hydrodynamic boundary layer
 - Importance of fluid behavior in bioprocessing
12. Solve the following (**ANY THREE**) [3Q × 1 = 3 marks]
- What is the flow rate of the fresh feed for a process with a feed of 100 kg/h and a recycle ratio of 0.25?
 - The diameter of the bioreactor is 1 m and height 2 m. Calculate the appropriate working volume for the reactor.
 - In a process, 2 kg of water at 100°C condenses to liquid. How much energy is released? (Latent heat of vaporization = 2260 J/g)?
 - If a fluid has a viscosity of 0.03 Pa.s and a shear rate of 10 s⁻¹. What is the shear stress?