KATHMANDU UNIVERSITY
Semester End Examination
June, 2018

Marks Scored:

Level : B. Tech
Year : II
Course : BIOT 204
Semester: I

Exam Roll No. :
Time :30 mins.
F. M. : 20

Registration No.:
Date JUN 12 2018

SECTION "A"
[20 Q. × 1 = 20 marks]

Choose and tick [✓] the most appropriate answer.

1. Extracellular polysaccharide Xanthum gum is produced from which of the organism:
[ ] *Xanthomonascampestris* [ ] *Xanthomonasbrevis*
[ ] *Xanthomonasutilis* [ ] *Xanthomonasxanthanis*

2. In the development of new bioprocess; which step is involved after Bench top bioreactor assay:
[ ] Small Scale Culture [ ] Pilot Scale Bioreactor
[ ] Industrial Scale Operation [ ] large Scale Culture

3. What is the dimension for Entropy?
[ ] L^2MT^{-2} [ ] LMT^{-2} [ ] $L^2MT^{-2}\,\theta^{-1}$ [ ] $LMT^{-2}\,\theta^{-1}$

4. Tick the value of ice point in RankineScale (^oR)
[ ] 671.67 ^oR [ ] 491.67 ^oR [ ] 691.67 ^oR [ ] 471.67 ^oR

5. The number of significant figures in 1.20×10^3 is:
[ ] one [ ] two [ ] three [ ] four

6. The following equation $y = 1/(Ax + B)$ plots a straight line on
[ ] y vs 1/x [ ] 1/y vs x [ ] x/y vs x [ ] 1/y vs 1/x

7. In which process, the total mass remains constant, but changes occurring inside the system properties vary with time
[ ] batch process [ ] semi-batch [ ] fed-batch [ ] continuous

8. A continuous process is set up for treatment of waste water, each day 10^5 kg cellulose and 10^3 kg bacteria enter in the feed, while 10^4 kg cellulose and 1.5×10^4 kg bacteria leave in effluent. The rate of cellulose digestion by the bacteria is 7×10^4 kg/day. The rate of bacterial growth is 2×10^4kg/day; the rate of cell death by lysis is 5×10^2 kg/day. How much cellulose accumulate in the system each day?
[ ] 5.5×10^3 kg [ ] 2×10^4 kg [ ] 5.5×10^2 kg [ ] 2×10^3 kg

9. Which of the following is not an intensive variable of a system
[ ] temperature [ ] density [ ] mole fraction [ ] mass

10. For the general equation for aerobic cell growth: $C_wH_xO_yN_z + aO_2 + bH_gO_hN_i = cCH_\alpha O_\beta N_\delta + dCO_2 + eH_2O$; Hydrogen balance can be represented by
[ ] $x + bg = c\alpha + 2e$ [ ] $x + g = \alpha + e$ [ ] $b = c + 2$ [ ] none of these

11. For the general equation foe aerobic cell growth stated above; Respiratory quotient is given by:
[ ] e/d [ ] e/a [ ] d/a [ ] a/d

12. In the microbial conversion of glucose to L-glutamic acid, what mass of oxygen is required to produce 25g glutamic acid? (M.W. Oxygen = 32; M.W. Glutamic acid = 147)

$$C_6H_{12}O_6 + NH_3 + 3/2\ O_2 \longrightarrow C_5H_9NO_4 + CO_2 + 3H_2O$$

[ ] 4.08 g [ ] 4.9 g [ ] 8.16 g [ ] 5.44 g

13. What is the enthalpy of 250 g formic acid at 50 °C and 1 atm relative to 25 °C and 1 atm (Cp for formic acid = 0.524 cal g^{-1} $°C^{-1}$)
[ ] 2275 cal [ ] 3275 cal [ ] 2375 cal [ ] 3375 cal

14. Which of the following are strictly non-Newtonian, but once the flow starts they behave essentially as Newtonian fluids?
[ ] Newtonian [ ] Pseudo plastic [ ] Bingham plastic [ ] Casson plastic

15. In Bingham Plastic, with increasing shear rate when the yield stress is exceeded, the apparent viscosity
[ ] increases [ ] remains constant [ ] decreases [ ] can't be predicted

16. Flow in stirred tanks may be linear for impeller Reynolds number (Re_i) of:
[ ] $Re_i \leq 10$ [ ] $10 \leq Re_i \leq 100$ [ ] $Re_i \geq 100$ [ ] Re_i can't be used

17. To achieve mixing on a scale smaller than Kolmogorov scale, we must rely on
[ ] Dispersion [ ] Diffusion [ ] Distribution [ ] Diameter

18. What happens to the product N_iT_m for Rushton turbine, as Reynolds number us increased above about 5×10^3?
[ ] approaches constant value [ ] increases significantly
[ ] decreases significantly [ ] none

19. Power requirement for laminar flow is independent of
[ ] fluid density [ ] fluid viscosity [ ] both [ ] none

20. In case of pseudoplastic, flow behavior index is
[ ] n=1 [ ] n>1 [ ] n<1 [ ] n=0

KATHMANDU UNIVERSITY
Semester End Examination [C]
June, 2018

JUN 12 2018

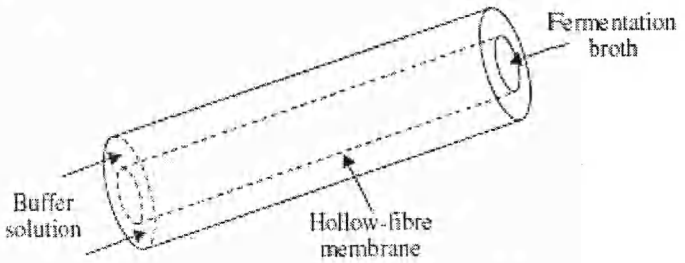
Level : B. Tech.
Year : II
Time : 2 hrs. 30 mins.

Course : BIOT 204
Semester: I
F. M. : 55

SECTION "B"
(Long answer questions)
[3Q. × 10 =30 marks]

Attempt *ANY THREE* questions.

1. A battery of cylindrical hollow-fiber membranes is operated at steady state to concentrate a bacterial suspension harvested from a fermenter. Fermentation broth is pumped at a rate of 350 kg min^{-1} through a stack of hollow-fiber membranes as shown. The broth contains 1% bacteria; the rest may be considered water. Buffer solution enters the annular space around the membrane tubes at a rate of 80 kg min^{-1}; because broth in the membrane tubes is under pressure, water is forced across the membrane into the buffer. Cells in the broth are too large to pass through the membrane and pass out of the tubes as a concentrate. The aim of the membrane system is to produce a cell suspension containing 6% biomass.



a) What is the flow rate of outgoing buffer solution?
b) What is the flow rate of cell suspension from the membrane tubes?

Assume that the cells are not active, that is, they do not grow. Assume further that the membrane does not allow any molecules other than water to pass from annulus to inner cylinder, or vice versa.

2. Bakers' yeast is produced in a 50,000-litre fermenter under aerobic conditions. The carbon substrate is sucrose; ammonia is provided as the nitrogen source. The average biomass composition is $CH_{1.83}O_{0.55}N_{0.17}$ with 5% ash. Under conditions supporting efficient growth, biomass is the only major product and the biomass yield from sucrose is 0.5 g g^{-1}. If the specific growth rate is 0.45 h^{-1}, estimate the rate of heat removal required to maintain constant temperature in the fermenter when the yeast concentration is 10 g l^{-1}. (molecular formula for sucrose is $C_{12}H_{22}O_{11}$, molecular weight of sucrose is 342.3, biomass formula weight is 25.04, molecular weight of oxygen = 32.0)

3. A well-mixed fermenter contains cells initially at concentration x_o. A sterile feed enters the fermenter with volumetric flow rate F; fermentation broth leaves at the same rate. The concentration of substrate in the feed is (s_i). The equation for the rate of cell growth is:

$$r_x = k_1 x$$

and the equation for the rate of substrate consumption is:

$$r_s = k_2 x$$

where, k_1 and k_2 are rate constants with dimensions T^{-1}, r_x and r_s have dimensions $L^{-3}MT^{-1}$, and x is the concentration of cells in the fermenter.

a) Derive a differential equation for the unsteady-state mass balance of cells.
b) From this equation, what must be the relationship between F, k_1, and the volume ofliquid in the fermenter V at steady state?
c) Solve the differential equation to obtain an expression for cell concentration in the fermenter as a function of time.

d) Use the following data to calculate how long it takes for the cell concentration in thefermenter to reach 4.0 g l^{-1}:
$F = 2200\ l\ h^{-1}, V = 10000\ l, x_o = 0.5\ g\ l^{-1}, k_1 = 0.33\ h^{-1}$

4. Explain the various physical processes involved in mechanisms of mixing with illustrated figures.

SECTION "C"
(Short answer questions)
[5Q. × 5 =25 marks]

Attempt *ANY FIVE* questions.

5. Explain the steps in development of a complete bioprocess for commercial manufacture of a new recombinant DNA derived product.

6. Under anoxic conditions, biological denitrification of waste water by activated sludgeresults in the conversion of nitrate to nitrogen gas. When acetate provides the carbonsource, the reaction can be represented as follows:

$$5CH_3COOH + 8NO^-_3 \rightarrow 4N_2 + 10CO_2 + 6H_2O + 8OH^-$$

a) Is the stoichiometric equation balanced?
b) In the absence of side reactions, what is the yield of nitrogen from acetate in g g^{-1}?
c) A certain waste water contains 6.0 mM acetic acid and 7 mM $NaNO_3$. If 25% of theacetate and 15% of the nitrate are consumed in other reactions (e.g., for growth oforganisms in the sludge), which is the limiting substrate in the denitrification reaction?
d) For the situation described in (c), what mass of gaseous nitrogen is produced from treatment of 5000 litres of waste water if the reaction is allowed to proceed until thelimiting substrate is exhausted?

7. Determine the equation for y as a function of x using the following information:
a) A plot of y vs $x^{1/2}$ on linear graph paper gives a straight line passing through the points (3.2,14.5) and (8.9,38.5)
b) A plot of y vs. x on semi-log paper gives a straight line passing through (1.5, 2.5) and (10, 0.036)

8. Production of single-cell protein from hexadecane is described by the following reaction equation:

$$C_{16}H_{34} + aO_2 + bNH_3 \longrightarrow cCH_{1.66}O_{0.27}N_{0.20} + dCO_2 + eH_2O$$

Where $CH_{1.66}O_{0.27}N_{0.20}$ represents the biomass. If RQ =0.43, determine the stoichiometriccoefficients.

9. A beaker containing 2 litres of water at 18°C is placed on a laboratory hot plate. The water begins to boil in 11 min.
a) Neglecting evaporation, write the energy balance for the process.
b) The hot plate delivers heat at a constant rate. Assuming that the heat capacity of water is constant, what is that rate?
(Density of water = 1 g cm^{-3}=1 kg l^{-1}, Cp water = 75.4 Jgmol^{-1} °C^{-1} = 75.4 KJ kgmol^{-1} °C^{-1}, Molecular weight of water = 18.0,1W = 1 J s−1)

10. Explain:
a) Streamlines
b) Hydrodynamic boundary Layers
c) Non-Newtonian fluids
d) Time-Dependent Viscosity
e) Viscoelasticity