Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/M.TECH (BT)/SEM-3/MBT-301/2010-11

2010-11

BIOPROCESS ENGINEERING & DOWNSTREAM PROCESSING

Time Allotted : 3 Hours   *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A
(Multiple Choice Type Questions)

1.   Choose the correct alternatives for any *ten* of the following :

$$10 \times 1 = 10$$

  i)   Which of the following is not equivalent to 1 standard atmospheric pressue ?

  a) $1 \cdot 01325$ bar

  b) $1 \cdot 01325$ Pa

  c)   760 mm of Hg

  d) $1 \cdot 01325 \times 10^5$ N/m^2 .

  ii)   How many kgs of CS_2 will contain 42 kg of carbon ?

  a) $3 \cdot 5 \times 10^3$ b) $266 \cdot 45$

  c) $76 \cdot 13$ d)   None of these.

40476   [Turn over

iii) The fraction of the total pressure exerted by oxygen in a mixture containing equal weights of methane and oxygen is

a) $\dfrac{1}{3}$

b) $\dfrac{1}{2}$

c) $\dfrac{1}{4}$

d) $\dfrac{3}{4}$.

iv) Forty five moles of oxygen is supplied for the combustion of 36 g-atom of carbon. The per cent excess reactant supplied is

a) 80%

b) 33·3%

c) 30%

d) 25%.

v) The heat supplied to a system under constant pressure is equal to

a) the work done by the system

b) the change in internal energy

c) the change in enthalpy

d) the change in kinetic and potential energy.

vi) The calorific value of a fuel is equal to

a) heat of formation of the fuel

b) heat of combustion of the fuel

c) negative of the heat of combustion

d) positive of the heat of combustion.

vii) Load count analysis is used to estimate the quantities of

    a) solid waste

    b) liquid waste

    c) both solid and liquid wastes

    d) none of these.

viii) Endogenous catabolism is a process for maintenance energy of the microbes where

    a) food is supplied from external source

    b) stored food is used

    c) both external and stored food are used

    d) none of these.

ix) Orifice meters and venturi metres measure the

    a) point velocity of the flow of fluid

    b) average velocity of the entire stream of fluid

    c) maximum velocity of the flow of fluid

    d) pressure of fluid.

x) Synthetic detergent powder is produced by drying detergent slurry in a

    a) spray dryer   b) cylinder dryer

    c) freeze dryer   d) open pan dryer.

xi) Most antibiotics are extracted from the fermentation broth by using

    a) acetic acid   b) amyl acetate

    c) isoamyl acetate   d) both (b) and (c).

xii) In the stationary phase net growth rate is

a) zero

b) increased exponentially

c) decreased exponentially

d) none of these.

xiii) Major method for protein precipitation is

a) salting out by adding $(NH_4)_2 SO_4$

b) salting out by adding $Na_2 SO_4$

c) salting out by adding $CaSO_4$

d) salting out by adding $K_2 SO_4$.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. CO (g) combines with Cl_2 (g) in the presence of a suitable catalyst to form $COCl_2$ (g) according to the following reaction :

$$CO (g) + Cl_2 (g) \varnothing COCl_2 (g) .$$
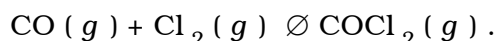
After reaction, the products contained 12 moles of $COCl_2$ (g) , 3 moles of Cl_2 (g) and 8 moles of CO (g).

Assuming that the original reactant mixture is free of $COCl_2$ (g) , calculate

a) the per cent excess reactant used

b) the per cent conversion of the limiting reactant

c) the moles of the total product per mole of the reactant mixture fed to the reactor. $2 + 2 + 1$

3. a) Define Darcy's law.

    b) Describe briefly the impact of C/N ratio in anaerobic biodigestion. $2 + 3$

4. A slab of paper pulb 100 cm ∞ 100 cm ∞ 1·5 cm is to be dried under constant drying conditions from 66·7% to 30% moisture. The value for equilibrium moisture for the material is 0·5%. If critical moisture content is 60% and the rate of drying at the critical point is 1·5 kg/hr.m ^{2}, calculate the drying time. The dry weight of each slab is 2·5 kg. All moisture content is on wet basis. 5

5. Discuss the major steps involved in the separation and purification of intracellular enzymes. 5

6. Discuss different phases of microbial growth curve. 5

GROUP – C
(Long Answer Type Questions)
Answer any *three* of the following. $3 \infty 15 = 45$

7. The pressure difference (ΔP) in a pipe of diameter (D) and ldength (l) due to turbulent flow depends on the velocity (v), viscosity (μ), density (ρ) and roughness (K). Considering the above parameters, obtain an expression for ΔP. 15
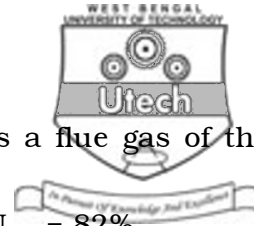
8. a) Combustion of solid wastes produces a flue gas of the following analysis :

CO_2 = 9%, CO = 2%, O_2 = 7% and N_2 = 82%.

Find the difference in enthalpies for this gas between the bottom and top of the stack if the temperature of the gas at the bottom is 600 K and that at the top is 375 K. The heat capacities of the gases are

$CO : C_p = 26·586 + 7·582 \times 10^{-3} \, T - 1·12 \times 10^{-6} \, T^2$

$CO_2 : C_p = 26·540 + 42·454 \times 10^{-3} \, T - 14·298 \times 10^{-6} \, T^2$

$O_2 : C_p = 25·74 + 12·987 \times 10^{-3} \, T - 3·864 \times 10^{-6} \, T^2$

$N_2 : C_p = 27·03 + 5·815 \times 10^{-3} \, T - 0·298 \times 10^{-6} \, T^2$

where C_p is in kJ/kmolK and T is in K.

b) Iron reacts with hydrochloric acid at 300 K according to : $Fe \, (s) + 2HCl \, (aq) \oslash FeCl_2 \, (aq) + H_2 (g)$. Determine the work done when 1 kg of iron fillings react with HCl in a closed vessel maintained at a constant pressure. Assume that hydrogen behaves as an ideal gas. 10 + 5

9. a) Describe a typical, standard-rate anaerobic digester consisting of a single-stage operation and diagram.

b) Thickened sludge is to be digested anaerobically in a single-stage digester having a total mass of solids 3088 kg/d. The raw sludge loading rate is 77·2 m^3 /d. The sludge is known to be about 705 organic and 305 inorganic in nature. Approximately 60% of the organic fraction is converted to liquid and gaseous end products after a 30 day period. The digested sludge has solids content of 5% and must be stored for periods of up to 90 days. Determine the volume requirement for a standard-rate single-stage digester.
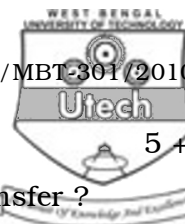
5 + 10

10. a) What are the different modes of heat transfer ?

b) An ice box has walls constructed of a 10 cm layer of cork board contained between two wooden walls, each two 2 cm thick. Find the rate of heat removal in kcal/m^2 hr if the inner wall surface is kept at – 10°C while the outer surface temperature is 30°C. Find out zone in the wall where temperature is 20°C. Thermal conductivities of cork board and wood respectively are 0·035 kcal/hr.m.°C & 0·09 kcal/hr.m.°C.   15

11. A strain of mold was grown in a batch culture on glucose and the following data were obtained :

Time (h)	0	9	16	23
Cell concentration (g/l)	1·25	2·45	5·1	10·5
Glucose concentration (g/l)	100	97	90·4	76·9

30	34	36	40
22	33	37·5	41
48·1	20·6	9·38	0·63

a) Calculate the maximum net specific growth rate.

b) Calculate the approximate growth rate.

c) What maximum cell concentration could one expect if 150 gm of glucose were used with the same size inoculum ?   15

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