



Name : .....

Roll No. : .....

Invigilator's Signature : .....

**CS/M.Tech (BT)/SEM-3/MBT-301/2009-10**

**2009**

**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 × 1 = 10

i) Fundamental Dimensions are

- |            |                   |
|------------|-------------------|
| a) H, T, P | b) V, T, P        |
| c) M, L, T | d) none of these. |

ii) Selectivity is measured as

- a) the proportion of the total reaction to produce desired product
- b) the rate of reaction for conversion of product formation
- c) the choice of reactants for the desired product formation
- d) none of these.



- iii) Compressibility factor measures the deviation of a gas from
  - a) ideal behaviour
  - b) real behaviour
  - c) critical behaviour
  - d) none of these.
- iv) In flash vaporization, a liquid mixture is
  - a) partially vapourized
  - b) completely vapourized
  - c) temporarily vapourized
  - d) none of these.
- v) Drying is a
  - a) unit operation
  - b) unit process
  - c) unit separation
  - d) none of these.
- vi) Enthalpy is a
  - a) state function
  - b) path function
  - c) state and path function
  - d) none of these.
- vii) Heat capacity of a substance is generally
  - a) constant but varies with temperature
  - b) not constant but varies with temperature
  - c) not constant but varies with volume
  - d) none of these.
- viii) First law of thermodynamics deals with
  - a) direction of energy transfer
  - b) reversible process only
  - c) irreversible process only
  - d) none of these.



- ix) Heat of reaction is
- a) dependent on pressure only
  - b) dependent on temperature only
  - c) dependent on pressure and temperature
  - d) none of these.
- x) Heat transfer by conduction is described by
- a) Fourier's law
  - b) Newton's law
  - c) Stefan Boltzmann's law
  - d) Fick's law.
- xi) Wetted wall tower experiments determine the
- a) molar diffusivity
  - b) volumetric coefficient
  - c) mass transfer coefficient
  - d) none of these.
- xii) The diffusivity has the same dimension as
- a) absolute viscosity
  - b) kinetic viscosity
  - c) density
  - d) concentration.



**GROUP – B**  
**( Short Answer Type Questions )**

Answer any *three* of the following.

3 × 5 = 15

2. State Raoult's law and Dalton's law. 5
  
3. a) What is mean by conversion of units ?  
 b) Stainless steel type 304 having composition of 18% Cr, 8% Ni and 0.08% C maximum, has a thermal conductivity ( K ) of  $16.2 \frac{\text{Btu}}{(\text{hr}) (\text{ft}) (^\circ\text{F})}$ . Convert (K) into  $\frac{\text{g-cal}}{(\text{sec}) (\text{cm}) (^\circ\text{C})}$ . 1 + 4
  
4. Draw a boiling point diagram (  $T-x-y$  ) for a binary mixture and explain. 5
  
5. What are the considerations to be followed for the particulates to choose proper air pollution control equipments ? 5
  
6. In a factory, a double effect evaporator concentrating a weak liquor containing 4% ( by wt. ) NaOH to produce lye containing 25% ( by wt. ) solid. Calculate the evaporation of water per 100 kg feed in the water. 5
  
7. Write down the Biochemical effects of Mercury. 5
  
8. a) Derive an expression for the calculation of resistance in case of hollow cylinder. 2



- b) A flat furnace wall is conducted of a 115 mm layer of sil-o-cel brick with a thermal conductivity of 0.4 kcal/hr.m°C backed by a 230 mm layer of common brick of conductivity 4 kcal/hr.m°C.

The temperature of the inner face of the wall is 760°C and that of the outer face is 77°C.

- i) What is the heat loss through the wall in kcal/ m<sup>2</sup> hr.
  - ii) What is temperature of the interface between the refractory brick and the common brick ? 3
9. a) Write down the mechanism of drying. 2
- b) Define, critical moisture, equilibrium moisture and free moisture content with diagram. 3
10. Discuss in brief, the microbial growth kinetics. 5

### GROUP – C

#### ( Long Answer Type Questions )

Answer any *three* of the following. 3 × 15 = 45

11. A drier is fed with wet solid to reduce the moisture content from 80% to 15%. The product leaving the drier is admitted to an oven which further brings down the moisture to 2%. If the drier can handle 1000 kg of wet solid per day, calculate
- a) The weight of products leaving the drier and the oven per day.
  - b) The percentage of the original water that is removed in the drier and the oven. 15



12. Propane is burned with excess air to ensure complete combustion. If 55 kg of  $\text{CO}_2$  and 15 kg of CO are obtained when propane is completely burned with 500 kg air, determine the following :
- a) The mass of propane burned ( in kg )
  - b) The percent excess air. 15
13. A crystallizer is charged with 100 kg of a solution containing 25%  $\text{Ba}(\text{NO}_3)_2$  in water. On cooling 10% of the original water present evaporates. Calculate the yield of crystals when the solution is cooled to 283 K. The solubility at 283 K is 7.0  $\text{Ba}(\text{NO}_3)_2$  / 100 kg total water. 15
14. Describe any *two* methods developed to recover microbial products. 15
15. a) Define distillation. What are the different types of distillation process ?
- b) A wet solid is dried from 25 to 10 percent moisture under constant drying conditions is 4.17 hr. If the critical and equilibrium moisture constants are 15 and 5 percent respectively, how long will it takes to dry the solid from 30 to 8 percent moisture under the same conditions ? 5 + 10



16. a) Write down the different modes of heat transfer with their coefficient units.
- b) A wet solid is dried from 25 to 10 per cent moisture under constant drying conditions is 4.17 hr. if the critical and equilibrium moisture contents are 15 and 5 per cent respectively, how long will it take to dry the solid from 30 to 8 per cent moisture under the same conditions.
17. a) Write down the different modes of heat transfer with all their coefficient's unit.
- b) A steel pipe 25 mm ID and 33 mm OD and insulated with rock-wool carries steam at 178°C. If the surrounding air temperature is 21°C, calculate the rate of heat loss from one metre length of pipe. The thickness of insulation is 38 mm. Thermal conductivity of steel and rock-wool are 10.74 and 0.0418 cal/sec.-m°C respectively. The inside and outside heat transfer coefficients are 1356.17 and 2.7133 cal/sec.m<sup>2</sup>°C respectively. Contact resistance between the pipe and insulation may be neglected.

5 + 10

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