

B.E. 3rd Sem; Dec 2022

Exam. Code: 0907  
Sub. Code: 6291

2122  
B.E. (Biotechnology) Third Semester  
BIO-311: Process Calculations

Time allowed: 3 Hours

Max. Marks: 50

**NOTE:** Attempt five questions in all, including Question No. 1 which is compulsory and selecting two questions from each Section. State clearly your assumptions.

x-x-x

- 1) Write briefly: (1 × 10 = 10)
- Define (i) Dew point, (ii) Bubble point.
  - Define extensive property.
  - What are Reduced Parameters? How are they calculated?
  - Define latent heat change.
  - What are the dimensions of  $T$ ,  $p$ ,  $V$ ,  $n$ ,  $R$  in the ideal gas law?
  - What are humidity charts and why are they used?
  - Define specific gravity. What is the dimension?
  - What is the ideal gas law?
  - What is referred to as the quality of a liquid mixture? How is the quality calculated?
  - What is the Hess's law?

**SECTION - A**

2. A) A container holds 1.704 lb of  $\text{HNO}_3$ /lb of  $\text{H}_2\text{O}$  and has a specific gravity of 1.382 at  $20^\circ\text{C}$ . Compute the composition in the following way,
- Weight percent of  $\text{HNO}_3$ .
  - Pounds  $\text{HNO}_3$  per cubic foot of solution at  $20^\circ\text{C}$ .
  - Molarity at  $20^\circ\text{C}$ .
- B) Convert 10 gal/hr to  $\text{m}^3/\text{s}$ ; 50  $\text{lb}_f$  to  $\text{N}/\text{m}^2$ . (6, 4)
3. A) An industrial strength drain cleaner contains 5.00 kg of water and 5 kg of  $\text{NaOH}$ . What are the mass fraction and mole fraction of each component in the cleaner?
- B) A relation for a dimensionless variable called the compressibility ( $z$ ) is given as  $z = 1 + P^B + P^2C + P^3D$  where  $P$  is the density in  $\text{g mol}/\text{cm}^3$ . What are the units of B, C and D?
- C) What is the potential energy in (ft) ( $\text{lb}_f$ ) of a 150 lb drum hanging 10 ft above the surface of the earth with reference to the surface of the earth? (4, 3, 3)
4. A) If a 70% by weight of solution of glycerol has a specific gravity of 1.184 at  $15^\circ\text{C}$ , what would be the density of the solution in (a)  $\text{g}/\text{cm}^3$ , (b)  $\text{lb}_m/\text{ft}^3$ , (c)  $\text{kg}/\text{m}^3$ ?
- B) A continuous mixer mixes  $\text{NaOH}$  and  $\text{H}_2\text{O}$  to produce an aqueous solution of  $\text{NaOH}$ . Determine the composition and flow rate of the product stream if the flow rate of the product stream is 1000 kg/hr and the ratio of flow rate of  $\text{H}_2\text{O}$  to product solution is 0.9. (5, 5)

**SECTION - B**

5. A) What is the minimum number of cubic meters of dry air at  $20^\circ\text{C}$  and 100 kPa necessary to evaporate 6 kg of ethyl alcohol if the total pressure remains constant at 100 kPa and the temperature remains constant at  $20^\circ\text{C}$ ? Assume that the air is blown through the alcohol to evaporate it in such a way that the exit pressure of the air alcohol mixture is at 100 kPa.

Contd....P/2

(2)

- B) The percent absolute humidity of air at  $30^{\circ}\text{C}$  and pressure of 750 mm Hg is 20%. Calculate the percent relative humidity, the humidity, and the partial pressure of water vapor in the air. What is the dew point of the air? (5, 5)
6. A) Draw the vapor pressure curve for water explaining all the relevant terms including triple point, sublimation curve, melting curve, sub cooled and saturated liquid, boiling point, superheated vapor and so on.
- B) A gaseous mixture has the following composition in mole percent:
- |                                  |    |
|----------------------------------|----|
| Methane, $\text{CH}_4$           | 20 |
| Ethylene, $\text{C}_2\text{H}_4$ | 30 |
| Nitrogen, $\text{N}_2$           | 50 |
- at a pressure of 90 atm at  $100^{\circ}\text{C}$ . Compare the volume per mole as computed by the methods of:
- The perfect gas law.
  - The pseudo reduced technique (Kay's method).
- (5, 5)
- 7) Consider hot water heater in your house, classify each case below as open or closed system:
- The tank is being filled with cold water.
  - Hot water is being drawn from tank.
  - Tank leaks.
  - Heater is turned on to heat the water.
  - Tank is full and heater is turned off.
- (10)

x-x-x