S/K/TY

Reg. No: 24BCTD102

Final Assessment Test – November 2025

VIT
Vellore Institute of Technology

Course: BBIT201L - Principles of Chemical Engineering
Class NBR(s): 0980
Slot: B1+TB1
Time: Three Hours
Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

COs	CO Statements
CO1	Explain the basics of engineering calculations pertaining to dimensions and system of units.
CO2	Summarize the material balances of biochemical processes and equipment.
CO3	Develop the energy balance calculations for various processes in chemical engineering.
CO4	Solve problems involving recycle, purge and bypass in a process or unit.
CO5	Assess different non-dimensional numbers and relating the variables using theorems.
CO6	Apply equations related to fluid flow and different types of flow measuring devices.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions
(10 X 10 = 100 Marks)

1. How much $Ca(OH)_2$ is required to prepare a 0.2 N solution? How do you prepare 1 L of 0.02 M solution from this stock solution? Molecular weight of $Ca(OH)_2$ = 74.09 g/gmol. **CO1 BL2**

2. A natural gas has the following composition by volume: CO_2-0.8%, N_2-3.2% and CH_4-96%. Calculate the average molecular weight and the density (Kg/m^3) at standard conditions of the gas. **CO1 BL3**

3. A solution containing 25% $MgSO_4$ and 75% water is cooled so that $MgSO_4.7H_2O$ crystals are obtained on crystallization. During this process, 6.5% of the total water present in the feed is lost due to evaporation. The solubility of anhydrous $MgSO_4$ in water at this temperature is 11 Kg anhydrous salt/ 100 Kg water. For treating 1000 Kg of solution, calculate the following: **CO2 BL3**

   a) The weight of $MgSO_4.7H_2O$ crystals obtained

   b) The weight of thick liquor obtained

   Molecular weight of $MgSO_4.7H_2O$= 246.47 g/gmol

   Molecular weight of $MgSO_4$= 120.36 g/gmol

4. Potable water containing not more than 500 ppm dissolved salt is made by desalinization through reverse osmosis of seawater which contains 3% salt. Fresh seawater is admitted at a rate of 1000 Kg/h. Potable water is withdrawn from the reverse osmosis cell as product while a fraction of the rejected brine **CO4 BL4**

that leaves the cell and containing 5.25% salt is recycled. The concentration of salt in the stream entering the cell after mixing the recycle stream with fresh water is 4%. Determine

a) The rate at which brine is removed from the plant (Kg/h)
b) The rate at which potable water is produced (Kg/h)
c) The fraction of the brine leaving the cell that is recycled

5. a) Calculate the heat that must be removed in cooling 32 Kg of oxygen from 488 K to 313 K using CO3 BL2

$Cp = 26.0257 + 11.7551 \times 10^{-3} T - 2.3426 \times 10^{-6} T^2$

Units of Cp is KJ/Kgmol

b) Calculate the standard heat of reaction of the following reaction:

$4 NH_3 + 5 O_2 \rightarrow 4 NO + 6 H_2O$

Component	ΔH^0_f, KJ/mol at 298.15 K
NH_3	-45.94
NO	90.25
H_2O	-241.82

6. A partially submerged body is towed in water. The resistance R to its motion depends on the density (ρ), viscosity (μ), length of the body (l), velocity of the body (v) and the acceleration due to gravity (g). Express the functional relationship between these variables and the resistance to motion displayed by the body using Rayleigh's method of dimensional analysis. CO5 BL3

7. A U-tube differential manometer connects two pressure pipes A and B. Pipe A contains solution A with specific gravity 1.594 under a pressure of 15 N/cm^2 and pipe B contains solution B with specific gravity of 0.8 under a pressure of 11 N/cm^2. The pipe A lies 2.5 m above pipe B. The mercury level in the limb connected to pipe B is 1 m below the pipe. Find the difference in mercury levels in the two limbs. CO6 BL3

8. For a fluid flowing in a pipe, discuss the significance of the following equations: CO6 BL2

a) Continuity equation
b) Bernoulli's equation

9.a) In a process in which benzene is used as a solvent, it is evaporated into dry nitrogen. The resulting mixture at a temperature of 300 K and a pressure of 101.3 KPa has a relative humidity of 60%. It is required to recover 80% of the benzene present by cooling to 283 K and compressing to a suitable pressure. The vapour pressure of benzene at 283 K is 6.02 KPa and that at 300 K is 13.81 KPa. To what pressure should the gas be compressed? CO1 BL4

OR

9.b) A carbon dioxide-water vapour mixture at 310 K and 100 KPa is measured to contain 0.022 Kg water per kg dry carbon dioxide. Caclulate the following: CO1 BL4

i. Molal humidity
ii. Relative saturation
iii. Percent saturation
iv. The temperature to which the gas is to be heated at constant pressure to reduce its percent saturation to 30 percent.

$$\ln P^S = 16.26205 - \frac{3799.887}{T - 46.854}$$

10.a) Describe venturimeter. Explain its principle of working. CO6 BL3

OR

10.b) Explain the principle of pitot tube with a neat diagram. CO6 BL3

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