**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI**
**(MID SEMESTER EXAMINATION)**

**CLASS: BTECH** **SEMESTER: VI**
**BRANCH: CHAMICAL ENGG** **SESSION: SP/2020**

**SUBJECT: CL6005 MODERN SEPARATION PROCESSES**

**TIME: 1.5 HOURS** **FULL MARKS: 25**

**INSTRUCTIONS:**
1. The total marks of the questions are 30.
2. Candidates may attempt for all 30 marks.
3. In those cases where the marks obtained exceed 25 marks, the excess will be ignored.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. The missing data, if any, may be assumed suitably.
6. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

---

Q1 (a) A 1-in-diameter Stefan tube is used to measure the binary diffusion coefficient of water vapor in air at 26.66°C and 1 bar. The tube is partially filled with water with a distance from the water surface to the open end of the tube of 10 in. Dry air is blown over the open end of the tube so that water vapor rising to the top is removed immediately and the concentration of vapor at the top of the tube is zero. During 10 days of continuous operation at constant pressure and temperature, the amount of water that has evaporated is measured to be 1.14 gm. Determine the diffusion coefficient of water vapor in air at 26.66°C and 1 bar. [5]

Q2 (a) The system n-pentane(1) n-hexane(2) and n-heptane form an ideal solution. If a feed stream of overall composition $x_1 = 0.3$, $x_2 = 0.3$ and $x_3 = 0.4$ is continuously fed to a flash vaporizer maintained at 200kPa and 90°C, determine the composition of the liquid and vapor streams leaving the flash unit and the fraction of feed vaporized in the unit. The Antoine constants are given by [5]

| | A | B | C |
|---|---|---|---|
| n-pentane (1) | 6.87632 | 1075.780 | 233.205 |
| n-hexane(2) | 6.91058 | 1189.640 | 226.280 |
| n-heptane(3) | 6.89386 | 1264.370 | 216.640 |

The Antoine equation is $\log_{10}^{P} = A - \frac{B}{t + C}$ ; where P is in Torr and t is in °C

Q3 (a) For the system ethyl ethanoate (1)/ n-heptane (2) at 343.15 K (70°C), [5]

$$\ln(\gamma_1) = 0.95x_2^2 \; ; \quad \ln(\gamma_2) = 0.95x_1^2$$

$$P_1^{sat} = 79.80kPa \; , \qquad P_2^{sat} = 40.50kPa$$

Assuming the validity of equation $Py_i = \gamma_i x_i P_i^{sat}$

What is the azeotrope composition and pressure at T = 343.15 K (70°C)?

Q4 (a) Derive the equations for calculation of bubble temperature, dew temperature, bubble pressure and dew pressure for multicomponent system. [5]

Q5 (a) Mention driving forces are involved in membrane separation processes. [2]
(b) State the principle of Reverse Osmosis. With the help of a diagram show the movement of solute and solvent particles. [3]

Q6 (a) What are the types of membrane fouling? Plot the fouling and cleaning curves of the same (flux v/s time). [2]
(b) Represent the characteristics of membranes used in different membrane separation processes(Microfiltration, Ultrafiltration, Reverse Osmosis, Electrodialysis, Gas Separation, Pervaporation and Nanofiltration) and applications of such processes in tabular form. [3]

**:::: 02/03/2020M ::::::**