BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

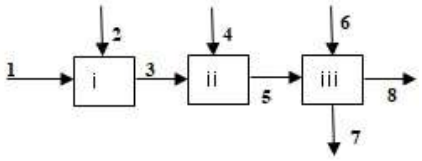
CLASS: BE **SEMESTER : V**
BRANCH: CHEM **SESSION : MO/18**

SUBJECT: CL5007 COMPUTER AIDED PROCESS ENGINEERING

TIME: **FULL MARKS: 60**

INSTRUCTIONS:
1. The question paper contains 7 questions each of 12 marks and total 84 marks.
2. Candidates may attempt any 5 questions maximum of 60 marks.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) Formulate independent material balance equations in a bio-system with three multiple unit operation at steady state. Organize the system with degree of freedom analysis. [8]



Note: The system has four components W (Water), G (Glucose), L (Lactobacillus) and V (Vitamin).

The mass compositions of each stream are as follows: 1) Water (W): 100%; 2) Glucose (G): 100%; 3) W and G, mass fractions: x_W = ? and x_G = ?; 4) Lactobacillus (L): 100%; 5) W, G, and L, mass fractions: x_W = 0.769, x_G = 0.192, x_L = 0.0385; 6) Vitamin (V): 100%; 7)W and V, mass fraction sx_W = ?, x_V = ?; 8) W and L mass fractions: x_G = 0.833, x_L= 0.167. The flowrates of all the streams are unknown.

Q.1(b) Apply a numerical method with solution methodology and algorithm for the bio-system of multiple units mentioned above. [4]

Q.2(a) Formulate unsteady composition and energy balance equations of a CSTR with cooling jacket for the following second order exothermic reaction: A+B→C+ΔH, with reaction rate $-r_A = -r_B = kc_Ac_B$. [6]

Q.2(b) Demonstrate *Matlab* function required to solve the CSTR-system mentioned. [4]

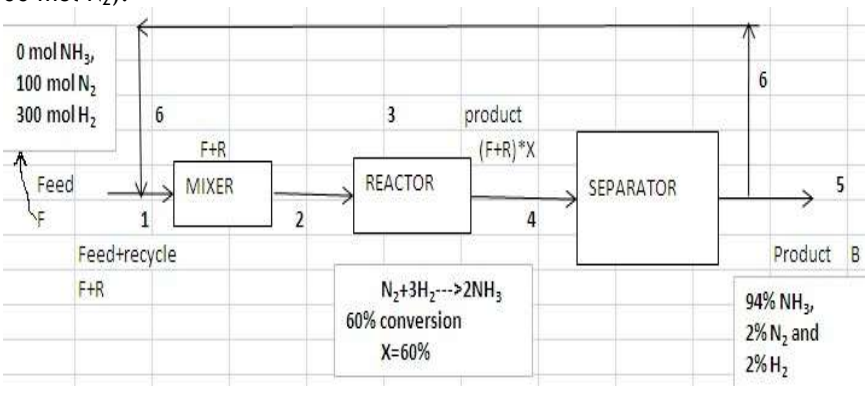
Q.2(c) Show the components of Matlab function '*fsolve*'. [2]

Q.3(a) Define liquid-liquid equilibria with its application in chemical engineering. [2]

Q.3(b) Solve the bubble point temperature from a saturated liquid mixture of benzene and toluene containing 45 mole percent benzene and 55 mole percent toluene at 200 kPa. Benzene and toluene mixture are considered as ideal. $lnP^{sat} = A - B/(T + C)$, P^{sat} in kPa and T is in K. Note: Show two iterations. [10]

Compound	A	B	c
Benzene (1)	14.1603	2948.78	– 44.5633
Toluene (2)	14.2515	3242.38	– 47.1806

Q.4(a) Formulate Excel-VBA spread-sheet calculationto find steady state molar flow rate of H_2recycle streams for 60% conversion; complete a mass balance for this process using Excel. Take basis F=400 mol (300 mol H_2 and 100 mol N_2). [8]



Q.4(b) Explain vapor-liquid equilibria of nonideal binary mixture using Wilson equation. [4]

PTO

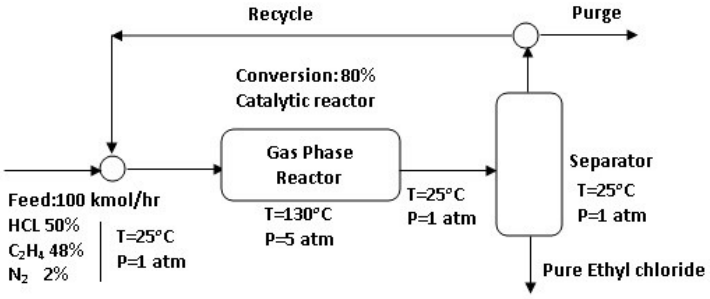
Q.5(a) What is transient analysis of a chemical process? [2]

Q.5(b) Derive material balance equations of a mixing tank to mix two inlet streams each of different composition of components A and B (compositions of stream 1: x_{1A}& $x_{1B}$and stream 2: x_{2A}& x_{2B}). [4]

Q.5(c) Derive unsteady state material and energy balance equations of a tubular plug flow reactor with axial dispersion (Diffusion coefficient D) for 1st order irreversible reaction, A→ B. [6]

Q.6(a) Explain the components and specifications of following units in ASPEN plus: i) RadFrac, ii) RStoic [6]

Q.6(b) Build ASPEN plus flow sheet of the ethyl chloride production process presented below. The required intermediate units are not presented here. Assume all the suitable units in the intermediate and actual places where these are required. $C_2H_4 + HCl \xrightarrow{Catalyst} C_2H_5Cl$ [6]



Q.7(a) Classify different types of probability density functions in engineering applications with example and mathematical formula? [6]

Q.7(b) An air filter has been designed to remove particulate matter. A test calls for 40specimens of air to be tested. Of 40 specimens, the number of specimens with their particle number are listed below. [6]

Number of particles	0	1	2	3	4
Specimen frequency	10	15	8	5	2

a) Evaluate experimental probability distribution.

b) Estimate the mean of the frequency distribution from the given data.

c) Evaluate Poisson probability distribution from the experimental data.

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