1. A feed mixture containing solute 1, solute 2 and the carrier in the ratio 2:3:4, available at overall feed rate of 90 moles/hour is subjected to two stage cross current extraction. The solvent flow rate at each stage is 10 moles/hour. Assume liquid-liquid equilibrium with constant distribution coefficients at the given temperature and pressure as follows

Component	Kdi value
Solvent	4.20
Component 1	1.75
Component 2	0.74
Carrier	0.34

   Calculate the compositions and the overall molar flow rates of extract from the 2 stages

   Hint: for each stage, get the initial estimate of Ψ, by checking whether the value of f(Ψ) is close to 0, as the value of Ψ is systematically varied within the range from 0 to 1 in steps of 0.2. You are expected to show two Newton Raphson iteration based on the initial estimate.

2. Answer briefly
   a) Which parameter is considered as a tear variable in isothermal sum rate method for liquid-liquid extraction? How is this tear variable related to other parameters in the algorithm?
   b) How is the tear variable initialized?
   c) How is the tear variable updated? What is the rationale?
   d) What is the error criterion to be checked with tear variable for convergence? Is normalization of tear variable required, and if so, why?
   e) How is the mole fraction normalized in the above-referred algorithm? Why is it necessary?

3. For a four-component mixture (Feed + solvent), the distribution coefficient of each component (xi1, xi2) is not composition dependent, and is listed here against the mixture mass fraction of the respective components.

Component	zi	Ki
1	0.01	16.2
2	0.15	5.2
3	0.39	1.98
4	0.45	0.28

   If in batch process the total weight of the mixture is 200gm, find the weights of extract and raffinate phases. Hint: for initial estimate of Ψ check whether the value of f(Ψ) is close to 0, as the value of Ψ is systematically varied within range from 0 to 1.

4. If 1 gm of the extract from the above process is mixed with 1 gm of a separate stock of the four-component mixture, referred above, find the weights of the extract and raffinate phases.

5. A three-component mixture (Feed + solvent) with composition, given below separates out into two liquid phases. The distribution coefficient of each component (xi1, xi2) is not composition dependent, and is listed here against the mixture mass fraction of the respective components.

Component	Zi	Ki
1	0.10	5.2
2	0.40	1.98
3	0.50	0.28

   If in batch process the total weight of the mixture is 100gm, find the weights of the two liquid phases at equilibrium. Hint: for initial estimate of Ψ check whether the value of f(Ψ) is close to 0, as the value of Ψ is systematically varied within range from 0 to 1.

6. If 1 gm of the liquid phase that contains higher fraction of Component 1 (in comparison with the other liquid phase, referred above) is mixed with 1 gm of Component 1 in pure state, find the weights of resulting two liquid phases at equilibrium.