MODEL QUESTION PAPER
Seventh Semester B.Tech Degree Examination
CHEMICAL ENGINEERING BRANCH
(2013 Scheme)
13.702 MASS TRANSFER OPERATIONS - II (H)

Time: 3 Hours Max. Marks: 100

PART-A

Answer **all** questions. **Each** question carries 2 marks.

1. Explain minimum reflux ratio in fractional distillation.
2. Explain maximum boiling azeotrope with the help of phase diagram.
3. Defend the use of steam distillation for purification of high boiling, heat sensitive materials.
4. Explain the ternary liquid equilibrium of type-I systems and the effect of temperature.
5. Explain selectivity and distribution coefficient and their significance in the choice of solvent for extraction.
6. Draw a neatly labelled sketch of a Rotating disk contactor.
7. Explain the Shank's system for leaching.
8. Explain ion-exchange equilibria.
9. Discuss the validity of Langmuir and Freundlich isotherms in separation by adsorption.
10. Explain breakthrough curve in fixed-bed adsorption.

(**10x2=20 Marks**)

PART – B

Answer **one full** question from **each** Module. **Each** question carries **20** marks.

Module – I

11. a). Derive Rayleigh's equation for differential distillation. **7**

b). A feed containing 40 mole percent methanol and 60 mole percent water at its boiling point is to be separated into an overhead product with 95% methanol and a residue of 6% methanol. The reflux ratio is 30% in excess of the minimum. The column is provided with a total condenser and a partial reboiler. Calculate the number of trays required if the overall efficiency is 70%.
Equilibrium data:

x	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
y	0.42	0.58	0.67	0.73	0.78	0.83	0.87	0.92	0.96	1.0

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12. A total of 100 gm-mol feed containing 40 mole percent n-hexane and 60 percent n-octane is fed per hour to be separated at one atm to give a distillate that contains 92 percent hexane and the bottoms 7 percent hexane. A total condenser is to be used and the reflux will be returned to the column as a saturated liquid at its bubble point. A reflux ratio of 1.5 is maintained. The feed is introduced into the column as a saturated liquid at its

bubble point. Use the Ponchon-Savarit method and determine the following:

(i) Minimum number of theoretical stages

(ii) The minimum reflux ratio

(iii) The heat loads of the condenser and reboiler for the condition of minimum reflux.

(iv) The quantities of the distillate and bottom streams using the actual reflux ratio.

VLE Data, Mole Fraction Hexane, 1 atm

x	0	0.1	0.3	0.5	0.55	0.7	1
y	0	0.36	0.7	0.85	0.9	0.95	1

Enthalpy – concentration data

Mole fraction, Hexane		0	0.1	0.3	0.5	0.7	0.9	1
Enthalpy, Cal/gm-mol	Sat. Liquid	7000	6300	5000	4100	3400	3100	3000
	Sat. Vap	15,700	15,400	14,700	13,900	12,900	11,600	10,000

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Module – II

13. 100kg of solution containing 10% acetaldehyde and 90% toluene is treated with water in a three-stage cross current unit to extract acetaldehyde. 25 kg water is used in each stage. The equilibrium is represented by $Y' = 2.2\ X'$ where X' is the kg acetaldehyde per kg toluene and Y' is the kg acetaldehyde per kg water. Assume that water and toluene are completely insoluble. Determine the percent extraction on acetaldehyde.

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14. a). Explain any two liquid extractor with the help of neat sketches. **8**

b). Explain the method of determination of number of stages in continuous multistage counter current extraction. **12**

Module – III

15. Flaked soyabeans are to be leached with hexane to remove the soyabean oil . The flakes in layer form are fed onto a slowly moving perforated endless belt that passes under a series of continuously operating sprays. As the solid passes under each spray, it is showered with liquid. The showered liquid percolates through a solid , collects in a trough below and is recycled to the spray by means of pump. The sprays are spaced in such a way that the solid leaving a spray is permitted to drain for a period of 6min before it reaches the next spray. The solvent also passes from trough to trough in countercurrent fashion with respect to a moving belt and hence maintaining truly continuous countercurrent stagewise operation with a each spraying and draining constituting a stage.It is found that the flakes retain solution after 6min drain time to an extend depending upon the oil content of the solution. The solution retained as function of oil concentration data are as follows:

Solution composition, weight % oil in solution	0	20	30

Solution retained, kg of solution/kg of insoluble solid	0.58	0.66	0.70

The soyabean flakes entering the unit contain 20% oil by weight and are to be leached to 1% oil (on solvent-free basis). The net forward flow of solvent to be 1kg hexane introduced as fresh solvent per kg of flakes. The fresh solvent is free of oil. The solvent draining from the flakes is generally free of solid except in the first stage, the miscella contains 10% of the insoluble solid in the feed as suspended solid, which falls through the perforations of the belt during loading. Determine graphically theoretical stages required. **20**

16. a). Write notes on:
i). Membrane separation process
ii). Electro dialysis
iii). Concentration polarization in reverse osmosis **6**

b). Oil is to be extracted from halibut liver using ether in a counter current multistage unit. The feed contains 0.35 kg oil per kg exhausted liver and it is desired to obtain a 90% oil recovery. The equilibrium data is given:

Concentration of overflow, kg oil/kg solution	0	0.10	0.20	0.30	0.40	0.50	0.60	0.67
Entrainment, kg solution/kg exhausted liver	0.28	0.34	0.40	0.47	0.55	0.66	0.80	0.96

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Module – IV

17. a). Explain heat of adsorption. **5**
b). Explain the phenomena of adsorption from dilute and concentrated solutions. **15**

18. The equilibrium adsorption of benzene vapour on activated charcoal is given as:

m^3 of benzene/100kg charcoal	15	25	40	50	65	80	90	100
Partial pressure of benzene, mm Hg	0.001	0.0045	0.0251	1.115	0.251	1.00	2.81	7.82

A gas mixture of nitrogen and benzene vapor containing 1% benzene by volume is passed at the rate of 100m^3/h countercurrent to a moving stream of activated charcoal to remove 95% of the benzene present. Determine:
i). The least amount of charcoal required.
ii). Concentration of benzene in the charcoal for twice the amount of charcoal
iii).The number of ideal stages for case ii). **20**

(**20x4=80**)