Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL

(A constituent institution of MAHE, Manipal)

V SEMESTER B.TECH BIOTECHNOLOGY

END SEMESTER EXAMINATIONS, NOVEMBER/DECEMBER 2018

23rd November 2018, 2-5 PM

SUBJECT: SEPARATION TECHNIQUES IN BIOTECHNOLOGY (BIO3103)

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A	It is decided to absorb 90% of Chlorine gas in air by using countercurrent flow of fresh water at 25^0C. **Data**: Henry's constant for chlorine in water is 0.095 mol/(liter.bar). Air flow rate is 10 m^3/min at 1 atm/25^0C. Initial concentration of chlorine gas is 0.5 % by volume. i. Convert the relationship in the form of Y (molar) vs X (molar) ii. Compute the minimum amount of solvent required in kg/min. iii. Estimate the number of trays required if 1.3 times the minimum solvent is utilized.	**2** **2** **1**
1B	A liquid feed with initial mole fraction of 0.55 is subjected to differential distillation such that mole fraction of the final liquid in residue is 0.30. Calculate the fraction of liquid vaporized. For the equilibrium data, assume constancy of relative volatility α=1.8 at the given pressure of operation.	**3**
1C	Explain how Eucalyptus oil can be extracted from its leaves using steam distillation process. Identify some of the process parameters that affect the efficiency of the operation.	**2**
2A	Two spent streams of Water-Acetic acid are mixed. First liquid stream (75 moles) with water (35% mole) and second stream (25 moles) with water (80% mole). The mixed solution was flashed at 26.66kPa such that final distillate mole fraction is 0.52.	**4**

Compute the Nm^3 (at NTP) of vapor generated and composition of the residue liquid. Mole fraction data of water in VLE is as below.

x	0	0.3	0.454	0.633	0.769	0.857	0.927	0.967	1
y	0	0.4	0.573	0.733	0.839	0.899	0.949	0.978	1

2B A binary feed consisting of 50 mol% of more volatile component is separated in a staged distillation column. The mole fraction of the more volatile component in the distillate product is 0.95. The molar flow rate of distillate is 50% of the feed flow rate and the McCabe-Thiele method can be used to analyze the column. The q-line intersects the operating line of the enriching (rectification) section at (0.35, 0.5). Compute (Do not use graph sheet) **3**

i. the residue liquid composition
ii. the slope of the stripping section operating line
iii. the reflux ratio

2C Describe the positive deviation from ideality in the case of VLE. Include azeotrope. **3**

3A At equilibrium, the concentration of water in vapour phase C^{eq} in kg/m^3 of air space and the amount of water (kg) adsorbed per kg of dry silica gel, m, are related by C^{eq}= 0.0667*m. It is required to maintain dry conditions in a room of air space 100 m^3 containing 2.2 kg of water vapour isothermally.

i. If 10 kg of dry silica gel is kept in the room, compute the fraction of initial water remaining in the air space after a long time. **2**
ii. The same operation was done in two stages. Each time 5 kg of dry silica gel was used. What is the final absolute moisture content of the air in kg-moisture/kg dry-air? Density of air is $1.22 kg/m^3$. **2**

3B Following is the isothermal adsorption data of a medicine in water solution (x) by an adsorbent (q). Fit Langmuir isotherm for the adsorption. **3**

q (mg/cm^3 adsorbent)	5.1	6.9	7.9	9.5	10.7
x (mg/Litre solution)	0.011	0.019	0.029	0.06	0.111

3C The literature describes an HPLC separation in which k'_A= 0.75, k'_B= 1.54, k'_C= 2.38, k'_D= 3.84. Can this separation be carried out in a low-pressure column having only 300 plates, with the same phase system and a minimum resolution of 1.0? **3**
Take each pair of neighboring analytes in the chromatogram and do the analysis. Take average k' for pairwise calculations.

4A The sample size in Ion Exchange Chromatography should be selected so that the maximum column exchange capacity is not utilized by more than 5%. The cation exchanger Li Chrosorb CXS has an exchange capacity of 850 μeq/g. The column is filled with 15g of gel. What is the maximum amount of radioactive $^{24}NaCl$ sample permitted? **2**

4B For an HPLC, describe the characteristics of an Ideal Detector. Take the case of UV and RI detectors for illustrations. **3**

4C

Explain the following,

i. Relationship between Mol. Wt., Molecular Size/Shape with k_d in size exclusion chromatography — **2**

ii. Operating principle of Affinity chromatography — **1**

4D

Determine the Van Deemter constants and optimum HETP for a 10μm particle HPLC column based on the following data. — **2**

HETP, cm	0.123	0.0883	0.306
u, cm/min	0.5	0.7	0.2

5A

Tomato needs to be dried by blowing hot air. With the help of an equilibrium diagram, explain the various types of moisture contents in the vegetable. — **2**

5B

In order to test the feasibility of drying a certain foodstuff, drying data were obtained in a tray dryer with air flow over the top exposed surface having an area of 0.186 m^2. The bone dry sample weight was 3.765 kg dry solid. The following sample weight vs. time were obtained in the drying test.

Time, h	Weight, kg	Time, h	Weight, kg	Time, h	Weight, kg
0	4.944	2.2	4.554	7.0	4.019
0.4	4.885	3.0	4.404	9.0	3.978
0.8	4.808	4.2	4.241	12.0	3.955
1.4	4.699	5.0	4.150	16.0	3.955

i. Compute the free moisture (kg/kg) and tabulate — **1**

ii. Compute and tabulate rate of drying (kg-M/[kg-DS.m^2.hr]) for each of time data based on central difference method. Provide one specimen calculation — **1**

iii. Plot rate of drying (kg-M/[kg-DS.m^2.hr]) vs. free moisture content (kg/kg) Comment on the type of solid and the driving force — **1**

5C

Explain the

i. Mier's theory of Supersaturation and its limitations — **2**

ii. Ostwald's ripening. — **1**

5D

An antibiotic needs to be crystallized from its solution. Describe the important factors affecting the crystal habit (external shape). — **2**