Name:

Enrolment No:

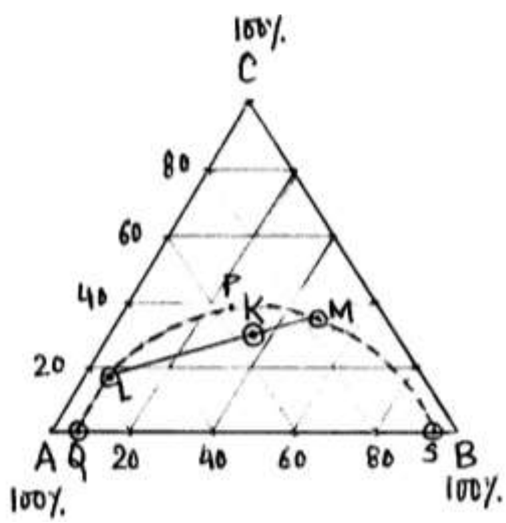
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2019

Programme Name: B. Tech in Applied Petroleum Engineering, Spl. Gas **Semester : IV**
Course Name : Mass Transfer Operations **Time : 03 hrs.**
Course Code : CHEG 211 **Max. Marks : 100**
Nos. of page(s) : 2

Instructions: The exam will be OPEN BOOK and OPEN NOTES exam. The students are allowed any textbooks, photo-copied and hand-written notes. The Question paper has to be returned.

SECTION A [30]

S. No.		Marks	CO
Q1.	When coal is burned, oxygen from air is used for the combustion and carbon dioxide is released. The rate of burning depends on the rate at which oxygen is reaching the coal surface. If the flow of oxygen and carbon dioxide is assumed to be equal, then calculate the rate of combustion of coal at 40°C and 1 atm. The concentration of oxygen at the coal surface may be assumed to be 5 mol%. The system may be assumed to be valid in cartesian coordinates. The Diffusivity over a small air film thickness of 5 cm near the coal surface is given by 2.5×10^{-5} m^2/sec.	**[15]**	**CO1**
Q2.	The ternary plot for an extraction process is given below. Let the point "K" represent the mixture of carrier A, solute C and solvent B, that is fed to the process for extraction. The curve QPS represents the Liquid-Liquid-Equilibrium (LLE) for the system. Using the figure get the following information: *(Solve on the question paper and return it along with the answer sheet)* a) Compositions of A, B and C at point K b) Composition of C in the Extract and Raffinate phases. 	**[15]**	**CO5**

SECTION B [40]

Q3. Sour water (H_2S+water) is added to a stripping column containing 0.5% H_2S in water at 200 kmol/hr. The process is carried out in a packed column of 2 m^2 cross-sectional area and containing 1.5 mm ceramic Raschig rings at 90°C and 1 atm. Pure steam is added from the bottom at 150 kmol/hr to remove 98% H_2S from water. Calculate the height of the packing required for the process if the overall mass transfer coefficient is $K_L.a$ = 150 kmol/hr.m^3. The equilibrium relation is given by **y = 1.58x.** Assume no condensation of steam is occurring in the column.
(Hint: You may take necessary assumptions)

[20] **CO4**

Q4. Benzene can be removed from air by adsorption process, using activated carbon. Air-benzene mixture containing 25% benzene vapor is fed to a cross-current 3 staged process at 50 Kg/hr at 35°C and 1 atm. If 300 kg/hr of activated carbon is equally divided in each of these stages, calculate the percentage recovery of benzene at the end of the process. The equilibrium data for the system is as follows:

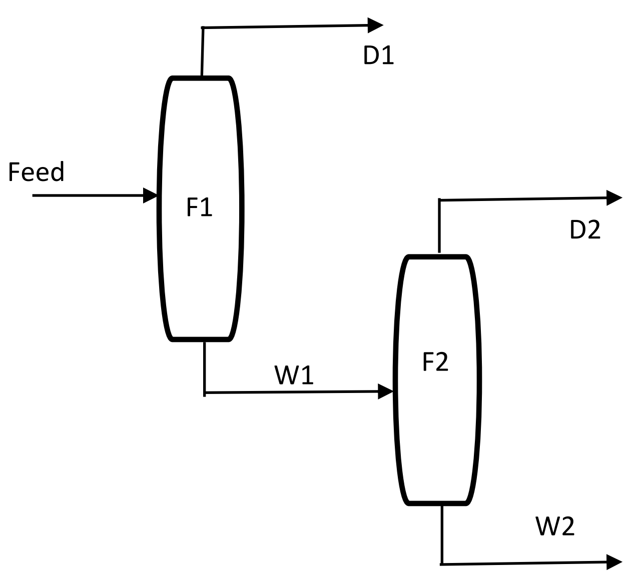
y	0.0010	0.0045	0.0251	0.115	0.251	0.398	0.515	0.813
X	0.0522	0.087	0.139	0.174	0.226	0.278	0.313	0.348

Here, y is Partial pressure of benzene in air (atm) and X is Kg benzene/kg carbon

[20] **CO4**

SECTION-C [30]

Q5. A liquid mixture containing 40% propane and 60% benzene is fed to 2 single staged flash separators as shown below. The liquid mixture is fed to flash F1 at 200 kmol/hr and the distillate D1 is removed at 80 kmol/hr. For improved separation, the residue from flash F1 is fed as a feed to flash F2, where the residue W2 is removed at 50 kmol/hr. Both the flash separators are operated at 10 atm and 80°C. The average relative volatility may be assumed constant at 2.9. Calculate the percentage of propane separated.



[30] **CO5**