Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2019

Course: Chemical Engineering II (Unit Operations) (CHEG 237) **Semester: IV**
Program: BTech Fires and Safety Engineering
Time: 03 hrs. **Max. Marks: 100**

Instructions: Students are advised to answer questions sequentially and start each answer of a new sheet of paper.

SECTION A
All the questions are compulsory (Max marks 4 x 5 = 20)

S. No.		Marks	CO
Q1	List various types of screens used in water/wastewater treatment and their corresponding size.	5	CO1, CO4
Q2	What are ceramics? List various types of ceramics.	5	CO5
Q3	What is the advantage of using conveyor belts for transportation of material?	5	CO1
Q4	Define i) Fourier's Law and ii) Fick's Law.	5	CO5
	SECTION B **All questions are compulsory (Max marks 4 x 10 = 40)**		
Q5	Explain the working of a double pipe and a shell and tube heat exchanger with the help of a diagram.	10	CO3, CO4
Q6	How do ceramics compare with metals? Which is a better choice for process requiring material with high hardness?	10	CO1, CO5
Q7	What is crystallization? What is the basic requirement for any crystallizer? What is the role of solubility curve of the solute in crystallization?	10	CO2, CO3,
Q8	With the help of a diagram describe the working of a rapid sand filter in detail. ***Or*** With the help of a diagram describe the working of a slow sand filter in detail.	10	CO1, CO5
	SECTION-C (2 x 20 = 40) **Answer any two question from this section (Max marks 40)**		
Q9	Derive the expression for heat transfer (from inside of the cylinder to outside) through a hollow cylinder. The inside radius of the cylinder is r_i, the outside radius is r_o, and the length of the cylinder is L. The thermal conductivity of the material of which the cylinder is made is k. The temperature of the outside surface is T_o, and that of the inside surface is T_i. Explain all the assumptions made in solving the problem. ***Or*** Consider a flat wall constructed of a series of layers (A, B and C). Let the thickness of the layers be B_A, B_B *and* B_C and the average conductivities of the material of which the layers are made be k_A, k_B and k_C, respectively. Also let the area of the compound wall, perpendicular to the direction of heat transfer, be A. Let ΔT_A, ΔT_B and ΔT_C be the temperature drops across the layers A, B and C,	20	CO2, CO3

<table>
<tr><td></td><td>respectively. Derive an equation for calculating the rate of heat flow through the series of layers and show how the rate can be calculated as the ratio of the overall temperature drop ΔT to the overall thermal resistance of the wall.</td><td></td><td></td></tr>
<tr><td>Q10</td><td>A continuous fractionating column is to be designed for separating 10,000 kg per hour of a liquid mixture containing 40 mole percent methanol and 60 mole percent water into an overhead product containing 97 mole percent methanol and a bottom product having 98 mole percent water. A mole reflux ratio of 3 is used. Calculate (i) moles of overhead product obtained per hour and (ii) number of ideal plates and location of the feed plate if the feed is at its bubble point.

Equilibrium data:
<table>
<tr><td>x</td><td>0.1</td><td>0.2</td><td>0.3</td><td>0.4</td><td>0.5</td><td>0.6</td><td>0.7</td><td>0.8</td><td>0.9</td></tr>
<tr><td>y</td><td>0.417</td><td>0.579</td><td>0.669</td><td>0.729</td><td>0.78</td><td>0.825</td><td>0.871</td><td>0.915</td><td>0.959</td></tr>
</table>
Where x = mole fraction of methanol in liquid
And y = mole fraction of methanol in vapor

What will be the effect on the overall economy of the process if the thermodynamic state of the feed is changed from bubble to dew point?</td><td>20</td><td>CO5</td></tr>
</table>

Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2019

Course: Chemical Engineering II (Unit Operations) (CHEG 237) **Semester: IV**
Program: BTech Fires and Safety Engineering
Time: 03 hrs. **Max. Marks: 100**

Instructions: Students are advised to answer questions sequentially and start each answer of a new sheet of paper.

SECTION A
All the questions are compulsory (Max marks 4 x 5 = 20)

S. No.		Marks	CO
Q1	List various types of screens used in water/wastewater treatment and their corresponding size.	5	CO1, CO4
Q2	Describe the steps involved in making activated carbon.	5	CO1
Q3	Under what conditions use of conveyor belts is more advantageous over manual handling for transportation of material.	5	CO4
Q4	Define i) magma and ii) CSD.	5	CO1
	SECTION B **All questions are compulsory (Max marks 4 x 10 = 40)**		
Q5	Explain the working of a double pipe and a shell and tube heat exchanger with the help of a diagram.	10	CO3, CO4
Q6	What is the importance of material balance in chemical process design? Write steps involved in material balance calculations.	10	CO3, CO5
Q7	What is crystallization? What is the basic requirement for any crystallizer? What is the role of solubility curve of the solute in crystallization?	10	CO2, CO3,
Q8	With the help of a diagram describe the working of a rapid sand filter in detail. ***Or*** With the help of a diagram describe the working of a slow sand filter in detail.	10	CO1, CO5
	SECTION-C (2 x 20 = 40) **Answer any two question from this section (Max marks 40)**		
Q9	Derive the expression for heat transfer (from inside of the cylinder to outside) through a hollow cylinder. The inside radius of the cylinder is r_i, the outside radius is r_o, and the length of the cylinder is L. The thermal conductivity of the material of which the cylinder is made is k. The temperature of the outside surface is T_o, and that of the inside surface is T_i. Explain all the assumptions made in solving the problem. ***Or*** Consider a flat wall constructed of a series of layers (A, B and C). Let the thickness of the layers be B_A, B_B *and* B_C and the average conductivities of the material of which the layers are made be k_A, k_B and k_C, respectively. Also let the area of the compound wall, perpendicular to the direction of heat transfer, be A.	20	CO2, CO3

<table>
<tr><td></td><td>Let ΔT_A, ΔT_B and ΔT_C be the temperature drops across the layers A, B and C, respectively. Derive an equation for calculating the rate of heat flow through the series of layers and show how the rate can be calculated as the ratio of the overall temperature drop ΔT to the overall thermal resistance of the wall.</td><td></td><td></td></tr>
<tr><td>Q10</td><td>A saturated liquid mixture containing 60 mole % benzene and 40 mole % toluene is to be distilled continuously into a distillate product containing 90 mole % benzene and the bottom product containing 5 mole % benzene. The fractional distillation column will operate at approximately constant pressure of 1 atm. The reflux ratio is 2. How many theoretical plates must the column have if the feed is introduced into the eighth plate? Equilibrium data are:

<table>
<tr><td>x</td><td>0</td><td>0.017</td><td>0.075</td><td>0.13</td><td>0.211</td><td>0.288</td><td>0.37</td><td>0.411</td><td>0.581</td><td>0.78</td><td>1</td></tr>
<tr><td>y</td><td>0</td><td>0.039</td><td>0.161</td><td>0.261</td><td>0.393</td><td>0.496</td><td>0.591</td><td>0.632</td><td>0.777</td><td>0.9</td><td>1</td></tr>
</table>

Where x = mole fraction of methanol in liquid
And y = mole fraction of methanol in vapor

What will be the effect on the overall economy of the process if the thermodynamic state of the feed is changed from saturated liquid to saturated vapour mixture?</td><td>20</td><td>CO5</td></tr>
</table>