Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, July 2020

Course: Chemical Engineering II (Unit Operations) (HSFS2004) **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	Define/write: a) Comminution b) Magma c) Fourier's law d) Fick's law	**5**	**CO1**
Q2	Suppose a stack gas contains equimolar amounts of CO_2, N_2 and H_2O. Find the composition on wet and dry basis?	**5**	**CO2**
Q3	Explain theory of diffusion using analogy between heat flow and mass diffusion. How heat flow is different from mass diffusion?	**5**	**CO2**
Q4	What is filtration? Give classification of filters based on driving force and filter media.	**5**	**CO4**
	SECTION B **All questions are compulsory (Max marks 4 x 10 = 40)**		
Q5	What is the effect of thermodynamic state of the feed on the position of the feed tray? Discuss in detail.	**10**	**CO4**
Q6	How do ceramics compare with metals? Which is a better choice for process requiring material with high hardness?	**10**	**CO5**
Q7	Analyze the role of solubility curve in selection of method used to supersaturate product in crystallization. Give examples. What is the basic requirement for any crystallizer?	**10**	**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**
	SECTION-C (2 x 20 = 40) **Answer any two question from this section (Max marks 40)**		
Q9	A tube 60 mm OD is insulated with a 50 mm layer of silica foam, for which the conductivity is 0.055 W/m^{o}C, followed with a 40 mm layer of cork with a conductivity of 0.05 W/m^{o}C. If the temperature of the outer surface of the pipe is 150^{o}C and the temperature of the outer surface of the cork is 30 ^{o}C, calculate the heat loss in watts per meter of pipe. **(8 marks)**	**20**	**CO3/CO5**

	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, 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. **(12 marks)**		
Q10	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: x: 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 y: 0.417, 0.579, 0.669, 0.729, 0.78, 0.825, 0.871, 0.915, 0.959 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? **OR** What is clarification or sedimentation and where is it used in water and wastewater treatment? Give classification of the types of sedimentations. **(marks 12)** Derive the expression for terminal velocity (V_t) of a spherical particle (density ρ_p, diameter d) settling in a fluid with density ρ_w and the drag coefficient in the liquid is C_d. **(marks 8)**	**20**	**CO5/CO3**