

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2018

Course: CHPD7008 – Process Design and Flowsheeting
Program: M. Tech Chemical Engineering (Process Design)
Time: 03 hrs.

Semester: II

Max. Marks: 100

Instructions:

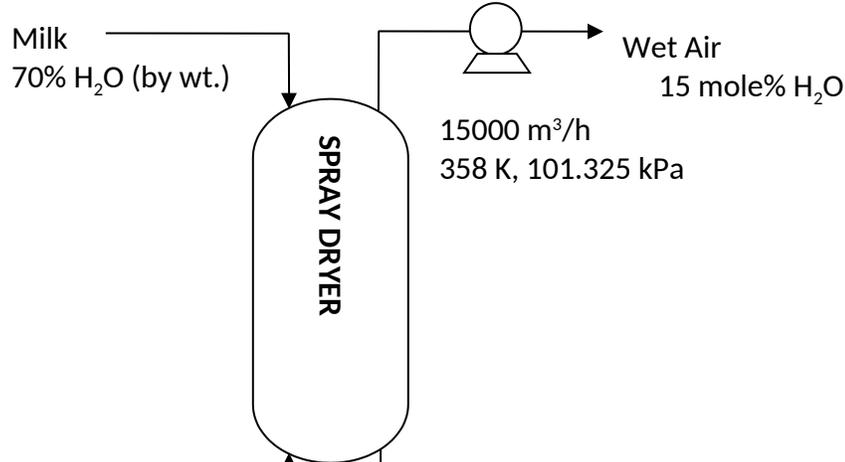
- Attempt *all* the questions
- Assume suitable data wherever necessary.
- The notations used here have the usual meanings.

SECTION A (4 x 5 = 20 Marks)

S. No.		Marks	CO
Q 1	Write in short about the working of a process simulator.	05	CO5
Q 2	Discuss about the fitness testing in a process design.	05	CO1
Q 3	Explain about the intensification used in inherently safe design with suitable examples.	05	CO1
Q 4	Distinguish between steady state and unsteady state simulation.	05	CO5

SECTION B (4 x 15 = 60 Marks)

Q 5	<p>Methyl ethyl ketone (MEK) is manufactured by the dehydrogenation of 2-butanol. A simplified description of the processes listing the various units used is given below:</p> <ol style="list-style-type: none"> 1. A reactor in which the butanol is dehydrated to produce MEK and hydrogen, according to the reaction: $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHOH} \longrightarrow \text{CH}_3\text{CH}_2\text{CH}_3\text{CO} + \text{H}_2$ <p>The conversion of alcohol to MEK is 88 per cent and the yield can be taken as 100 per cent.</p> 2. A cooler-condenser, in which the reactor off-gases are cooled and most of the MEK and unreacted alcohol are condensed. Two exchangers are used but they can be modelled as one unit. Of the MEK entering the unit 84 per cent is condensed, together with 92 per cent of the alcohol. The hydrogen is noncondensable. The condensate is fed forward to the final purification column. 3. An absorption column, in which the uncondensed MEK and alcohol are absorbed in water. Around 98 per cent of the MEK and alcohol can be considered to be absorbed in this unit, giving a 10 per cent w/w solution of MEK. The water feed to the absorber is recycled from the next unit, the extractor. The vent stream from 	15	CO2
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	<p>the absorber, containing mainly hydrogen, is sent to a flare stack.</p> <ol style="list-style-type: none"> An extraction column, in which the MEK and alcohol in the solution from the absorber are extracted into trichloroethylene (TCE). The raffinate, water containing around 0.5 per cent w/w MEK, is recycled to the absorption column. The extract, which contains around 20 per cent w/w MEK, and a small amount of butanol and water, is fed to a distillation column. A distillation column, which separates the MEK and alcohol from the solvent TCE. The solvent containing a trace of MEK and water is recycled to the extraction column. A second distillation column, which produces a pure MEK product from the crude product from the first column. The residue from this column, which contains the bulk of the unreacted 2-butanol, is recycled to the reactor. <p>Draw a process flow diagram for the process.</p>		
Q 6	<p>Draw a neat diagram of block and bypass valve assembly for a control valve used in P&ID. Explain its working.</p>	15	CO4
Q 7	<p>Milk powder is produced in spray dryer which evaporates all of liquid water. The process operation is shown in Fig. 1.</p> <div style="text-align: center;">  <p>Fig. 1: Production of milk powder in spray dryer</p> </div> <p>If dry air is used as inlet air, calculate: (a) production rate of powdered milk; (b) molar flow rate of inlet air.</p>	15	CO3
Q 8	<ol style="list-style-type: none"> Discuss about the various constraints in process design. Discuss about the importance of energy availability in selecting the plant location for chemical engineering industry. 	10 05	CO1

