BACHELOR OF CHEMICAL ENGINEERING EXAMINATION, 2018

(FOURTH YEARSECOND SEMESTER)

PETROLEUM REFINERY ENGINEERING & PETROCHEMICALS

Time: Three hours | Full Marks: 100
(50 marks for each part)

Use a separate Answer-script for each part

Part I

Answer ***any ten*** questions 10×5

Answers must be brief and to the point

1. What pre-treatments are necessary for LNG preparation and why?
2. What important properties (specifications) LPG must possess? Justify each of them.
3. Justify the necessity of crude desalting step.
4. What is pump-around reflux? Why is it necessary?
5. Hydrogenation reactors are fixed-bed reactors. Why?
6. All the products of the hydrocracker are of the finest variety save and except one — do you agree? Give reasons.
7. Catalytic reforming process in a refinery employs three reactors in series — why? Why they are fixed-bed reactors and of different sizes?
8. On one occasion, naphtha goes to Merox unit whilst in another occasion it goes to the hydrodesulfurization unit. What are the two occasions? Give reasons.
9. There are three main outlets of heavy naphtha. What are they? What are the products produced in each case?
10. What will happen if the RVP of gasoline is too high or too low?
11. Aviation fuel must be tested for its thermal stability — why?

Ref. No.: **Ex/ChE/T/424B/2018**

B. Chemical Engineering (4th Year 2nd Semester) Examination, 2018

PETROLEUM REFINERY ENGINEERING & PETROCHEMICALS

Time: Three Hours | Full Marks: 100

Use a separate Answer-Script for each part

Part II

Answer questions covering the COs (Course outcomes)

CO4 [30]	**Answer Q. 1 or Q. 2** [30] 1.(i) Consider, the following cases and comment on the separation/purification requirements of the feedstock: (a) Separation of methane from hydrogen in toluene hydrodealkylation process. (b)Separation of CO from H_2 for phosgene production. [4+4] 1. (ii) In the production of methanol from synthesis gas route, elucidate the purpose of using "cold (or) hot shot" between staged adiabatic packed beds of catalysts. [5] 1.(iii) In the chlorination of ethylene to produce dichloroethane (DCE) , the conversion of ethylene is reported as 99.0%. If 94 mol of DCE are produced per 100 mol of ethylene reacted, calculate the selectivity and the overall yield based on ethylene. The unreacted ethylene is not recovered. [5] 1.(iv) The balanced process for vinyl chloride production, comprises of the following blocks. Each block represents a reactor and several other processing units. The main reactions are: *Block A. Chlorination* $C_2H_4 + Cl_2 \rightarrow C_2H_4Cl_2$, yield on ethylene 98% *Block B. Oxyhydrochlorination* $C_2H_4 + 2HCl + 0.5O_2 \rightarrow C_2H_4Cl_2 + H_2O$, yields: on ethylene 95%, on HCl 90% *Block C. Pyrolysis* $C_2H_4Cl_2 \rightarrow C_2H_3Cl + HCl$, selectivity of DCE to VC 99%, selectivity to HCl 99.5% The HCl from the pyrolysis step is recycled to the oxyhydrochlorination step. The flow of ethylene to the chlorination and oxyhydrochlorination reactors is adjusted so that the production of HCl is in balance with the requirement. The conversion in the pyrolysis reactor is limited to 55%, and the unreacted dichloroethane (DCE) is separated and recycled. Using the yields given, and neglecting any other losses, calculate the flow of ethylene to each reactor and the flow of DCE to the pyrolysis reactor, for a production rate of 12,500 kg/h vinyl chloride (VC). [12] 2.(i) There are two technically feasible routes for production of benzene from toluene: (1)

	Disproportionation of toluene and (2) Hydrodealkylation of toluene; as shown below: Route 1 $2A \Rightarrow S + R$ A: Toluene Route 2 $A + H_2 \Rightarrow S + CH_4$ S: Benzene R: Xylene Assuming that pure toluene is fed to the process, the solvents S and R are separable by simple distillation and both are much less volatile than either methane or hydrogen. Sketch block flow diagrams for routes 1 and 2 . Which process is more economical? Explain your reasoning and assumptions. [4+4] 2.(ii) In the production of ethanol by the hydrolysis of ethylene, diethyl ether is produced as a byproduct. A typical feed stream composition is 55 % ethylene, 5% inerts and 40% water. A typical product stream is 52.26% ethylene, 5.49% ethanol,0.16 % ether, 36.81 % water and 5.28% inerts. Calculate the selectivity of ethylene for ethanol and for ether. [8] 2.(iii) Ethylbenzene is primarily produced through two routes: liquid phase with $AlCl_3$ catalyst or vapour phase in catalytic fixed-bed reactor. Assess the differences as well as advantages and disadvantages of these routes. Enumerate pros and cons in selecting suitable reactors. [4+4] 2. (iv) In toluene hydrodealkylation process, diphenyl is also produced as an unwanted product. Briefly justify the recycling option for toluene: (i) Recycle toluene along with diphenyl (ii) Separate toluene from diphenyl before recycling. [3+3]
CO5 [20]	Answer Q. 3 or Q.4 [20] 3.(i) Elucidate the requirement of steam addition to feedstock for the following productions: (a) Oxidation of propylene to acrylic acid (b) Dehydrogenation of ethylbenzene to styrene [3+3] 3.(ii) Briefly describe Ziegler Process for polyethylene production mentioning the process conditions using a block flow diagram. [6] 3. (iii) Briefly discuss the production of butyl rubber using Ziegler –Natta catalyst using isobutylene and isoprene as feedstock. Use a block flow diagram. [8] 4.(i) Explain "Auto-acceleration" (Gel Effect) behaviour in free radical polymerization systems. [4] 4. (ii)What is critical micelle concentration pertaining to emulsion polymerization for PVC production?. How would you distinguish between suspension and emulsion polymerization? [3 +2] 4.(iii) Briefly describe (using a block flow diagram), the production of polyester fiber employing terephthalic acid as the feedstock. Mention all pertinent reactions, catalysts and process conditions for each conversion step. [6] 4.(iv) Outline the production of Phenol Formaldehyde resin using a block flow diagram. Mention all major reactions involved in the production. [5]

CO4 **Appraise** Scope of petrochemical industry and **identify** conventional and alternate Feedstock for production of Synthesis gas and Chemicals **K4& K6**

CO 5 **Analyse** production of Polymers of olefins including fibres, rubber, Plastics, detergents and carbon black **K4**