UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For The Following Qualification:-

M.Sc.

Biochem Eng G20: Bioprocess Engineering Design and Regulatory Constraints

COURSE CODE	:	**BENGEG20**
DATE	:	**09-MAY-06**
TIME	:	**14.30**
TIME ALLOWED	:	**2 Hours**

06-C0125-3-30

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*Answer **Question 1** and **THREE** other questions from the rest of the paper.*

Only the first four answers given will be marked.

ALL questions carry a total of 25 marks each, distributed as shown [ ]

1 a) Define the following terms, giving an example related to process plant safety for each of them: [10]

i) Failure

ii) Hazard

iii) Accident

iv) Consequence

v) Severity

b) Safety in a workplace activity is legally regulated by COSHH. Define what is meant by this term. [3]

c) Describe the actions to be taken to comply with COSHH. [12]

2. In the design of a process for the production of Chlorobenzene, C_6H_5Cl, with 1 atm boiling point (bp) of 405.2 K, the effluent of the reactor consists of the Chlorobenzene product, Benzene (a reactant, with bp 353.2 K) and two side-products (p-$C_6H_4Cl_2$, bp 447.3 K, and $C_6H_3Cl_3$, bp 486.2 K). Both side-products are considered waste products. Answer the following questions with this process in mind.

a) Describe level 2 of the Douglas hierarchical approach for process synthesis. [10]

b) Having applied level 3 of the Douglas hierarchy to the process, it has been decided that the benzene in the reactor effluent will be recycled. Suggest one reason which would support this decision. [5]

c) You are now asked to apply level 4 of the Douglas hierarchy to this problem. Given the reactor effluent described above with the following flow rates: 100 kmol h^{-1} of Chlorobenzene, 300 kmol h^{-1} of benzene and 20 kmol h^{-1} of each of the side-products, suggest what the first step in the separation section would be, assuming distillation only. Give two reasons which this step would be appropriate. [10]

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3. Consider the design of a heat-exchanger network with two cold and two hot streams with the following plant data:

Stream Number	Q (kW)	Tin (K)	Tout (K)
1	1400	650	370
2	4400	590	370
3	3000	410	610
4	2700	350	500

Assume that steam and cooling water are available at appropriate temperature levels.

Apply the pinch analysis on the system by using a minimum approach temperature of 10 °C to determine the pinch point temperatures as well as the minimum heating and cooling loads. [15]

Design an appropriate process heat exchanger (inlet and outlet temperatures and amount of heat exchanged) above the pinch, justifying carefully why such an exchanger is possible and how the quantities are determined. [10]

4. a) Define the following: [10]

i) Yield strength

ii) Microcrack

iii) Fatigue

iv) Young's modulus of elasticity

v) Brinnell test

b) Provide brief notes on the mechanism of galvanic corrosion and on erosion. Detail also how they might be avoided, or their effects minimised, in a process context. [10]

c) Give a short example of a processing situation where stainless steel is not the obvious choice as a material of construction. [5]

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5. a) Define

i) Partitioning [2]

ii) Tearing [2]

b) Partition the process flowsheet shown below in Figure Q5 into those regions containing recycles and those without. [6]

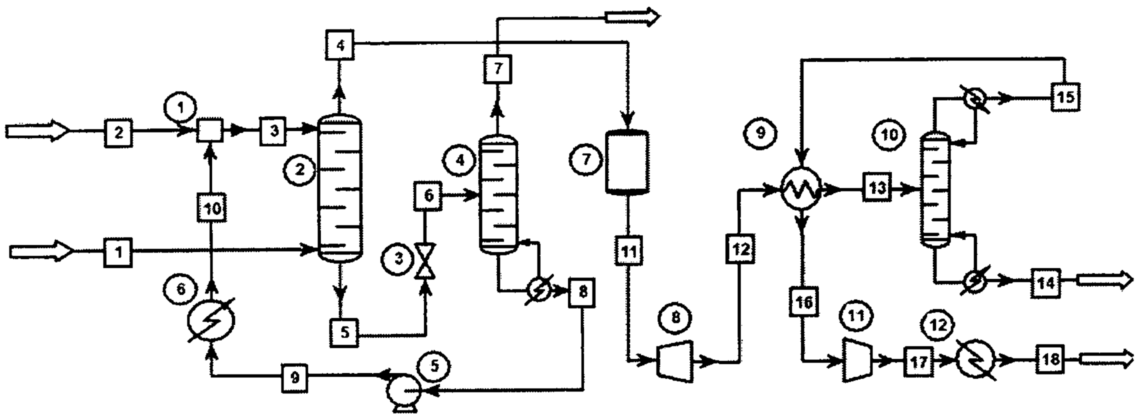

Figure Q5: Process Flowsheet

c) Using essential and non-essential stream node reduction of the signal flowgraph, obtain a minimum tear stet for this process flowsheet. [15]

6. Discuss **TWO** of the following in the context of process simulation:

a) Quasi-linear solution methods. [12½]

b) Recycles and recycle convergence. [12½]

c) The incorporation of batch and semi-batch unit operations into steady state process simulators. [12½]

END OF PAPER