UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2022/2023

COURSE NAME	:	FUNDAMENTAL OF PLANT TECHNOLOGY
COURSE CODE	:	BDJ 20403
PROGRAMME CODE	:	BDJ
EXAMINATION DATE	:	JULY/ AUGUST 2023
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	1. ANSWERS **ALL** QUESTIONS
		2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK**
		3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

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Q1   (a)   Process engineering is essential for the development, improvement, and maintenance of efficient production processes, and hence plays a significant role in a variety of industries. Identify **TWO (2)** industries and describe the role of the process engineer in each area.

(6 marks)

(b)   The current 8-hour limit for HCN in the air set by OSHA is 8 ppm. At room temperature, a lethal dose of air is 300 mg/kg of air. The molecular weight of HCN is 27.03 g/mol, while the molar mass of air is 29 g/mol.

(i)   Determine how many mg of HCN per kg of air 8 ppm equals.

(6 marks)

(ii)   Calculate the fraction of the lethal dose in 8 ppm.

(2 marks)

(c)   Using **Figure Q1(c)**, identify the associated process plant and describe the process in detail.

(5 marks)

(d)   Valves play a crucial role in controlling the flow of fluids in various industrial processes. Analyze the following scenario and justify your response.

(i)   A fail-closed valve that regulates the flow of benzene into a storage tank.

(3 marks)

(ii)   A fail-open valve that regulates the flow of coolant into an engine.

(3 marks)

Q2   (a)   **Figure Q2(a)** depicts a two-unit continuous process in steady-state operation. Each stream of the procedure contains two distinct components in varying quantities. The flow rates and/or compositions of streams 1, 2, and 3 are unknown. Determine the undetermined flow rates and compositions of all streams.

(7 marks)

(b)   An aqueous solution of sodium hydroxide contains 30 % NaOH by mass. As indicated in **Figure Q2 (b),** it is desired to produce a solution of 12 % NaOH by diluting it with a stream of pure water.

(i)   Determine the ratios of (g H$_2$O / g feed solution) and (g product solution / g feed solution).

(5 marks)

(ii)   Calculate the feed rates of 30 % solution and dilution water required to generate 1048 kg/min of the 12 % solution.

(5 marks)

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(c)   Analyze the chemical reaction of acetylene and hydrogen to produce ethane. Determine the limiting reactant and calculate the percent excess reactant, using the given inlet conditions for C_2H_2 and H_2 are 20 kmol/h and 50 kmol/h, respectively.

(8 marks)

Q3   (a)   (i)   Explain the operating principles of a shell and tube heat exchanger.

(3 marks)

(ii)   Describe how a cooling tower works.

(3 marks)

(b)   **Table Q3 (b)** provides a list of details about a refrigerator system. Given the available data,

(i)   Analyze the time required to cool down 5 watermelons.

(6 marks)

(ii)   Determine the COP if 10 watermelons must be cooled in the same amount of time.

(4 marks)

(c)   A house is heated by a 1200 kWh electric resistance heater during a winter month. The owner had studied the potential of a heat pump to replace the electric resistance heater usage. If the coefficient of performance (COP) of a heat pump is 2.4 and an electricity rate of 0.085 MYR/kWh,

(i)   Calculate the amount of money that could be saved if the heat pump is chosen.

(6 marks)

(ii)   Estimate the savings if the coefficient of performance (COP) is doubled.

(3 marks)

Q4   (a)   The operation of an industrial chiller is governed by three interdependent systems: refrigerant circulation, water circulation, and automatic electric control. In a chiller plant with a low-pressure problem, the inlet pressure of the compressor is too low, triggering the low-pressure protection relay. Analyze the circumstance and emphasize:

(i)   **THREE (3)** potential causes of the problem.

(6 marks)

(ii)   **TWO (2)** solutions to the difficulties.

(4 marks)

(b)   Compare and contrast active and passive design solutions for process safety in industrial plants, providing at least two examples for each type.

(7 marks)

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(c) Compute the percentage of hydrogen, carbon and oxygen in pentanol ($C_5H_{11}OH$), where the molar mass of C = 12.01 (g/mol), H = 1.01 (g/mol) and O = 16 (g/mol), respectively.

(8 marks)

-END OF QUESTIONS-

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Figure Q1 (a)

Figure Q2 (a)

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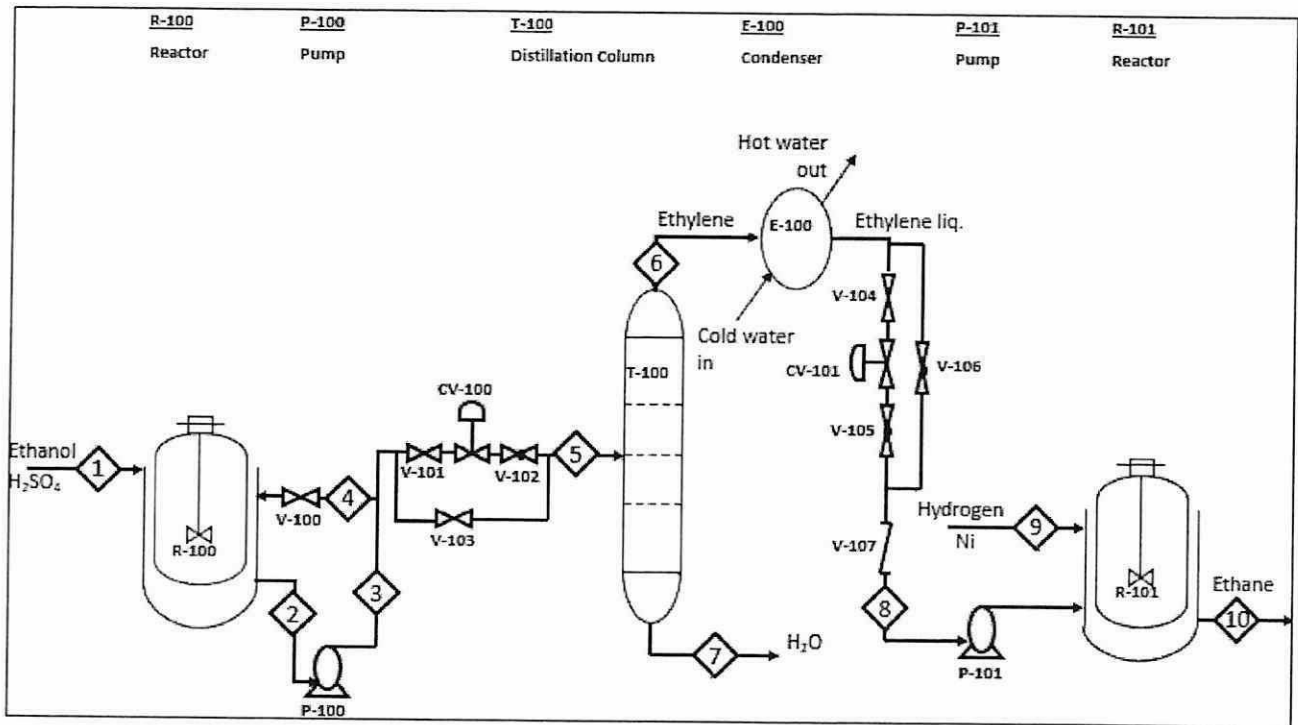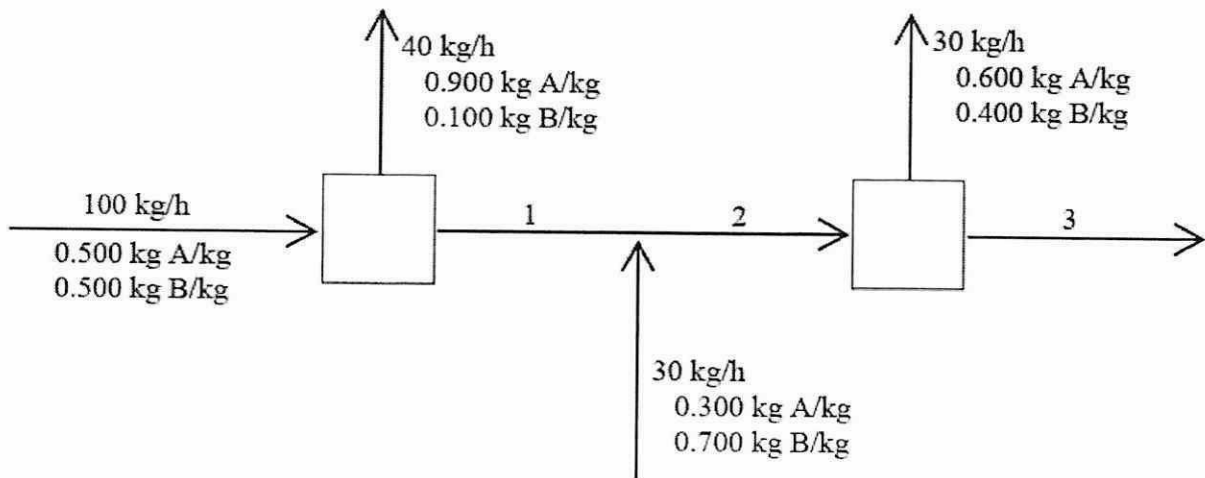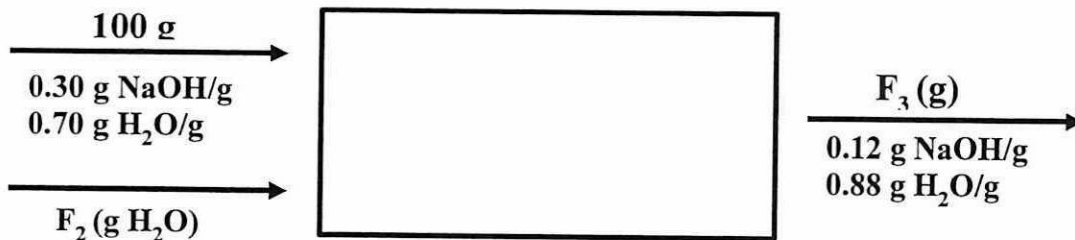COURSE NAME   : FUNDAMENTAL OF PLANT TECHNOLOGY COURSE CODE : BDJ 20403

100 g

0.30 g NaOH/g
0.70 g H₂O/g

F₂ (g H₂O)

F₃ (g)

0.12 g NaOH/g
0.88 g H₂O/g

Figure Q2 (b)

Table Q3 (b): Refrigerator system

Properties	Data
Mass of watermelon (1pcs)	10kg
Initial temperature	20 °C
Final temperature	8 °C
Specific heat of watermelon	4.2 kJ/kg.°C
Refrigerator power input	450 Watt
Refrigerator COP	2.5

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