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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER II
SESSION 2018/2019**

COURSE NAME : CHEMICAL PROCESS AND SUSTAINABILITY
COURSE CODE : DAK 32103
PROGRAMME : DAK
EXAMINATION DATE : JUNE / JULY 2019
DURATION : 3 HOURS
INSTRUCTION : ANSWER ALL QUESTIONS IN SECTION A AND ONE (1) QUESTION IN SECTION B

THIS QUESTION PAPER CONSISTS OF FIVE (5) PAGES

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SECTION A

- Q1** (a) Catalysis is one of the critical enabling factors for sustainability in the specific field of chemical processes.
- (i) Define catalyst. (1 mark)
 - (ii) Identify **three (3)** factors which indicates the importance of catalyst to achieve sustainability concept. (3 marks)
 - (iii) The use of homogenous enzyme is more desirable in bioethanol production via fermentation process. Distinguish **three (3)** advantages and disadvantages of using homogenous catalyst in a fermentation process (6 marks)
- (b) Sustainability focuses on conforming the needs of the present environment without compromising the ability of future generations to meet their needs.
- (i) Identify **two (2)** key factors to achieve sustainability. (2 marks)
 - (ii) Based on the description below, identify and interpret **five (5)** Approaches used to achieve sustainability and **three (3)** advantages which can be obtained from the case study.

NewRule Chemicals Sdn. Bhd decided to adopt the sustainability concept in designing its new chemical plant in Tanjung Langsat. The new chemical plant will be 11000 sq ft in size which is 20 times smaller than its first plant. The new plant will be equipped with 5000 sq ft of solar panels to generate 20 000kW of electricity per day. The plant produces 12000kg/hour of products which is produced upon request maintaining the capacity of its previous invention. This new plant uses a safer and less hazardous approach in its processes which the use biocatalyst will be incorporated

(13 marks)

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- Q2** (a) Process intensification is one of the sustainable development tools that is used to revolutionize a chemical engineering process.
- (i) Define the term process intensification. (1 mark)
 - (ii) Relate **six (6)** advantages of implementing intensification in a chemical engineering process. (6 marks)
- (b) Green chemistry concepts facilitate the development of a new or improved chemical process to decrease hazards on human health and the environment.
- (i) Write the principles of green chemistry. (12 marks)
 - (ii) List **two (2)** advantages of reducing the use of derivatives in a chemical process. (2 marks)
 - (iii) List **four (4)** examples of energy used in a chemical process. (4 marks)

- Q3** (a) Ecological indicators are used to communicate information about ecosystems and the impact of human activity on the ecosystems.
- (i) Identify **three (3)** functions of ecological indicators. (3 marks)
 - (ii) Identify **three (3)** footprints which involve in protecting the environment including its function. (3 marks)
 - (iii) Outline **four (4)** long term goals of an indicator. (4 marks)
- (b) Various metrics and methods in engineering design are used to evaluate and measure different aspects of environmental impact from industrial activities and services.
- (i) Define the term metric. (1 mark)
 - (ii) Write the details regarding sustainability accounting. (4 marks)
 - (iii) Benzyl alcohol (10.81 g, 0.10 mol, MW 108.1) is reacted with p toluenesulfonyl chloride (21.9 g, 0.115 mol, MW 190.65) in solution [toluene (500 g) and trimethylamine (15 g)] to induce the reaction to give sulfonate ester (MW 262.29) isolated in 80% yield (0.09 mol, 23.6 g). Calculate the atom economy, atom efficiency and the E-factor of the given process. (10 marks)

SECTION B

- Q4** Biomass to liquid is categorized as the second generation of renewable energy which starts with gasification followed by the liquid biofuel synthesis process.
- (a) Define the term renewable energy. (1 mark)
 - (b) Identify **four (3)** possible sources of renewable energy. (4 marks)
 - (c) Identify **four (4)** advantages of offshore power wind turbines. (4 marks)
 - (d) Prepare a complete process flowchart to convert biomass into gasoline which include Fischer- Tropsch synthesis process. (16 marks)
- Q5** Over 90% of chemical industrial processes use catalyst whether directly or indirectly.
- (a) With the aid of a diagram sketch a simple reaction pathway with and without the presence of catalyst. (4 marks)
 - (b) Identify **four (4)** types of catalyst used in a chemical process. (4 marks)
 - (c) Relate **three (3)** directions of catalysis science for energy applications. (3 marks)
 - (d) Choose **three (3)** sectors that involve the use of catalyst. (3 marks)
 - (e) Describe **six (6)** advantages of using catalyst in a chemical process. (6 marks)
 - (f) Homogenous catalyst is more preferable to be used in a chemical process than heterogenous catalyst. Relate the factors involve which leads to this situation. (5 marks)

-END OF QUESTIONS-