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**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER II  
SESSION 2016/2017**

COURSE NAME : CHEMICAL PROCESS AND SUSTAINABILITY  
COURSE CODE : DAK 32103  
PROGRAMME : DAK  
EXAMINATION DATE : JUNE 2017  
DURATION : 3 HOURS  
INSTRUCTION : SECTION A : ANSWER ALL QUESTIONS  
SECTION B : ANSWER TWO (2) QUESTIONS ONLY

**TERBUKA**

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

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## SECTION A

- Q1** (a) Biomass is fuel that is developed from organic materials, renewable and sustainable source of energy used to create electricity or other forms of power.
- (i) Define biofuel. (1 marks)
- (ii) Propose **TWO (2)** types of conversion process of biomass energy systems to biofuels. (2 marks)
- (iii) Explain each process to support the answer in **Q6 (a) (ii)**. (10 marks)
- (b) The rationale for using biomass as a chemical feedstock is illustrate by several important advantages. Demonstrate **FOUR (4)** advantages of biomass feedstocks. (8 marks)
- (c) Briefly discuss **TWO (2)** available basic platforms of biofuels production from renewable biomass. (4 marks)
- Q2** (a) A number of metrics have been proposed over the past 5 to 10 years to make chemists aware of the need to change the methods used for chemical syntheses and chemical processes. Define the metric of:
- (i) The atom economy (AE).  
(ii) E-Factor.  
(iii) Reaction mass efficiency (RME).  
(iv) Mass Intensity (MI).  
(v) Mass productivity (MP). (15 marks)
- (b) Environmental impact indicators are focus on the impact of synthetic processes, by assigning impact scores to the raw materials.
- (i) Describe the usage of environmental impact indicators. (2 marks)
- (ii) Explain **TWO (2)** types of environmental impact indicators (8 marks)

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- Q5** (a) Many assessment methodologies have been developed that include not only the product or process but also the entire supply chain and disposal that is the cradle to grave approach. One of the approach is life cycle assessment (LCA).
- (i) Define Life Cycle Assessment (LCA) (1 mark)
- (ii) State **SIX (6)** assessment of Life Cycle Assessment (LCA) that includes the entire life cycle of the product, process or activity and encompassing. (6 marks)
- (ii) Explain **SIX (6)** reasons why conduct Life Cycle Assessment (LCA). (12 marks)
- (b) With rapidly rising costs of fossil fuels, the reduction of energy intensity of chemical production is a primary objective. Choose **THREE (3)** necessary indicators for energy intensity. (6 marks)
- Q6** (a) The ecological footprint (EF) is one of the most widely used indicators of sustainability.
- (i) Define ecological footprint. (3 marks)
- (ii) Propose **TWO (2)** example of ecological footprint with the measurements unit. (6 marks)
- (b) Describe **THREE (3)** usage of ecological indicators. (6 marks)
- (c) Various metrics and methods in engineering design are used to evaluate and measure the different aspects of the environmental impact of industrial activities and services. Demonstrate the sustainability metrics classifications in **FIVE (5)** broad categories. (10 marks)

**TERBUKA****-END OF QUESTIONS-**