



**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER II  
SESSION 2023/2024**

- COURSE NAME : INDUSTRIAL CATALYSIS
- COURSE CODE : BWK 30903
- PROGRAMME CODE : BWK
- EXAMINATION DATE : JULY 2024
- DURATION : 3 HOURS
- INSTRUCTIONS :
1. ANSWER ALL QUESTIONS
  2. THIS FINAL EXAMINATION IS CONDUCTED VIA
    - Open book
    - 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 **THREE (3)** PAGES

**TERBUKA**

- Q1** A catalyst is a substance which aid in accelerating the rate of a chemical reaction without undergoing any permanent changes itself.
- (a) Briefly explain the role of catalyst in chemical reaction.  
(2 marks)
- (b) Provide **TWO (2)** examples of catalysts and the reactions they facilitate, highlighting the impact of the proposed catalyst towards the rate of reaction.  
(4 marks)
- Q2** Heterogeneous catalysis encompasses catalytic reactions whereby the catalyst and reactant are in distinct phases. This typically involves a solid catalyst and gaseous or liquid reactants.
- (a) Identify **TWO (2)** prominent properties of heterogeneous catalysis.  
(4 marks)
- (b) The efficiency of heterogeneous catalysts is impacted by various factors, including surface area, surface chemistry, and catalytic activity sites where the reactant molecules adsorb and undergo reaction. Illustrate a diagram depicting the **SEVEN (7)** steps involved in a heterogeneous catalytic reaction.  
(10 marks)
- Q3** Homogeneous catalysis involves catalytic reactions where both the catalyst and the reactants are in the same phase, typically liquid or gas.
- (a) The transition metal complex in the homogeneous catalyst played a key role in driving the chemical reaction to completion.
- (i) Discuss **TWO (2)** advantages of transition metal complexes as homogeneous catalyst in organic synthesis.  
(2 marks)
- (ii) Propose **TWO (2)** reactions catalyzed by transition metal complexes.  
(2 marks)
- (b) Provide a comparative analysis of solution polymerization and bulk polymerization processes focusing on their respective mechanisms.  
(6 marks)
- Q4** The Heck reaction is a widely used chemical transformation in organic synthesis. It involves the palladium-catalyzed coupling between an aryl or vinyl halide and an alkene or alkyne to form a substituted alkene. Illustrate the general mechanism of the Heck reaction. Accurate depiction of the Heck reaction should include correct labelling and inclusion of chemical component.  
(10 marks)

- Q5** Catalyst deactivation denotes the gradual decline in catalytic activity throughout chemical reaction. In contrary, catalyst regeneration involves reinstating deactivated catalysts to their original or near-original state.
- (a) Illustrate **TWO (2)** mechanisms associated with catalyst deactivation in industrial processes.  
(4 marks)
- (b) Two main approaches to catalyst regeneration are physical and chemical methods, each with its own set of advantages and limitations. Compare the physical and chemical methods of catalyst regeneration.  
(6 marks)
- (c) Analyze the economic and environmental implications of catalyst deactivation and regeneration in industrial processes. Determine how factors such as catalyst-related expenses, downtime, and environmental regulations influence the decision-making process concerning catalyst regeneration as opposed to replacement.  
(10 marks)
- Q6** Emerging trends in catalysis reflect a dynamic landscape of innovation and discovery, encompassing novel materials, advanced synthesis techniques, and interdisciplinary approaches aimed at addressing complex challenges in energy, environmental sustainability, and chemical synthesis.
- (a) Define nanocatalyst and explain how their unique properties contribute to catalytic efficiency.  
(2 marks)
- (b) The design and synthesis of nanocatalysts are tailored for specific chemical transformations. Briefly explain how do factors such as nanoparticle size, shape, composition, and surface modification influence catalytic activity and selectivity.  
(8 marks)
- (c) Explain the fundamental principles of photocatalysis and its utilization in environmental remediation, renewable energy generation, and organic synthesis.  
(5 marks)
- (d) Illustrate a diagram with labels demonstrating the mechanism of photocatalysis and its key components.  
(5 marks)

- END OF QUESTIONS -