



MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING, SCIENCE AND TECHNOLOGY

DEPARTMENT: CHEMICAL AND PROCESSING ENGINEERING

MODULE: FUELS AND ENERGY

CODE: HCHE 523

SESSIONAL EXAMINATIONS

APRIL 2023

DURATION: 3 HOURS

EXAMINER: MRS MUHEZWA C.

INSTRUCTIONS

1. Answer **any four** questions.
2. Start a new question on a fresh page
3. Total marks 100

Aitional material(s): Calculator

QUESTION 1

- a) Describe how natural gas is formed. [3]
- b) Identify the environmental impacts of using fossil fuels [8]
- c) Describe how biomass is tapped as a source of energy [6]
- d) Outline the advantages and disadvantages of using wind energy. [6]
- e) What is the mandate of The Environmental Management Agency (EMA)? [2]

QUESTION 2

- a) Differentiate between the *proximate* and the *ultimate* analysis as far as fuels are concerned. [4]
- b) With respect to petroleum fuels, explain the following terms
 - i. *specific gravity*
 - ii. *flash point*
 - iii. *calorific value*
 - iv. *ash content* [8]
- c) A petroleum component has a density of 600 kg/m^3 and pure water, a density of 1000 kg/m^3 . Calculate the API gravity value for the component. Hence explain the significance of this value [4]
- d) Describe and explain the fractional distillation of petroleum in a fractionating column [9]

QUESTION 3

- a) What is meant by *coal rank*? [1]
- b) Distinguish between high rank and low rank coals. Give **two** examples of each. [8]
- c) Define *weatherability* and *grindability index* as applied to coal [2]

- d) Explain why coal with a sulfur content $> 5\%$ is not recommended for combustion [2]
- e) Describe the principles of operation of a moving bed gasifier [4]
- f) Distinguish between an *allorthermal* and an *autothermal* process during coal gasification [2]
- g) Identify any **three** products of the gasification process and one use of each of these products [6]

QUESTION 4

- a) The Fischer–Tropsch process is a fully developed and exploited technique for solving energy uses in different countries.
- Name four catalysts that are used in the process [4]
 - Give the temperature and the pressure under which the process occurs [2]
 - Describe the principle behind the process [4]
 - Give two products formed from the process [2]
- b) Briefly describe the operation of a heat pump. Give two examples of heat pumps [5]
- c) Catalytic convertors are an essential component of internal combustion engines
- Describe the use of a catalytic convertor in engines [2]
 - Give chemical equations of any three chemical reactions that take place in a three-way catalytic convertor [3]
 - What causes knocking in engines and how may anti-knock properties of gasoline be improved. [3]

QUESTION 5

- a) After the fractionating process in the petrochemical industry lower distillates and the residues can be made to undergo the *cracking* process.

- i. Define *cracking* [2]
 - ii. Outline properties of the lower distillates and the residuals [4]
 - iii. Compare and contrast thermal and catalytic cracking [6]
- b) Hydrogen has been forecasted to become one of the renewable energy source in a universally acknowledged ‘hydrogen economy.’
- i. Describe what is meant by *The Hydrogen Economy*. [3]
 - ii. Give any **five** processes that can be used as a source of hydrogen [5]
 - iii. Outline advantages of a hydrogen fuel cell [3]
 - iv. State the energy conversion that take place in a fuel cell [2]

END OF EXAMINATION