



MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING

DEPARTMENT: CHEMICAL AND PROCESSING ENGINEERING

MODULE: FUELS AND ENERGY

CODE: HCHE 523

SESSIONAL EXAMINATIONS

DECEMBER 2022

DURATION: 3 HOURS

EXAMINER: C. MUHEZWA

INSTRUCTIONS

1. Answer *any four* Questions
2. Total marks 100

QUESTION 1

- a) Describe how natural gas is formed. [3]
- b) Identify the environmental impacts of using fossil fuels. [8]
- c) Describe how solar is tapped as a source of energy. [4]
- d) Outline the advantages and disadvantages of solar as a source of energy. [8]
- e) What is the mandate of the Environmental Management Agency (EMA)? [2]

QUESTION 2

- a) What do you understand by the terms *octane number* and *knocking* as applied to engines? [4]
- b) With respect to petroleum fuels, explain the following terms
 - i. specific gravity
 - ii. viscosity
 - iii. calorific value
 - iv. ash content [8]
- c) A petroleum component has a density of 650 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) Distinguish between high rank and low rank coals. Give two examples of each. [8]
- b) Define *weatherability* and *grindability index* as applied to coal [2]
- c) Explain why coal with a sulfur content $> 5\%$ is not recommended for combustion. [3]
- d) Describe the principles of operation of an Entrained flow gasifier [4]
- e) Distinguish between an *allorthermal* and an *autothermal* process during coal gasification. [2]
- f) 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.
 - i. Name four catalysts that are used in the process [4]
 - ii. Give the temperature and the pressure under which the process occurs. [2]
 - iii. Describe the principle behind the process [4]
 - iv. 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.
 - i. Describe the use of a catalytic convertor in engines [3]

- ii. Give chemical equations of any three chemical reactions that take place in a catalytic convertor [3]
- iii. What causes knocking in engines and how can anti-knock properties of gasoline be improved. [2]

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. Outline the energy conversion that take place in a fuel cell [2]

END OF EXAMINATION