



(University of Choice)

**MASINDE MULIRO UNIVERSITY OF
SCIENCE AND TECHNOLOGY
(MMUST)**

MAIN CAMPUS

UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE

OF

BACHELOR OF SCIENCE IN RENEWABLE ENERGY

COURSE CODE: RET 244

COURSE TITLE: BIOMASS ENERGY

DATE: 27-04-2022

TIME: 08:00-10:00

INSTRUCTIONS TO CANDIDATES

1. This paper consists of FOUR questions
2. Answer question ONE (**compulsory**) and any other TWO questions
3. All symbols have their usual meaning
4. Water density = 1000kg/m^3

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

This paper consists of 3pages. Please turn over

QUESTION ONE (30 Marks)

- a) Explain the three (3) main processes involved in briquette making (3 marks)
- b) Landfills forms part of energy generation especially the produced gases which can be used as a source of energy. Explain the three (3) main processes which contributes to gas formation in a landfill (3 marks)
- c) Explain the working principle of ash handling system in a sugar production plant using bagasse as a source of fuel in the furnace to generate steam (4 marks)
- d) Describe how Carbon Sequestration takes place in soil (3 marks)
- e) i) Highlight three (3) benefits of biomass as an energy source as compared to the conventional sources of energy (3 marks)
- ii) A company plans to use 260 kilo tones of dry bagasse every year to produce 50 kilo tones of bio-ethanol in a year. If the above plan is accurate, calculate the bioethanol conversion efficiency from the feedstock (3 marks)
- f) Using a well labelled diagram, explain how a gas generator produces electricity (5 marks)
- g) Explain three (3) main technical challenges associated with biomass gasification (4 marks)
- h) Explain in details the reason why stack emission analysis is important in a biomass power plant using bagasse in their furnace to generate steam (3 marks)

QUESTION TWO (20 marks)

- a) Differentiate between tube gas digester and a balloon digester (4 marks)
- b) Using a well labeled diagram, explain the working principles of an updraft gasifier mentioning the position of fuel introduction compared to the air (6 marks)
- c) During the processes of a bio digester, slurry requires heating which means energy is needed for this process. Give the relationship explaining every term used to arrive at the power required to heat the slurry in a digester (4 marks)

- d) In bio digesters, explain four (4) main phases involved in digestion to produce biogas (6 marks)

QUESTION THREE (20 marks)

- a) (i). State the main parts of a working biogas power plant layout (1.5 marks)
 (ii). Describe how a biogas power plant works (3.5 marks)
- b) Define the term Cogeneration as used in biomass energy technology (1 marks)
- c) A gas power plant in Kenya has gas input of 115 GJ for the power generating station, the power plant experiences energy losses of 60GJ. If the same power plant has independent heat producing boiler with fuel input of 100GJ and boiler energy losses of 20GJ.

Calculate:-

- i) Useful Energy of the Power station (2 Marks)
- ii) Power Generation Efficiency (3 marks)
- iii) Boiler useful energy (2 marks)
- iv) Thermal Heat Efficiency (3 marks)
- v) Efficiency of the conventional generation to meet both heat and power (4 marks)

QUESTION FOUR (20 marks)

- a) (i) What are the three(3) main components in most non-automated stoves (3 marks)
 (ii) Explain the use of the above components named in (i) above (3 marks)
- b) Give two (2) feed stocks which can be used for biodiesel production (2 marks)
- c) A certain biodiesel plant in Bulgaria produces 60,000 Metric tonnes of biodiesel in a year, using raw material of 15,000 tonnes per month which gives a production of 6000 tonnes of seed oil per month. Calculate:-
- I. The following process conversion efficiencies:-
- (i) Raw material to oil conversion efficiency (2 marks)
- (ii) Seed oil to biodiesel conversion efficiency (2 marks)
- (iii) Overall process conversion efficiency (2 marks)
- II. Using the calculated efficiencies in (a) above and given that; the demand for biodiesel in that country is 80,000 tonnes /year, the yield of the raw material is estimated as 2.49

tonnes/ha/year. Calculate the estimated land required to fulfil the country's demand for the year. (3marks)

d) Describe the process of using sugarcane bagasse in a sugar factory set up to generate heat and electricity ensuring your answers are backed up with an elaborate diagram. (3 marks)

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