KIBABII UNIVERSITY

2020/2021 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER

MAIN EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN RENEWABLE ENERGY AND BIOFUELS TECHNOLOGY

COURSE CODE: REN 324/IET431

COURSE TITLE: Bioenergy 2

DATE: 6/10/2021 TIME: 8:00-10:00AM

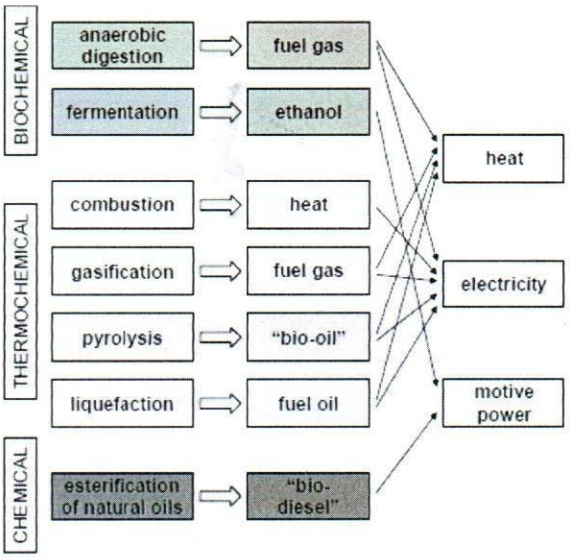
INSTRUCTIONS TO CANDIDATES

Answer question ONE and any other two questions

This paper consists of 4 printed pages. Please Turn over

**Question One**

(a) The figure below shows the pathways for converting biomass to high value energy [6 marks]




For each of the pathway(s):

Identify suitable biomass resource

Describe the characteristics of the resource that make it suitable for the pathway Justify your choice

(b) *"bio-diesel is not a sustainable fuel; it is a transitional fuel"* [6 marks]

Discuss the statement.

(c) Kenya once had a scheme of blending petrol with ethanol produced at the Muhoroni Sugar Company to produce a fuel called gasohol in the 1980s. Explain why this project stopped. [6 marks]

(d) Effective combustion is dependent on 3 Ts; temperature, time and turbulence. With the aid of a sketch, explain how the efficiency of a solid biomass stove can be enhance by improving the three factors. [5 marks]

(e) As a consultant hired to advice Kibabii University on Waste-to-Energy scheme. Prepare a very brief report highlighting the opportunities to be investigated and cautionary sustainability issues inherent in some options. [5 marks]

(f) Some of the main attractions of biomass energy is its *capacity factor* and *dispatchability*. Explain [2 marks]

**Question Two**

(a)

| Energy Densities (GJ/t) | |
|---|---|
| Petroleum Diesel | 42.8 |
| Petrol (gasoline) | 37.6 |
| Biodiesel | 37.8 |
| Palm oil | 36.7 |
| Bioethanol | 26.7 |
| Wood fuel | 18-22 |
| Coal | 15-30 |

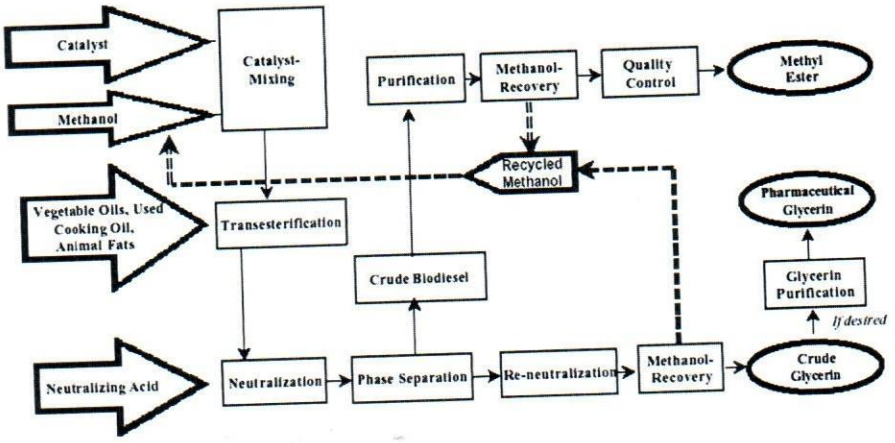
With reference to the table of calorific values of fuels above

(i) Explain why bio-diesel is a better substitute for Petroleum Diesel than Bioethanol is for Petrol [2 marks]

(ii) Comment on the calorific value of wood fuel and coal [2 marks]

(iii) Palm oil as fuel for Diesel engines is referred to as a straight vegetable oil (SVO). Explain its advantage and disadvantage as fuel in Diesel engine. [6 marks]

(b) Explain biodiesel production as depicted in the figure below [10 marks]



## Question Three

The table below is extracted from a report entitled *"Feasibility study and preparation of an integrated watershed management program and investment proposal for Sio-Malaba-Malakisi sub-basin"*. In the report the population of Bungoma town in 2009 is reported as approximately 81,000.

*Projection of the Total Waste Generation in Bungoma Municipality, (Tons/Day)*

| **Waste Characterization** | **2012** | **2017** | **2022** | **2027** | **2032** |
|---|---|---|---|---|---|
| Residential Waste | 45 | 52 | 61 | 72 | 84 |
| Markets Waste | 11 | 13 | 15 | 18 | 21 |
| Commercial Waste | 11 | 13 | 15 | 18 | 21 |
| Medical Waste | 0.122 | 0.14 | 0.17 | 0.20 | 0.23 |
| **Total** | | | | | |

(a) (i) Determine amount of waste available for possible energy generation in 2022 **[1 Mark]**

(ii) Propose the technologies suitable for power generation using the municipal solid waste **[2 Marks]**

(iii) Give a detailed description of suitable thermo-chemical scheme for conversion of MSW into electrical power **[16 Marks]**

(b) Describe how the hazardous waste should be disposed **[1 Mark]**

## Question Four

In many countries, less developed as well as industrialized, bioenergy has become a centerpiece of renewable energy plans and policies because of its many practical, social and economic advantages. More fundamentally, modern bioenergy is now widely regarded as an important player in the global transition to a low carbon energy future, which is needed to reduce human induced climate change. **[20 Marks]**

This enthusiasm is based on five key advantages that modern bioenergy offers compared to fossil fuels and/or other renewable energy sources:

- *Widely available resource*
- *Available on demand*
- *Convertible to convenient forms*
- *Potential to contribute to greenhouse gas reductions and other environmental objectives*
- *Source of rural livelihoods*

Explain, with examples; each of the five advantages

**Question Five**

Marigat (Baringo County) Gasification Power Plant based on the invasive plant *Prosopis juliflora (Mathenge)* has experienced challenges right from the beginning. The challenges experienced can be summarized as follows: 20 Marks

Bioenergy systems require *sufficient*, *reliable*, *sustainable*, and *affordable* biomass supplies. These supplies must be *grown*, *harvested*, *gathered*, and *transported* to the energy conversion plant, sometimes from a large number of dispersed suppliers. They must usually be *stored* and perhaps *dried* to avoid deterioration. In many cases the biomass must be *chopped*, *pelletized* or otherwise prepared for use as a biofuel.

Based on your knowledge of the Marigat Plant explain the effect of the underlined terms on the viability of the project.