



# KIBABII UNIVERSITY

2020/2021 ACADEMIC YEAR

FOURTH YEAR SECOND SEMESTER

MAIN EXAMINATIONS

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

COURSE CODE: REN 313

COURSE TITLE: Bioenergy 1

DATE: 20/07/2021

TIME: 9:00-11:00AM

## INSTRUCTIONS TO CANDIDATES

Answer question ONE and any other two questions

This paper consists of 4 printed pages. Please Turn over

### Question One

- (a) Bioenergy sources are used in all the three main application fields in the energy industry:
- pure heat production
  - electricity generation, and combined heat and power (Cogeneration)  
*(Cogeneration is an energy efficient technology that generates electricity and captures the heat that would otherwise be wasted to provide useful thermal energy-such as steam or hot water-that can be used for space heating, cooling, domestic hot water and industrial processes.)*
  - vehicle fuel (motive power).
- (i) Identify heating requirements/services in the domestic and industrial sector [4 marks]
- (ii) Explain the difference in the requirements for biomass fuel in the two cases [4 marks]
- (iii) Briefly describe any two technologies for converting bioenergy to electricity [4 marks]
- (b) State the factors that affect the overall efficiency of combustion [6 marks]
- (c) Briefly describe the production of biogas by anaerobic digestion [6 marks]
- (d) Describe in detail the main features of any improved biomass stove that you are familiar with. [6 marks]
- (e) Explain in detail the importance of carrying out resource assessment before setting up an energy plant based on biomass [6 marks]

### Question Two

- a) Discuss and evaluate the barriers to the development of biomass energy schemes. [12 marks]
- b) Outline strategies and opportunities to mitigate the effects [8 marks]

### Question Three

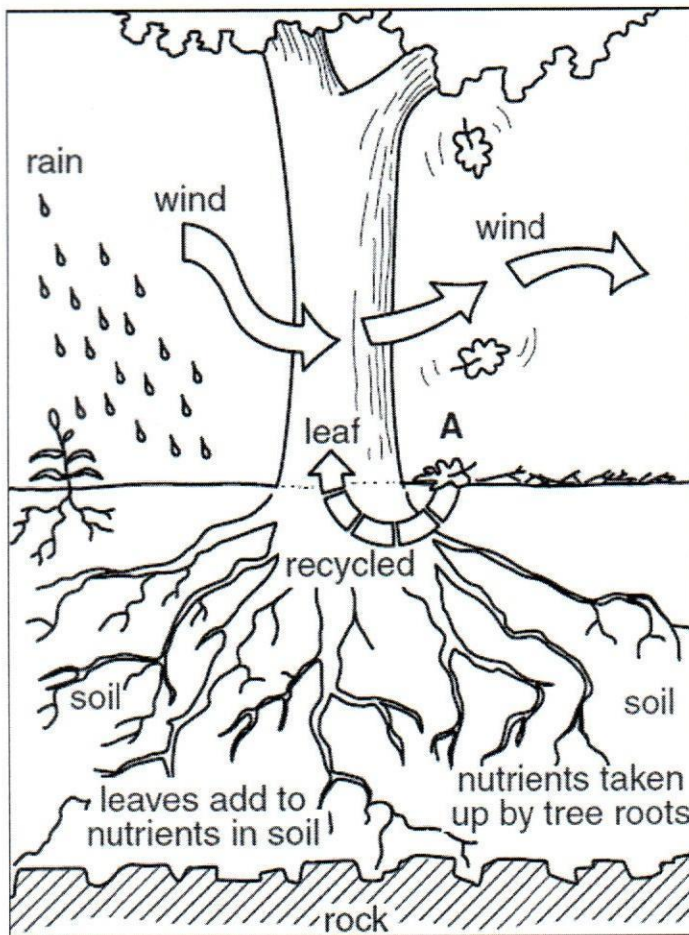
Describe the process of pyrolysis of biomass materials giving information of the products produced, the effects of altering pyrolysis conditions, and the main modes of pyrolysis. [20 marks]

#### Question Four

- (a) With the aid of diagrams briefly describe the different stages of the combustion process, giving information on the effects of the air/fuel ratio, moisture content and fuel grade (i.e., size, density, shape etc.) on the process. [8 marks]
- (b) Briefly describe the gasification process and with the aid of sketches briefly describe the operating principles of the down-draught, up-draught and the bubbling fluidized bed gasifiers giving details of feed stock requirements and typical applications. [12 marks]

#### Question Five

Natural ecosystems are maintained by *energy flows* and the *recycling of nutrients*. Study the diagram showing nutrient recycling in a natural forest ecosystem.



- (a) (i) Describe what happens at A to recycle plant nutrients. [2 Marks]