



KENYATTA UNIVERSITY

UNIVERSITY EXAMINATIONS 2011/2012

SECOND SEMESTER EXAMINATION FOR THE DEGREE OF MASTER OF SCIENCE

(RENEWABLE ENERGY)

SET 610: BIOMASS CONVERSION TECHNOLOGY I

DATE: FRIDAY, 13TH APRIL 2012

TIME: 2.00 P.M. – 5.00 P.M.

INSTRUCTIONS:

There are FIVE questions in this paper.

All questions carry equal marks.

Answer ANY THREE questions.

QUESTION ONE

The primary biomass materials comes principally in solid form; and some in liquid form.

Unfortunately, not all can be used directly as a fuel for some reasons. Biomass conversion technologies are very advanced today.

Outline, and discuss each in details (giving examples where relevant), the reasons for converting the primary biomass to secondary biofuels (i.e., what necessitates conversion of biomass).

(25 marks)

QUESTION TWO

Before direct utilization of a biomass material as a fuel, or converting it to another biofuel, it is important to understand its **physical** and **chemical properties**.

- (a) Outline and clearly explain each, giving examples where relevant; the reasons why it is important to understand the physical and chemical properties of biomass materials.

(15 marks)

- (b) Name the **physical properties** of biomass, and clearly explain each, giving formulae where relevant.

(10 marks)

QUESTION THREE

Biomass biochemical conversion processes are **biological** processes which involves some micro-organisms and chemical reactions.

- (a) Name the micro-organisms in biochemical conversion processes, and show under which specific process each is involved. (2 marks)
- (b) There are factors affecting the growth and survival/metabolism of micro-organisms.
 - (i) Name the two board key factors that affect the growth and survival/metabolism of micro-organisms initiating biochemical conversion of biomass; and under each, name the specific principles factors. (5 marks)
 - (ii) Outline and discuss each in details, the influence/effects and role of each of the key specific factors, on the micro-organisms. Indicate the optimum ranges where relevant. (18 marks)

QUESTION FOUR

Through **Anaerobic Digestion**, a biochemical transformation process, organic materials can be decomposed under appropriate conditions to produce **biogas**, a high quality gaseous fuel.

- (a) Name the most important suitable bio-materials for biogas production through anaerobic digestion process. Show examples where relevant. (5 marks)
- (b) Name the THREE consecutive stages of the anaerobic digestion process that takes place in the biogas production, and describe each in details showing all relevant chemical reactions and products under each stage.
Use suitable illustration of the reactions (i.e, a simplified illustration of the “Anaerobic Digestion process) to demonstrate the process. (20 marks)

QUESTION FIVE

Alcohol fermentation, the process of **Ethanol production** from suitable biomass materials, takes place in a series of stages/steps.

- (a) Describe in details, stage-by-stage, the ethanol-production process. Show all chemical reactions and/or products of each stage. (20 marks)
- (b) One of the process stages can be **BATCH** or **CONTINUOUS**, i.e., the two modes of that stage.

Name the relevant process-stage that can be batch or continuous.

Define each mode of operation, and name the advantages of each.

(5 marks)
