



## TECHNICAL UNIVERSITY OF MOMBASA

### FACULTY OF APPLIED SCIENCES

### MATHEMATICS AND PHYSICS DEPARTMENT

UNIVERSITY EXAMINATION FOR BACHELOR OF TECHNOLOGY DEGREE IN

RENEWABLE ENERGY (BTRE)

APS 4332: BIOFUELS AND WIND ENERGY

END OF SEMESTER EXAMINATION

**SERIES: May Series 2016:**

**TIME: 2 HOURS**

**DATE: May 2016**

#### Instructions to Candidates

You should have the following for this examination

*Answer Booklet, examination pass and student ID*

This paper consists of **FIVE** questions. Attempt Question **ONE** and any other **TWO** questions.

**Do not write on the question paper.**

#### QUESTION ONE (30 MRKS)

- (a) (i) Define the term biomass. (1mrks)
- (ii) List any three types of traditional biomass. (3mrks)
- (iii) Explain the concept of 'Carbon neutral' environment. (3mrks)
- (iv) Differentiate between Green diesel and Syngas. (2mrks)
- b) (i) Why is biogas technology considered to be an appropriate technology for the next energy generation? (4mrks)
- (ii) Mention four benefits of a biogas plant. (4mrks)
- (iii) Explain how is biogas produced in a biogas digester. (2mrks)
- (iv) Explain between the following biogas digestions processes that occur in the digester. (3mrks)
1. Psychrophilic digestion
  2. Mesophilic digestion
  3. Thermophilic digestion
- c) (i) Calculate the velocity of wind whose density is 2000g per unit cubic metre moving in an open field towards a weather station if it carries a kinetic energy of  $1.17 \times 10^3$  kj. (3mrks)
- (ii) Determine its specific power at this site. (2mrks)
- (iii) Give any two major parts of a wind turbine. (2mrks)

### **QUESTION TWO (20 MRKS)**

- 2 (a) Give the function of the following units in a wind turbine. (5mrks)
- (i) Nacelle
  - (ii) Electrical generator
  - (iii) Yaw mechanism
  - (iv) Blade
  - (v) Sensors and control
- b) (i) Define the term specific power of wind energy. (2mrks)
- (ii) Calculate the kinetic energy of wind with a density of 2340g per unit cubic metre moving with speed 60 km towards east. (3mrks)
  - (iii) Determine its specific power of this wind at this site. (3mrks)
  - (iv) If the wind velocity becomes discontinuous from 60km/hr to 70km/hr at the “plane” of the rotor blades used to harvest their energy, calculate the mass flow if the area of the plates are given as  $06M^2$ . (3mrks)
  - (v) Calculate the annual energy potential if the annual average wind speed here is 60km/hr. (4mks)

### **QUESTION THREE (20 MRKS)**

- (a) Differentiate between the following; (3mks)
- (i) Direct and Indirect methods of converting biomass to energy.
  - (ii) Differentiate between electrochemical and a biochemical conversions of biomass.
  - (iii) Define the term Pyrolysis as used in biomass.
- b) (i) What does the term “First generation biofuel” refer to? (1mrk)
- (ii) List any three First generation biofuels. (3mrks)
  - (iii) Describe briefly any two biofuels you have given above. (4mrks)
  - (iv) Describe the following types of biofuels;
    - a) Biogas. (2mrks)
    - b) Green diesel. (2mrks)
- c) (i) What are Second generation biofuels? (1mrk)
- (ii) Differentiate between first generation biofuels and second generation biofuels. (1mrk)
  - (iii) Describe how anaerobic digestion process that produces biogas. (3mrks)

### **QUESTION FOUR (20 MRKS)**

- a) (i) What does the term ‘scaling a biogas’ refer to? (2mrks)
- (ii) Define the following terms as used in scaling of a biogas plant operation. (3mrks)
    - a. Dry matter
    - b. Organic dry matter
    - c. Digester loading
  - (iii) Given that a certain digester has a digester volume ( $V_D$ ) of 4800 litres. Determine its retention time (RT) if its daily supply ( $S_d$ ) period of 60 days. (3mrks)
  - (iv) A certain Biogas plant in Kilifi has the following data: Digester volume ( $V_D$ ): 4.8 m<sup>3</sup>; Retention time (RT): 80 days; Daily amount of fermentation slurry ( $S_d$ ): 60 kg and the proportion of organic matter: 5 %. Calculate its digester loading. (3mrks)
  - (v) Give one negative environmental impact of biofuels. (1mrks)
- b) (i) Define the term Spatial Mapping and Modeling as used in wind energy. (2mrks)
- (ii) Moving wind has kinetic that be harnessed. Calculate the kinetic energy wind of density 2340g per unit metre moving with speed 60 km towards east. (2mrks)
  - (iii) Determine the specific power of the wind in b (ii) above at this site. (2mrks)
  - (iv) What is a wind turbine? (2mrks)

**QUESTION FIVE (20 MRKS)**

- (a) What are the following terms as used in the wind power industry: (6mrks)
- a. High-speed shaft
  - b. Brake
  - c. Gearbox
  - d. Generator
  - e. Nacelle
- b) Speed control used to control wind power turbine fall into the following categories given below. Describe each method given. (8mrks)
- (i) No speed control
  - (ii) Yaw and tilt control
  - (iii) Pitch control
  - (iv) Stall control
- c) What are the functions of the following parts of a wind energy harvesting device? (3mrks)
- i). Pitch
  - ii) Upwind and downwind
  - iii) Vane
- d) State one advantage and two disadvantages of wind energy. (3mrks)

**END**