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 MKS)

a) (i) Give one difference between the direct method and the indirect methods of converting
   biomass to energy.   (2mks)
  (ii) Describe the following types of biofules.
    a)   Biogas   (6mrks)
    b)   Green diesel   (3mrks)
  (iii) Differentiate between first generation biofules and second generation biofuels.(1mrk)
  (iv) What is an anaerobic digestion?   (1mrk)
  (v) Describe anaerobic digestion process that produces biogas.   (5mrks)
b) Explain the following biogas digestion processes that occur in the biogas digester
        (i)   Psychrophilic digestion   (2mrks)
        (ii)   Mesophilic digestion   (2mrks)
        (iii)   Thermophilic digestion   (2mrks)
c) (i) In Kenya's south coast region, the average wind density is $2000g/M^3$. Calculate the
average velocity of this wind moving in an open beach field towards a weather station if it
carries a kinetic energy of 1.17×10^3 kj.   (3mrks)
  (ii) Determine its specific power at this meteorological whether station.   (2mrks)
  (iii) Give any two components of a wind power turbine.   (2mrks)

QUESTION TWO (20 MRKS)
a) (i) Define the term pyrolysis as used in biofuel technology. (1mrk)

(ii) Give two methods in which conversion of biomass conversion can undergo during anaerobic digestion. (2mrks)

(iii) Give four examples of a first generation biofuel. (4mrk)

(iv) Determine the digester volume (V_D) for a digester with retention time (RT) of 80 days if its daily supply (S_d) period of 60 cubic metres of feed materials. (2mrks)

(v) A certain Biogas plant in Kilifi has the following data: Digester volume (V_D): 4.8 m³; 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. (2mrks)

b) (i) Define the term specific power. (1mrks)

(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 its specific power at this site. (2mrks)

c) (i) If the air velocity is 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 $06M^2$ (2mrks)

(ii) Calculate the annual potential energy if the average speed of the wind is 60km/hr (2mrks)

QUESTION THREE (20 MKS)
a) (i) Explain the concept of 'Carbon neutral' environment. (2mrks)

(ii) Give one difference between Green diesel biofuel and Syngas biofuel. (2mrks)

b) (i) Why is biogas technology considered to be an appropriate technology for the next generation? (5mrks)

(ii) Explain four ways in which we benefit from locally made biogas plants. (4mrks)

(iii) Explain how biogas produced in a digester of a biogas plant. (2mrks)

c) (i) Define the term tip speed ratio as used in wind turbine. (1mrk)

(ii) What is the function of the following components of a wind turbine as a device for harnessing wind energy: (4mrks)
  a) Nacele
  b) Yaw drive
  c) Blade
  d) Sensors and control

QUESTION FOUR (20 MKS)
a) (i) Define the term fermentation slurry. (1mrks)

(ii) Differentiate between batch plants and continuous plants. (1mrk)

b) (i) List three main types of simple biogas plants. (3mrks)

(ii) Give advantages and disadvantages of the biogas plants in b(i)] above. (4mrks)

(iii) Define the following terms as used in scaling of a biogas plant. (3mrks)
  a) Biochemical oxygen demand (BOD)
  b) Retention time (RT)
  c) Digester loading (R).

(iv) 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. (2mrks)

c) (i) A certain Biogas plant in Kilifi has the following data: Digester volume (V_D): 4.8 m³;

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. (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 its specific power at this site. (2mrks)

QUESTION FIVE (20 MKS)

(a) What are the following terms as used in the wind power industry; (6mrks)
    i. High-speed shaft
    ii. Brake
    iii. Gearbox:
    iv. Generator:
    v. Nacelle:

b) Briefly discuss the speed control methods used in wind power harnessing. (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 turbine device? (3mrks)
    i). Pitch
    ii) Upwind and downwind
    iii) Vane
    iv) Yaw drive

d) State one advantage and two disadvantages of wind energy. (3mrks)

END