



## TECHNICAL UNIVERSITY OF MOMBASA

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*Faculty of Engineering and Technology in Conjunction with Kenya Institute of  
Highways & Building Technology (KIHBT)*

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

**UNIVERSITY EXAMINATION FOR 2017/2018:**

**HIGHER DIPLOMA IN TECHNOLOGY**

**ELECTRICAL POWER ENGINEERING**

**ERE 3230: RENEWABLE ENERGY**

**END OF SEMESTER EXAMINATION**

**SERIES: DECEMBER 2017**

**TIME: 2 HOURS**

**DATE:** Pick Date Select Month Pick Year

### **Instructions to Candidates**

You should have the following for this examination

*-Answer Booklet, examination pass and student ID*

This paper consists of **FIVE** Questions; each question carries 20 Marks. Attempt any **THREE** Questions.

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

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## QUESTION ONE

- a)
- i. State THREE advantages of Solar PV energy systems over other renewable energy systems.
  - ii. Explain with the aid of a diagram the principle of operation of a Solar PV cell.
  - iii. Highlight the process followed in Solar PV energy system design of domestic nature. **(10 Marks)**
- b) Given the following load base condition:
- I. 2 CFLs (18 watts each), for 12hrs a day.
  - II. 2 fans (60 watts each) for 6hrs a day.
- Using commonly applied factors of efficiency and duration as well as local prices, design a solar PV system and estimate:
- i. The number of PV panels
  - ii. The dimensions of battery bank
  - iii. Inverter rating
  - iv. Cost estimation of the system. **(10 Marks)**

## QUESTION TWO

- a)
- i. State any THREE roles of National Environmental Management Authority (NEMA) during the development of Geothermal Energy.
  - ii. State any TWO advantages of Geothermal Energy over other sources.
  - iii. With the aid of a single line diagram show how electrical power from a Geothermal Power Station located in a remote location is integrated into the National Grid. **(10 Marks)**
- b) A geothermal well has 100 Million tons of hot rock having calorific value of 5000kCal/Kg. The overall thermal efficiency of the well is 30% and that of the turbine is 25%. The electrical efficiency of the generator is 90%. (take 1kWhr = 860kCal)
- i. Estimate the average load on the plant.
  - ii. Annual Volume of Carbon emission reduced when the plant replaces an equivalent 95% efficiency Diesel Plant burning diesel having calorific value of 10,000kCal/Kg and releasing 10m<sup>3</sup> of gases per Kilogram of diesel. **(10 marks)**

## QUESTION THREE

- a)
- i. State any TWO advantages of Hydroelectric Power over other sources.
  - ii. Explain any THREE major factors affecting the specifications of a hydro-generator set.
  - iii. Explain with the aid of a labeled diagram how a Hydroelectric power plant works. **(10 Marks)**

- b) A minimum river runoff of  $47\text{m}^3/\text{s}$  is available for a mini Hydro project in Kenya having gross plant efficiency of 80%. If the head is 19.5m, determine:
- Project Capacity
  - Yearly Gross Output
  - During medium and high rain seasons the river run-off increases to  $94\text{m}^3$  and  $141\text{m}^3$  when a second and the third generator are engaged respectively. Given that this happens in the second and fourth quarter of the year respectively, show through calculation and a sketch the total yearly Gross Output.

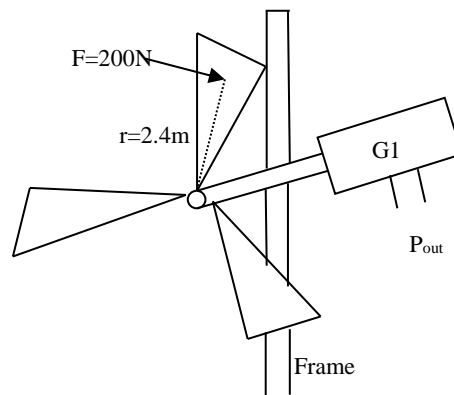
**(10 Marks)**

#### QUESTION FOUR

- a)
- Explain any TWO problems associated with wind energy systems.
  - State THREE benefits realized in the application of Merit Order Scheduling in a Power System with wind energy source.
  - With the aid of a sketch describe the features at a Wind Power Generating Station.

**(10 Marks)**

- b) A uniform wind thrust of 200N hits a three plate turbine (**Figure Q4 below**) each with an effective radius of 2.4m, to turn it at an average speed of 750 revolutions per minute.



**Figure Q4**

Given that an 8 pole rotating field synchronous generator is connected via the shaft, and that the plant has mechanical and electrical inefficiencies of 40% and 10% respectively, calculate:

- The frequency of the output voltage.
- The power output of the plant.

- iii. The plant is operated 6 Hours a day with staff, maintenance and capital expenses totaling KSh 1.2 Million per annum. Determine the cost per unit of electricity produced. **(10 Marks)**

### QUESTION FIVE

- a)
- i. Explain THREE reasons why leading industrialized nations still utilize coal and oil as major sources of electrical power despite concerted efforts towards renewable energy.
  - ii. Highlight any TWO sources of Biomass raw material in a large city.
  - iii. With the aid of a flow chart explain the process in a Biomass Power Generating Plant. **(10 Marks)**
- b) A Biomass fueled steam station spends Ksh. 30 Million per annum to buy Biomass whose calorific value is 5000kcal/Kg and costs KSh. 3.00 per Kg. If the station has thermal and electrical efficiencies of 33% and 90% respectively, take 1kWhr = 860kCal to calculate:
- i. The average load on the station.
  - ii. The power loss due to inefficiency of the plant in Watts.
  - iii. The financial savings made if alternative biomass source is found that has a calorific value of 6000kcal/Kg and costs KSh. 2.50 per Kg. **(10 Marks)**