



**College of Engineering, Science and Technology**

**School of Electrical and Electronics Engineering  
Trimester 2, 2019**

**Diploma in Electrical Engineering  
(Electrical & Renewable Energy)**

**EEE438 Renewable Energy Technologies**

**Duration: 3 hours & 10 minutes**

**Date: TBA**

**Time: TBA**

**Room: As per Timetable**

**Total Marks: 100**

**Total No. of Pages: 5**

**Instructions to Students**

1. You are allowed an extra ten (10) minutes of reading time during which you are NOT allowed to write.
2. Write your answers in the answer booklet provided.
3. Write your Student ID number at the top of each attached sheet
4. You may use calculators provided they are non-programmable.
5. Clearly number the questions in your answer paper in their correct sequence and write legibly. Show all working.
6. Attach any extra sheets used to your answer booklet securely with the string provided
7. There are two (2) Sections in this paper. **All Sections are compulsory.**

Answer ALL questions

**Question 1**

**[Total 14 marks]**

- A. Briefly elaborate on the global renewable energy progress logistics stating percentage contribution or global capacity of major RE sources. **[3 marks]**
- B. Discuss the social/economic/environmental impacts of Renewable Energy Technologies. **[3 marks]**
- C. Sketch the IV & Power curve of a solar cell clearly showing  $V_{oc}$ ,  $I_{sc}$ ,  $V_{mpp}$  and  $I_{mpp}$ . **[3 marks]**
- D. List any three (3) factors that affect the output power of the solar module? **[3 marks]**
- E. Elaborate on the reasons of having high household energy bills and how this issue could be encountered? **[2marks]**

**Question 2**

**[Total 17 marks]**

- A. Sketch a schematic diagram of dc bus system connected to both ac and dc loads. Describe the operation and function of each components of the system. **[4 marks]**
- B. List down any 4 major components of a wind turbine. **[2 marks]**
- C. Why should batteries be raised off the ground or concrete floor? **[3 marks]**
- D. Draw the power curve of a wind turbine clearly labelling “cut-in” speed, “cut-out” speed and “rated” speed. **[4 marks]**
- E. Discuss the two types of Terrain. **[4 marks]**

**Question 3**

**[Total 9 marks]**

- A. State any two factors to take note of whilst installing the PV Inverter? **[2 marks]**
- B. Illustrate and elaborate about combined Heat and power plant [CHP] **[4 marks]**
- C. Turbines are classified into two groups. Elaborate with example on two types turbines. **[3 marks]**

**Question 4****[Total 16 marks]**

- A. In a Domestic installation where Residential Tariff is used, a kWh meter established 1011kWh. The previous monthly reading was 0916 kWh. The Government subsidy is applied for first 100 units, considering the customer's household income is below \$30,000. **(Refer to Table 1)**
- I. Calculate the cost of energy for the current billing month of 31 days. **[4 marks]**
  - II. If the previous monthly reading was 0813 kWh, then what will be charge for that month. **[3 marks]**

<p><b>Domestic Category</b>  <b>Domestic Tariff – Government subsidy.</b> This Tariff only applies if customer has Combined household income Less than or equal to (<math>\leq</math>) \$30,000.00 per annum and registered for Government subsidy. Customers who qualify and are registered will be subsidized for the first 100 units of consumption.</p> <p><b>Domestic Tariff-</b> domestic customers who do not qualify for Government subsidy. All consumption will be charged at the rate of 33.10 c/unit.</p>	<p>33.10 cents          (15.90 cents/unit will be subsidized by the Government and customer pays 17.20 cents/unit)</p> <p>33.10 cents</p>
---	---

- B. The daily dc requirement is 150Wh, and daily ac requirement is 800Wh. You are told that the inverter has an efficiency of 90%. What is the total energy requirement for the day? **[3 marks]**
- C. Find the declination angles and the length of the day on 28<sup>th</sup> September, 2019 in:
  - I. Suva (latitude 18.2° South) and in
  - II. South Korea (latitude 36° North). **[6 marks]**
- D. If 10 lights rated at 20W each are operating 6 hours a day for the whole year, how many units of energy will be used up by the lights in a year? **[3 marks]**

**Question 5****[ Total 20 marks]**

- A. For the system specifications given below:
- I. Carry out system sizing showing the possible arrangement of batteries and solar PV panels. **[15 marks]**
  - II. Size the inverter and the charge controller. **[5 marks]**

*Inverter Efficiency = 95%*  
*Location = Nasarwaqa*  
*Inverter Voltage = 24V*  
*BP Solar panel 125W,  $I_{mpp} = 6.56A$*

*Battery DOD = 60%*  
*Peak sun hour = 4 hrs.*  
*Battery Capacity = 100Ah @ 12V*  
*Consecutive days without sun light = 2*

**Load table:**

<b>Appliance</b>	<b>AC/DC</b>	<b>Watts</b>	<b>Duty cycle hour/day</b>
<i>4 Lights@5 W each</i>	<i>AC</i>	<i>20</i>	<i>6</i>
<i>TV</i>	<i>AC</i>	<i>50</i>	<i>4</i>
<i>Radio</i>	<i>AC</i>	<i>40</i>	<i>5</i>
<i>Phone Charger</i>	<i>AC</i>	<i>15</i>	<i>2</i>
<i>Lights</i>	<i>DC</i>	<i>10</i>	<i>4</i>

**Table 1.0**

**Question 6**

**[Total 21 marks]**

- A. The annual energy production from a HAWT is 4.66GWh. Given a 3-bladed 20m radius wind turbine operating in a wind regime with an average wind speed of 10m/s, estimate the power coefficient if it is operating under standard conditions. **[2 marks]**
- B. A catchment area of 20km long and 20km width is needed to build a hydro system. With a head height of 300m to dam the turbine can be installed to produce power from the dam. If the region has an annual rainfall of 800mm, consider the yield factor of 50% and load factor of 60%. Calculate **[10 marks]**
- I. The power produced.
  - II. The capacity of the power plant if the power plant has an efficiency of 80%.
- C. A village requires 5kW of electrical power to cater for their needs. A river which can provide a gross head of 60m, is considered for hydro – power source. A 4 jet Pelton wheel is to be utilised. If the efficiency of the turbine and the genset of the proposed power station are 90% and 80% respectively, calculate the following:
- I. The required power input at the jet **[3 marks]**
  - II. What will be the velocity of the water at the jet if head loss is 5m? **[2 marks]**
  - III. What is the flow rate at the jet if there is a head loss of 5m? **[2 marks]**
  - IV. What will be the radius of the jet? **[2 marks]**

**END OF EXAMINATION**

### Formula sheet

$$\delta = \delta_0 \sin \left[ \frac{360 (284 + n)}{365} \right]$$

$n = \text{day in the year } (n = 1 \text{ on January } 1)$

$\delta_0 = 23.45^\circ \text{ in northern hemisphere}$

$\text{or } -23.45^\circ \text{ if southern hemisphere}$

$$N = \frac{2}{15} \cos^{-1}(-\tan \phi \tan \delta)$$

$\phi = \text{latitudes}$

$\delta = \text{declination}$

$$\text{AEP} = P_w \times 8760 \text{ hrs}$$

$$Q = Av$$

$$P(\text{kW}) = 45jA(H^3)^{1/2}$$

$$V = \sqrt{2gh}$$

$$P_{\text{out}} = P_{\text{in}} \times \text{efficiency}$$

$$\eta_{\text{Gen}} \times \eta_{\text{Turbine}} = 100 \%$$