



# **MAASAI MARA UNIVERSITY**

## **REGULAR UNIVERSITY EXAMINATIONS 2018/2019 ACADEMIC YEAR FOURTH YEAR SECOND SEMESTER**

### **SCHOOL OF SCIENCE BACHELOR OF SCIENCE**

**COURSE CODE: PHY 427**

**COURSE TITLE: SOLAR ENERGY**

**DATE: 15/04/2019**

**TIME: 0830 - 1030 AM**

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#### **INSTRUCTIONS TO CANDIDATES**

1. Answer Question **ONE** and any other **TWO** questions
2. Use of sketch diagrams where necessary and brief illustrations are encouraged.
3. Read the instructions on the answer booklet keenly and adhere to them.

## USEFUL INFORMATION

The following information is available (at STC where applicable)

Module rated power = 300Wp

Module  $V_{oc}$  = 43.2 V

Module  $I_{sc}$  = 8.6 A

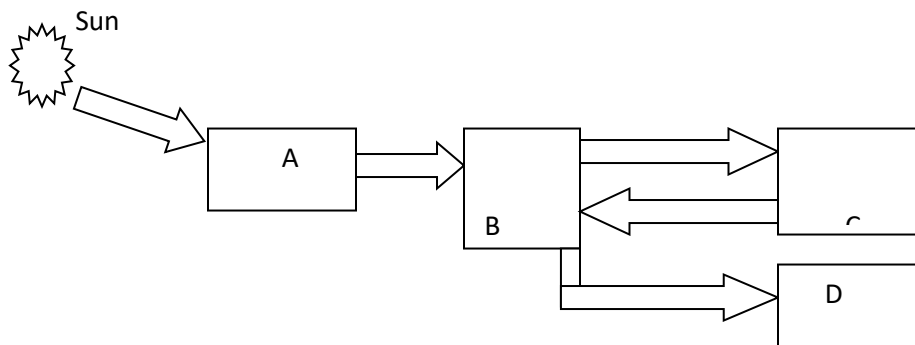
Module  $V_{mp}$  = 38.2 V

Module  $I_{mp}$  = 7.9 A

$T_c$  for  $V_{oc}$  = -0.011 V/°C

## QUESTION ONE (30 MARKS)

- (a)(i) Define the term *Allowable DoD* as used in solar PV design **(1 Mark)**  
(ii) How does DoD affect the lifetime of a battery bank? **(2 Marks)**
- (b) (i) Name ANY TWO items that can be found on a Solar Water Heating Job Safety Analysis form **(2 Marks)**  
(ii) Hence list ANY TWO risk control measures one can undertake when working on solar water heating installation **(2 Marks)**
- (c) Briefly describe the effect of the following on the output of a solar PV system:  
(i) Temperature **(2 Marks)**  
(ii) Irradiance **(2 Marks)**
- (d) The flow diagram below represents a certain type of solar PV solar PV system installation



- (i) Name the type of system it represents **(1 Mark)**  
(ii) State TWO main reasons that would motivate one to install such a system **(2 Marks)**  
(iii) Name the parts labeled C & D **(2 Marks)**

- (e) List down and hence state the functions of **ANY THREE** components of a flat plate collector used in solar water heating. **(6 Marks)**
- (f) A client on the outskirts of Narok wishes to install a solar water heating system on his premises for domestic use. The premises are fifteen years old and the roof cover is made of corrugated galvanized iron sheet material. The area is not served by Kenya power and the client relies on water from an underground source that is salty.
- (i) Discuss the key demanding aspects one needs to take into consideration before carrying out the installation **(4 Marks)**
- (ii) Advise the client on the most suitable type of installation giving reasons. **(4 Marks)**

### **QUESTION TWO (20 MARKS)**

- (a) Discuss ANY TWO factors one would put into consideration when mounting a solar collector whether for solar PV or solar thermal system. **(4 Marks)**
- (b) Draw and label clearly the circuit diagram for a series type of charge controller **(6 Marks)**
- (c) An inverter is one of the components that are a basic requirement for a solar PV installation.
- (i) State and describe the working of the three main types that are commonly found on the market based on the system type. **(6 Marks)**
- (ii) If a client wishes to install a solar PV system in an urban setup where the grid exists, which type of inverter would you recommend and what would be the motivation behind your choice? **(4 Marks)**

### **QUESTION THREE (20 MARKS)**

A new hotel lodge is being put up on the outskirts of Maasai Mara Game Reserve with a bed capacity of 40. The owner wishes to incorporate solar water heating system that is expected to serve the lodge at full capacity. It is also worth noting that the area is not connected on the grid.

- (a) Determine the daily hot water demand for the lodge **(3 Marks)**

- (b) (i) Determine the suitable size for the hot water tank storage **(4 Marks)**  
(ii) Determine the suitable size of the collector if the client chooses to use  
A: Flat plate collector **(3 Marks)**  
B: Evacuated tube collectors **(2 Marks)**
- (c) (i) Discuss any TWO parameters that you would cover during the site visit exercise **(4 Marks)**  
(ii) State any two equipment that you may use to collect site data during the site visit exercise. **(4 Marks)**

#### **QUESTION FOUR (20 MARKS)**

Maasai Mara University has proposed to install a solar PV system to supply electricity to critical loads in its Physics Laboratory. The proposed loads to be powered are shown in the table below.

<b>No.</b>	<b>Appliance</b>	<b>Rated Power (W)</b>	<b>Usage Time (h)</b>
1	De-ioniser	100	4
2	LCD Projector	50	3
3	Computer Server	40	24

It is proposed that the loads run purely on offgrid system with over 99% reliability. The average monthly insolation for the site is as follows:

<b>MONT H</b>	<b>JA N</b>	<b>FE B</b>	<b>MA R</b>	<b>AP R</b>	<b>MA Y</b>	<b>JU N</b>	<b>JU L</b>	<b>AU G</b>	<b>SEP T</b>	<b>OC T</b>	<b>NO V</b>	<b>DE C</b>
AV. PSH (hrs)	5.5	5.3	4.8	4.6	4.6	4.3	4.2	4.8	5.2	5.4	5.5	5.6

- a) Determine the daily energy demand for the system. **(4 Marks)**  
b) Determine the PV system size required from the monthly insolation data and module parameters provided **(8 Marks)**  
c) Determine the battery bank size taking into consideration 2 days of autonomy and recommended DoD 50%. **(5 Marks)**  
d) Provide any other useful advice to the client that will be of help in reducing the upfront cost. **(3 Marks)**

**//END**