MACHAKOS UNIVERSITY

University Examination 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

FIRST YEAR SECOND SEMESTER EXAMINATION FOR

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING

EED 115: SOLAR TECHNOLOGY SYSTEMS

DATE: 29/4/2019 **TIME: 2.00-4.00 PM**

INSTRUCTIONS:

Answer question and any other two questions

QUESTION ONE (30 MARKS)

a) State any three advantages of renewable energy (3 marks)

b) Explain the problem caused by,

i. oversizing a battery

ii. undersizing a battery. (4 marks)

c) Calculate the approximate power conversion efficiency of a poly-crystalline PV module at an ambient temperature if the solar irradiance is 950w/m^2 , Imp is 5.00A, Vmp is 17.8V and the size of the module 0.68m^2 (4 marks)

d) With the aid of a well labeled diagram, explain the following solar PV systems:

i. stand alone

ii. Hybrid system. (4 marks)

e) After a comprehensive site survey, the following details were collected;

Load description	Quantity	Wattage (W)	Total Wattage	Daily use in hours	Weekly use Days/week	Average Daily load
LED lights (Bed room)	2	6		3	6	
LED lights (Bath room)	1	6		1	5	
LED lights (living room)	3	6		5	6	
LED lights (kitchen)	1	6		2	6	
Radio (AC)	1	30		5	5	
Television (AC)	1	60		5	4	
Laptop charger (AC)	2	40		3	4	
Mobile phone charger (AC)	4	2		3	5	

i. Determine the total watt-hours for each category. (2 marks)

ii. Determine the average daily load for each load . (2 marks)

iii. Determine the total daily DC energy (1 mark)

iv. Determine the total daily AC energy (1 mark)

v. Determine the total daily energy requirement (1 mark)

Given that,

days of autonomy = 5

Depth of discharge = 75%

Derating factor = 0.8

Peak sun hours (PSH) = 4.5 hours

Safety factor = 1.25

DC losses = 5%

Inverter efficiency = 90%

Buffer for growth = 10%

Battery equalization factor = 1.1

System voltage = 12 V

Design a suitable system to serve the customer adequately (8 marks)

QUESTION TWO (20 MARKS)

a) Explain the term photovoltaic effect. (2 marks)

b) Given that the irradiance in Nyeri is 900w/m^2 and 4 sunshine hours per day are experienced. How much insolation is given by the sun

i. Per day

ii. Per week (4 marks)

iii. Explain the technical specifications found on a genuine PV module. (10 marks)

c) Explain the term voltage equalization and how it is done. (4 marks)

QUESTION THREE (20 MARKS)

a) State any five activities involved in final inspection and commissioning of a solar PV project. (5 marks)

b) Figure 1 is given below,

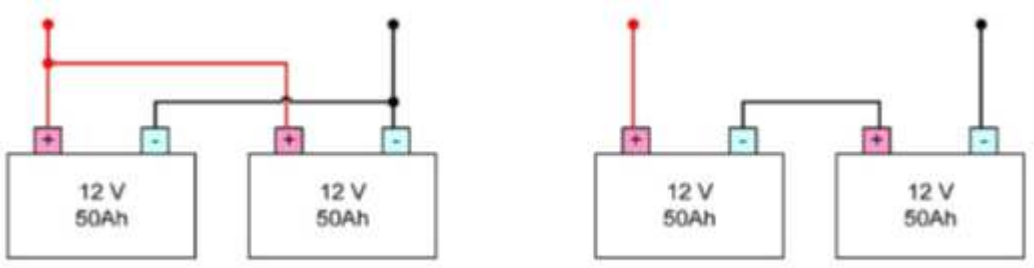

Figure 1

b) For each case, calculate the total voltage and total power. (5 marks)

c) The following details are given,

P_{mp} = 20W, V_{mp} = 18V, Imp = 1.11A, V_{oc} = 21.6A, I_{sc} = 1.28A, Irradiance = 1000w/m^2 and area A of the PV module = 0.68m^2 .

Calculate the (i) Efficiency of the PV module and (ii) the fill factor. (5 marks)

(5 marks)

d) With the aid of a well labeled I-V curve explain the effect of temperature on the output voltage (5 marks)

QUESTION FIVE (20 MARKS)

a) Define the following terms with reference to solar PV design.

i. Peak sun hours

ii. cycle

iii. Days of autonomy

iv. Depth of discharge

v. Airmass (10 marks)

b) Explain how sulfation and stratification are prevented. (4 marks)

c) With the well labeled waveforms, explain any three types of stand alone inverters (6 marks)

QUESTION FIVE (20 MARKS)

a) Explain any four components of a solar PV systems. (8 marks)

b) State any four voltage levels managed by the charge controller (4 marks)

c) Explain why dissimilar PV modules should not be connected in series. (2 marks)

d) Details of solar pv project are as follows.

Load	Quantiy	Rated watts	Daily use (hours)	Weekly use (days)
LED lights	3	6	3	6
Incandescent lamps	2	20	4	5
Radio (AC)	1	30	5	4

Determine the daily energy requirements and the battery size (6 marks)