



MACHAKOS UNIVERSITY

University Examinations for 2019/2020 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

FIRST YEAR THIRD SEMESTER EXAMINATION FOR

DIPLOMA IN ELECTRICAL ENGINEERING

EED 2601/105/SIT: SOLAR TECHNOLOGY SYSTEMS

DATE: 18/12/2020

TIME: 8:30 – 11:30 AM

INSTRUCTIONS: Answer ALL the questions in this section

1. a) Explain any FOUR methods of mounting a PV module (6 marks)
- b) A battery has a SOC of 25% at 50Ah, calculate the
- i) Depth of discharge (DOD)
- ii) Battery full capacity (4 marks)
- c) Table 1 shows the daily energy requirements of a farmer in Kitui. Assuming 15% of power is lost through inefficiencies in the battery and wire connections, determine the total daily energy supplied by the module to satisfy the farmer.

load	Quantity	Volts (V)	Power (W)	Daily use, hours
Fluorescent lamp	2	12	8	3
LED lamp	2	12	12	1.5
Radio	1	6	6	2

(10 marks)

2. a) State any four major steps involved in final inspection and commissioning of a stand alone PV system.. (4 marks)
- b) Explain why dissimilar PV modules should not be connected in series (2 marks)

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

Load description	Quantity	Wattage (W)	Total Wattage	Daily use in hours
LED lights (Bed room)	3	5		3
LED lights (Bath room)	1	5		1
LED lights (living room)	2	5		5
LED lights (kitchen)	2	5		3
Radio (AC)	1	30		5
Television (AC)	1	60		5
Laptop charger (AC)	1	40		3
Mobile phone charger (AC)	3	2		3
Bread toaster (AC)	1	20		2
Fridge (AC)	1	60		8

Given that,

days of autonomy = 5

Depth of discharge = 75%

Derating factor = 0.8

Peak sun hours (PSH) = 4.5hours

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 (14 marks)

3. a) With the aid of a circuit diagram, explain the construction of a shunt charge controller (5 marks)
- b) With an aid of a well labeled diagram, explain the following terms;
 - Solar constant
 - Direct radiation
 - Diffuse radiation (5 marks)

- c) Explain the connecting/disconnecting sequence of a charge controller (4 marks)
- d) A battery is supplying electrical energy to an appliance. If the percentage voltage drop is 5.56% and the battery voltage at the terminals is 12.6V, calculate the voltage at the appliance. (3 marks)
- e) The following details are given,
Peak sun hours = 5 hours/day
Rating of a given PV module = 150W
Efficiency of the given PV module = 80%
Calculate the total energy given out by the PV module in a week. (3 marks)
4. a) Define the following terms,
i) days of autonomy
ii) depth of discharge
iii) State of charge (6 marks)
- b) Explain the problems associated with
i) under sizing the battery
ii) Over sizing the battery (4 marks)

b) Figure 1 is given below,

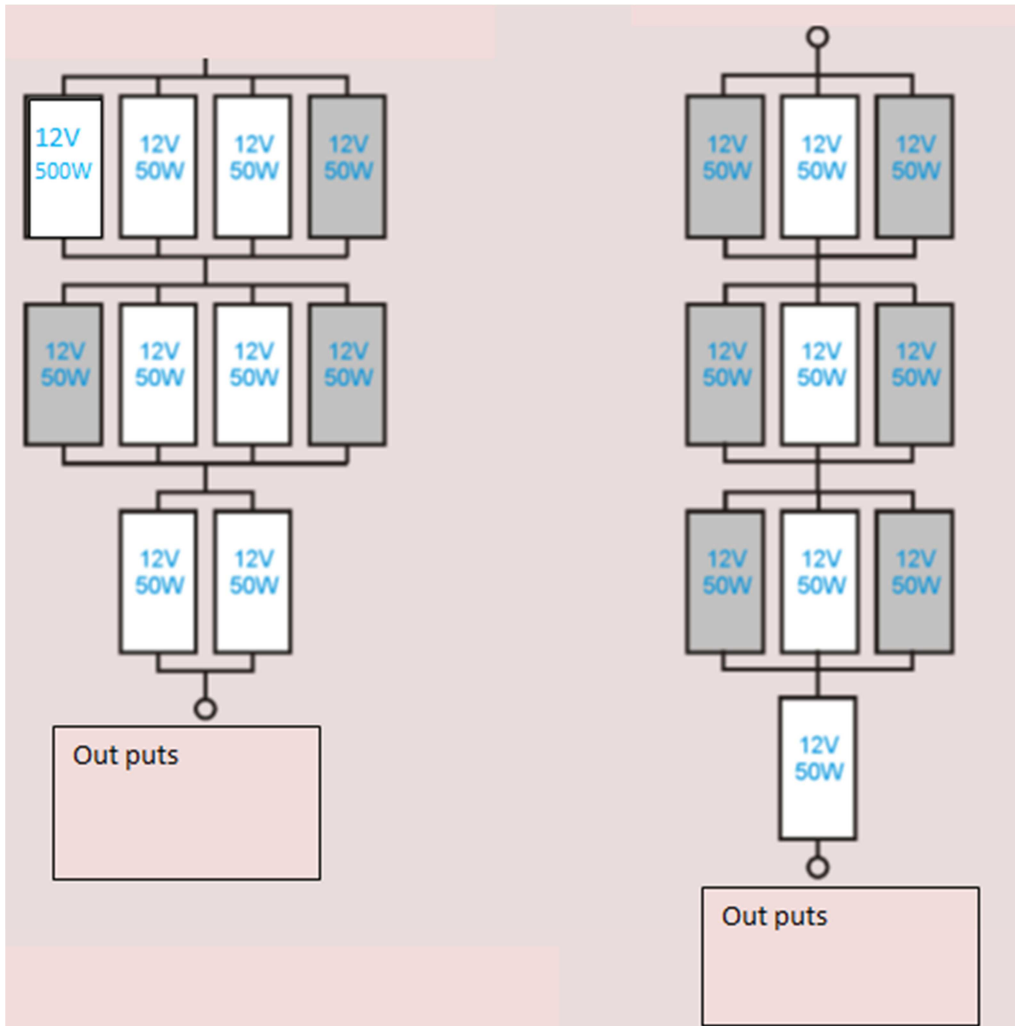


Figure 1

For each case, calculate the output voltage and power.

(6 marks)

- c) Calculate the approximate power conversion efficiency of a poly-crystalline PV module at an ambient temperature if the solar irradiance is 950 W/m^2 , I_{mp} is 5.00 A , V_{mp} is 17.8 V and the size of the module 0.68 m^2

(4 marks)

5. Figure 2 is given below

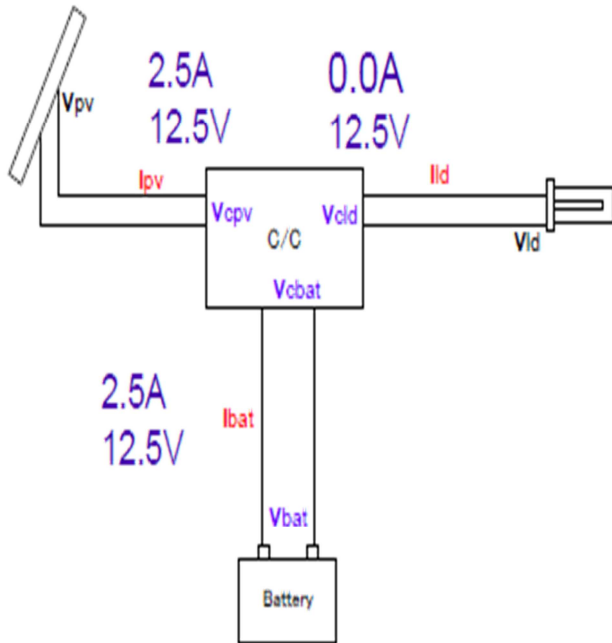


Figure 2

- i) State whether the readings were taken during the day or night.
 - ii) Calculate the load power
 - iii) Calculate the PV module power output (5 marks)
- b) Explain how sulfation and stratification are prevented. (4 marks)
- c) Table 1 shows loads supplied by a 12V solar battery with a 60% depth of discharge. If the number of days of autonomy is 4, determine the
 - i) Daily energy requirement
 - ii) Battery capacity.
 - iii) Size of the PV array (11 marks)

Table 1

Loads	Quantity	Rating	Usage hours/day
Lights	4	10W	4 ours
T.V.	2	20W	2 hours

5. a) Explain the importance of the following
- i) Low voltage disconnect in a charge controller
 - ii) Blocking diodes (4 marks)
- b) Explain Any three types of inverters (6 marks)
- c) A 12 dc home solar system supplies a load which consists of four 10 watt lamps and an 80 watt televion set. If the daily use for each appliance is 2 hours, determine the,
- i) Total daily energy demand
 - ii) Daily system charge requirement (10 marks)