



MACHAKOS UNIVERSITY

University Examination 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

FIRST YEAR FIRST SEMESTER EXAMINATION FOR

DIPLOMA IN ELECTRICAL AND ELECTRONIC ENGINEERING

2605: SOLAR TECHNOLOGY SYSTEMS

DATE: 24/4/2019

TIME: 2.30-5.30 PM

INSTRUCTIONS:

Question ALL the questions.

Show all your workings clearly

QUESTION ONE (30 MARKS)

- a) State the Standard Test Conditions of PV modules (3 marks)
- b) Explain why dissimilar PV modules should not be connected in series (2 marks)
- c) The following details are given,
 $P_{mp} = 20W$, $V_{mp} = 18V$, $I_{mp} = 1.11A$, $V_{oc} = 21.6V$, $I_{sc} = 1.28A$, 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)
- d) State any four major steps involved in final inspection and commissioning of a stand alone PV 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
LED lights (Bed room)	3	6		3
LED lights (Bath room)	1	6		1
LED lights (living room)	2	6		5
LED lights (kitchen)	2	6		2
Radio (AC)	1	30		5
Television (AC)	1	60		5
Laptop charger (AC)	1	40		3
Mobile phone charger (AC)	3	2		3

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

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 (12 marks)

QUESTION TWO (20 MARKS)

- a) With an aid of a diagram, explain the following terms;
 - i. Solar constant
 - ii. Direct radiation
 - iii. Diffuse radiation (5 marks)
- b) The following details are given,
 - i. Peak sun hours = 5 hours/day
 - ii. Rating of a given PV module = 150W
 - iii. Efficiency of the given PV module = 80%

Calculate the total energy given out by the PV module in a week. (5 marks)
- c) Explain the different types of PV modules, stating their efficiencies, and compare their physical sizes (10 marks)

QUESTION FOUR (20 MARKS)

- a) A battery with a capacity of 160Ah is discharged by 120Ah, calculate the
- State of charge (SOC)
 - Depth of discharge
- (5 marks)
- b) Figure 1 is given below,

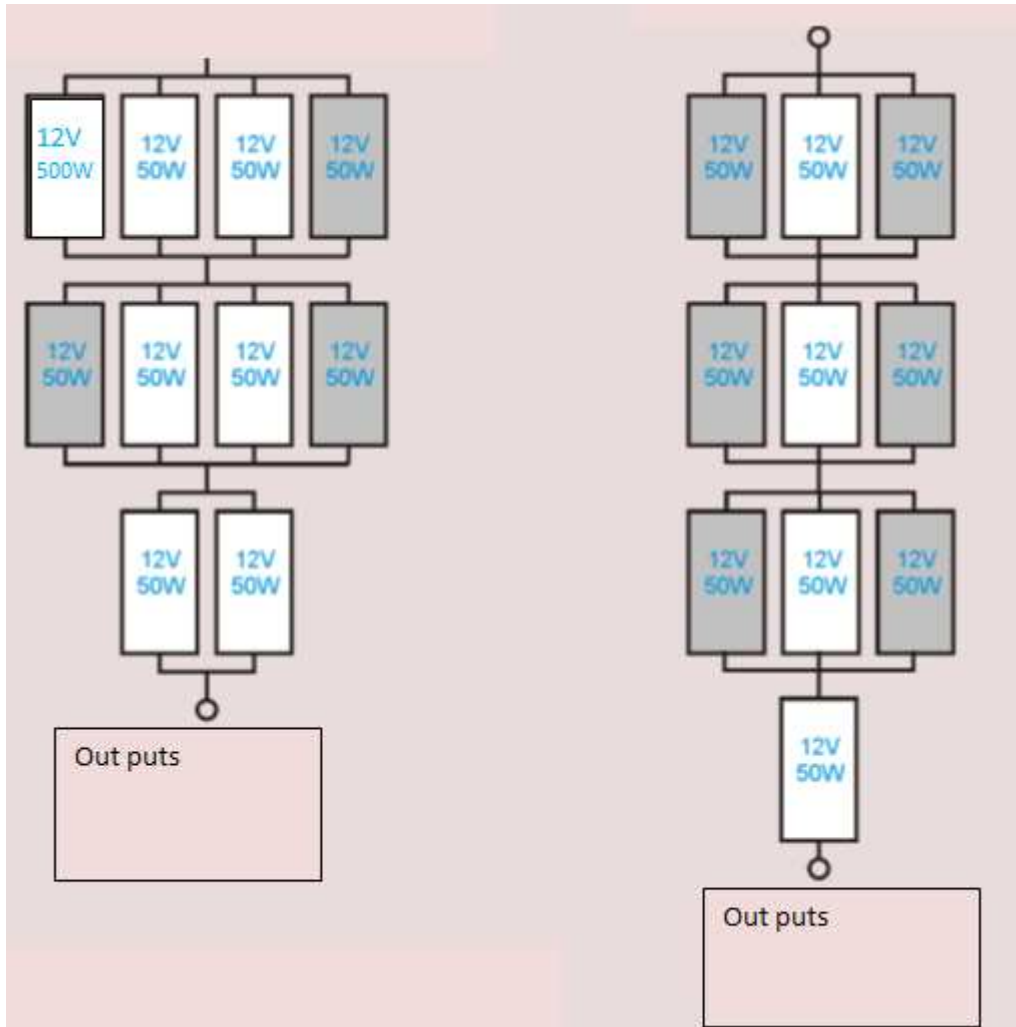


Figure 1

- 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 950W/m^2 , I_{mp} is 5.00A , V_{mp} is 17.8V and the size of the module 0.68m^2 . (4 marks)
- d) Figure 2 is given below

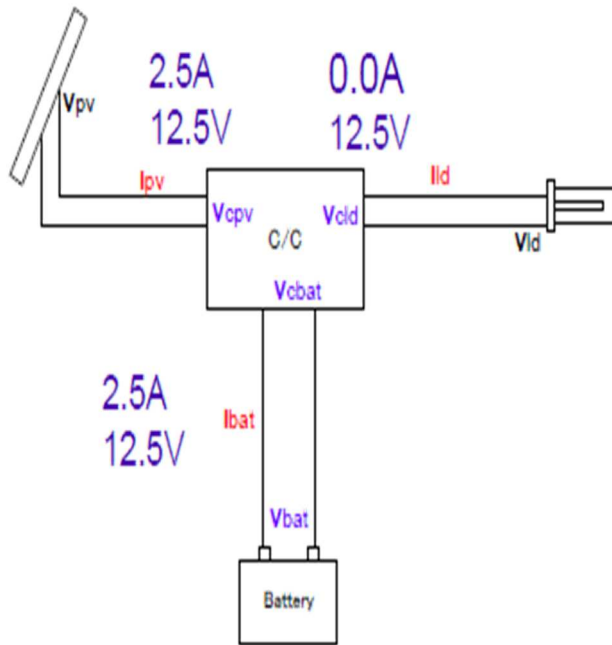


Figure 2

- State whether the readings were taken during the day or night.
- Calculate the load power
- Calculate the PV module power output (5 marks)

QUESTION FOUR (20 MARKS)

- Define the following terms with reference to solar PV systems.
 - irradiance
 - Insolation
 - Days of autonomy
 - Peak sun hours (8 marks)
- Explain how sulfation and stratification are prevented. (4 marks)
- 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 battery capacity. (8 marks)

Table 1

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

QUESTION FIVE (20 MARKS)

- 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 television 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)