



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

CERTIFICATE ELECTRICAL ENGINEERING

1601/105/SIT: SOLAR INSTLLTION SYSTEMS

DATE: 18/12/2020

TIME: 2:30 – 5:30 PM

INSTRUCTIONS: Answer ALL the questions in this section

1. a) State FOUR main specifications of the following,
 - (i) charge controller
 - (ii) Power inverter (8 marks)
- b) Explain any Four point voltages of a charge controller (8 marks)
- c) Calculate the direct irradiance if the total measured irradiance is 950w/m^2 and the measured diffuse irradiance is 65w/m^2 (4 marks)
2. a) With the aid of circuit diagrams, explain the construction of a Series charge Controller (5 marks)
- b) Explain ANY three possible causes of PV module that is not producing any output to the battery during a normal sunny day (6 marks)
- c) Draw a wiring diagram of a solar installation system supplying a d.c. final circuit consisting of two lamps controlled by two way switches. (5 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. (4 marks)

3. a) State the main steps involved in a design of a suitable solar PV system (6 marks)
- b) The following details were collected after a comprehensive site survey

Load description	Number of loads	Size in Watts (Per load)	Daily use Hours/Day	Weekly use Days/week
LED lights (Bedrooms),DC	3	6	3	6
LED lights (Bathroom),DC	1	6	1	6
LED lights (Living Area),DC	2	6	5	4
LED lights (Kitchen),DC	2	6	2	5
Radio (AC)	1	30	5	5
Television (AC)	1	60	5	4
Laptop Charger (AC)	1	40	3	3
Mobile Phone Chargers (AC)	3	2	3	6
Bread toaster (AC)	1	10	4	3
Shaver (AC)	1	5	3	2
LED Security Lights	5	15	8	7
Fridge (AC)	1	60	8	5

Given the following details,

Depth of Discharge (DOD)= 75%

Days of Autonomy = 5

Battery efficiency = 60%

Battery charge equalization= 1.1

5% as the cable losses

90% as the inverter efficiency

10% as the buffer growth factor

System voltage is 12V

Safety factor = 1.25

And irradiance in the year as follows,

Jan	Feb	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
5.19	5.34	5.62	5.08	4.8	4.49	4.6	5.22	5.27	5.35	5.41	6.11

Design a suitable system to serve the customer adequately

(14 marks)

4. a) With the aid of an I-V curve, explain the effect of the following on the performance of a PV module:
- (i) Solar irradiance
 - (ii) Temperature
 - (iii) Shading (6 marks)
- b) Explain how sulfation and stratification are prevented. (4 marks)
- c) A battery is rated 6,200AH. If three of the rated battery are connected in
- (i) Series
 - (ii) Parallel

Sketch the arrangement and determine the voltage and capacity in each case.

(10 marks)

5. a) With the aid of waveforms, explain Any three types of stand-alone inverters. (6 marks)
- b) 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) battery capacity (6 marks)

- c) Explain the economic effect of greater autonomy period (4 marks)

- d) 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. (4 marks)