



JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

**UNIVERSITY EXAMINATION FOR THE DEGREE IN SCIENCE IN RENEWABLE
ENERGY TECHNOLOGY AND MANAGEMENT**

3RD YEAR 1ST SEMESTER 2024/2025 ACADEMIC YEAR

CENTRE: MAIN CAMPUS

COURSE CODE: TEB 1301

COURSE TITLE: PHOTOVOLTAIC TECHNOLOGY

EXAM VENUE: STREAM: BSc. REN ENGY TEC & MGT

DATE: 6/1/2025 EXAM SESSION:9-11 AM

DURATION: 2 HOURS

Instructions

- 1. Answer question 1 (Compulsory) and ANY other two questions**
- 2. Candidates are advised not to write on question paper**
- 3. Candidates must hand in their answer booklets to the invigilator while in the examination room.**

Question One (Compulsory)

- a) State **THREE** battery efficiencies that are used to compare storage devices used for standalone systems.
(3 Marks)
- b) A solar cell having a fill factor (FF) 60% gives 2.5A current at maximum power point at standard test conditions STC. The cell gives 3 A short circuit current and 0.5 V open circuit voltage. Calculate the voltage at maximum power point of the solar cell. **(3 Marks)**
- c) Using a well labeled diagram of an $I-V$ curve show and discuss the effect of increase of temperature on a solar PV module. **(3 Marks)**
- d) There are various solar photovoltaic technologies available in the market for manufacturing solar cells. As an expert in PV technology outline **THREE** types of thin film solar cells you would recommend to a solar manufacturer based in Kisumu. **(3 Marks)**
- e) As the Maintenance Engineer of a solar photovoltaic system in your company, you have noted that one of the modules in the PV array has a dead cell. Describe briefly is the effect of the dead cell on the module. **(3 marks)**
- f) Efficiency is critical in designing a solar system. Outline **THREE** factors that determine electricity generated by a solar cell found in solar module. **(3 Marks)**
- g) Outline **THREE** factors that can cause failure in PV modules. **(3 Marks)**
- h) As an expert in photovoltaic technology. Enumerate **FOUR** desirable features that an engineer should consider while designing solar PV module installation for an iron sheet roof mounted system **(4 Marks)**
- i) As a certified solar technician site survey is one of the crucial activity that has to be carried prior to solar installation. Enumerate **FIVE** objectives of a site survey for a PV installation. **(5 Marks)**

QUESTION TWO

- a) According to the international energy agency the demand of solar panels has grown significantly. Describe **FIVE** factors key factors driving the demand for solar panels globally. **(10 Marks)**

b) Discuss three factors an engineer should consider while optimizing the performance of the photovoltaic installation array. **(6 Marks)**

c) Discuss any **FOUR** applications of solar photovoltaic technology giving two examples for each application. **(4 Marks)**

QUESTION THREE

a) As an expert in renewable energy design a standalone AC solar PV system for client in Siaya who has the following loads. **(14 Marks)**

Consider the following assumptions.

- ✓ Available battery is 12V 100 Ah, 50% DOD
- ✓ Available Module is KYOCERA 120 W: $I_{SC} = 7.45 \text{ A}$, $I_{MP} = 7.10 \text{ A}$
- ✓ Inverter losses = 30%
- ✓ Days of Autonomy = 2

Appliance	Quantity	Voltage (V)	Wattage	Daily hours of use	Wattage consumption in Hours
Indoor Lights	10	12	9	3	
Security Lights	4	12	11	4	
Radio	1	12	10	5	
TV	1	240	40	3	
Refrigerator	1	240	75	10	
Water dispenser	2	240	45	3	
Daily energy demand					

- i. Determine the client’s daily energy demand
- ii. Design the balance of system and recommend the ratings and numbers • PV array • Batteries • Charge controller • Inverter

QUESTION FOUR

b) Using examples explain three steps of evaluating a completed PV installation before educating the end user and handing over the installation.

(6 Marks)

b) Using a well labeled diagram briefly discuss the terminologies found on an IV curve.

(14 Marks)

QUESTION FIVE

(a) Discuss the architectural/fundamental differences between a grid tie solar PV system and an off grid solar PV system. **(4 marks)**

(b) A solar photovoltaic system requires a balance of system (BoS) components to function properly. During the design of a PV system, discuss the BoS components that must be considered. **(5 marks)**

(c) Discuss three factors that should be considered when sizing the battery for a standalone photovoltaic system **(5 Marks).**

(d) As an expert in PV technology recommend **THREE** common instruments used to test state of health batteries **(6 Marks).**