Solar PV Module Technologies Training System

IIT Bombay

User Manual

Solar PV Module Technologies training system is used to measure the performance different silicon PV modules

Parts of Solar PV Module Technologies Training System

1) **Solar panel**

There are 4 types of solar panels are provided to observe the difference.

1.CdTe Solar panel:

The parameters of solar panel at STC conditions 1000W/m^2, 25^{o}C

1) Open circuit voltage Voc =61 V
2) Short circuit current Isc = 1.98 A
3) Voltage at maximum power Vm = 48.5V
4) Current at maximum power Im = 1.76A
5) Maximum power Pm = 85Wp

2. Amorphous silicon(A-si):

The parameters of solar panel at STC conditions 1000W/m^2, 25^{o}C

1) Open circuit voltage Voc = 58.1 V
2) Short circuit current Isc = 3.26 A
3) Voltage at maximum power Vm = 42.5 V
4) Current at maximum power Im = 2.82 A
5) Maximum power Pm = 120Wp

3) Mono crystalline:

The parameters of solar panel at STC conditions 1000W/m^2, 25^{o}C

1) Open circuit voltage Voc = 22.91 V
2) Short circuit current Isc = 3.54 A
3) Voltage at maximum power Vm = 18.88 V
4) Current at maximum power Im = 3.30 A
5) Maximum power Pm = 62.24Wp

4. Multi crystalline

The parameters of solar panel at STC conditions 1000W/m^2, 25^oC

1) Open circuit voltage Voc = 22.1 V
2) Short circuit current Isc = 3.8 A
3) Voltage at maximum power Vm = 18.2 V
4) Current at maximum power Im = 3.6A
5) Maximum power Pm = 65 Wp

List Of Experiments

S.No	Experiment Name	Date
1	To study the voltage and current characteristics of MONO crystalline silicon PV array	
2	To study the voltage and current characteristics of Multi crystalline silicon PV array	
3	To study the voltage and current characteristics of A-si PV Module	
4.	To study the voltage and current characteristics of CdTe PV Module	

1. To study the voltage and current characteristics of MONO crystalline silicon PV array

Objectives:

- Measurement of operating parameters i.e. current and voltage of Mono crystalline silicon PV module by considering PV module as a power source.

Expected Outcome of experiment:

- Ability to plot I-V Curve and find out P_{max}
- Ability to understand the power variation leading to different loads
- Ability to understand the maximum power extraction from PV Module.
- Ability to understand the efficiency of Monoi Crystalline PV Module

Apparatus Required:

Sr. No.	Unit	Description/Rating	Quantity
1	Control Box		1
2	Rheostat	10 A	1
3	Solar Panel Mono	62 Wp	2
4	Connecting wires		1 set

Methodology for measurement:

1. Initially before starting experiment ensure, all the switches are in 'OFF' position, and ensure no connection is connected in the system
2. Connect the mono crystalline solar panels connections using MC4 connectors

3. Now connect the system to 230 V AC power supply and switch on system by pressing the switch to **ON** position
4. Now connect the rheostat and vary the rheostat slowly and note down all the readings in table-1
5. Plot the I-V curve and P-V curve in the graph-1,2 using table-2

Observation Table:

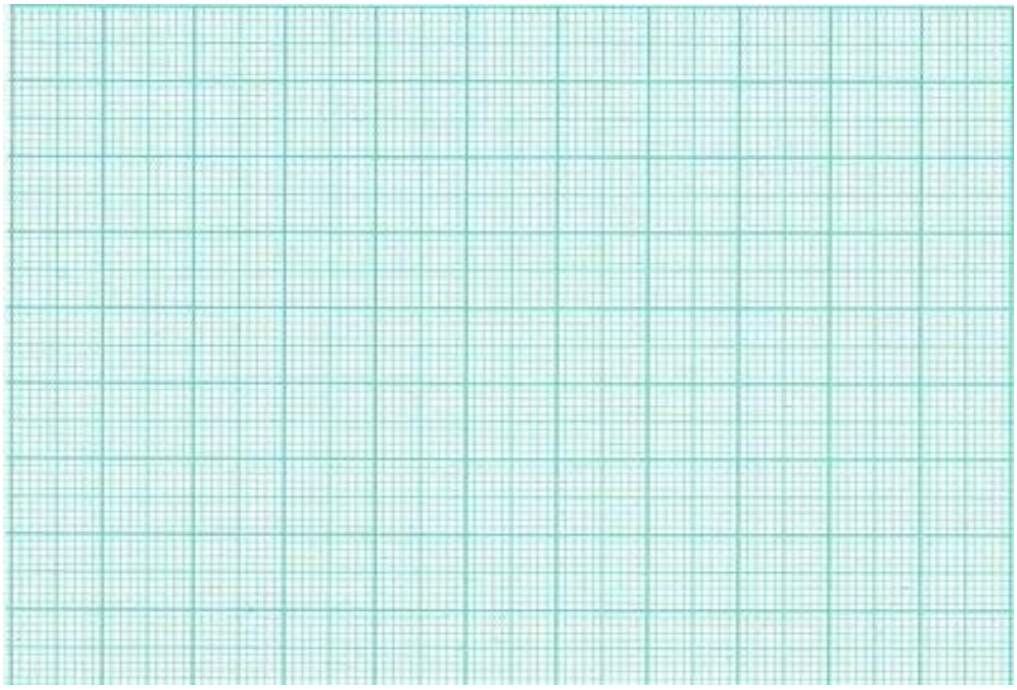
Table-1: Voltage & Current across PV module.

S.no	Voltage (V) V	Current (A) I	Power (W) P = V x I

Graph-1.

Refer your readings in table 1 and plot the I-V curve by considering the different load condition

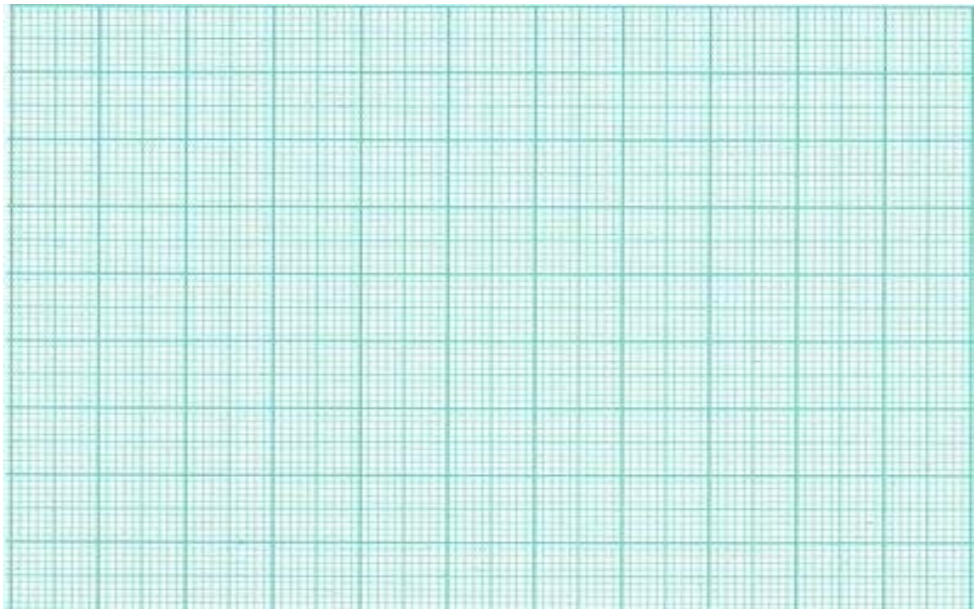
X-axis: Voltage(V) **Y-axis: Current(A)**



Graph-2.

Refer your readings in table 1 and plot the P-V curve by considering the different load condition

X-axis: Voltage(V) **Y-axis: Power(w)**



Calculate the Efficiency and Fill factor

$$\text{Efficiency} = \frac{P_m}{\text{Intensity}*\text{Area}}$$

$$\text{Fill Factor} = \frac{V_m * I_m}{V_{oc} * I_{sc}}$$

Conclusion:

2. To study the voltage and current characteristics of Multi crystalline silicon PV array

Objectives:

- Measurement of operating parameters i.e. current and voltage of Multi crystalline silicon PV module by considering PV module as a power source.

Expected Outcome of experiment:

- Ability to plot I-V Curve and find out P_{max}
- Ability to understand the power variation leading to different loads
- Ability to understand the maximum power extraction from PV Module.
- Ability to understand the efficiency of Multi Crystalline PV Module

Apparatus Required:

Sr. No.	Unit	Description/Rating	Quantity
1	Control box		1
2	Rheostat	10A	1
3	Solar Panel Multi	65Wp	2
4	Connecting wires		1 set

Methodology for measurement:

1. Initially before starting experiment ensure, all the switches are in 'OFF' position, and ensure no connection is connected in the system
2. Connect the solar panels connections using MC4 connectors
3. Now connect the system to 230V AC power supply and switch on system by pressing the switch to **ON** position
4. Now connect the rheostat, Vary the rheostat slowly and note down all the readings in table-2
5. Plot the I-V curve and P-V curve in the graph-3,4 using table-2

Observation Table:

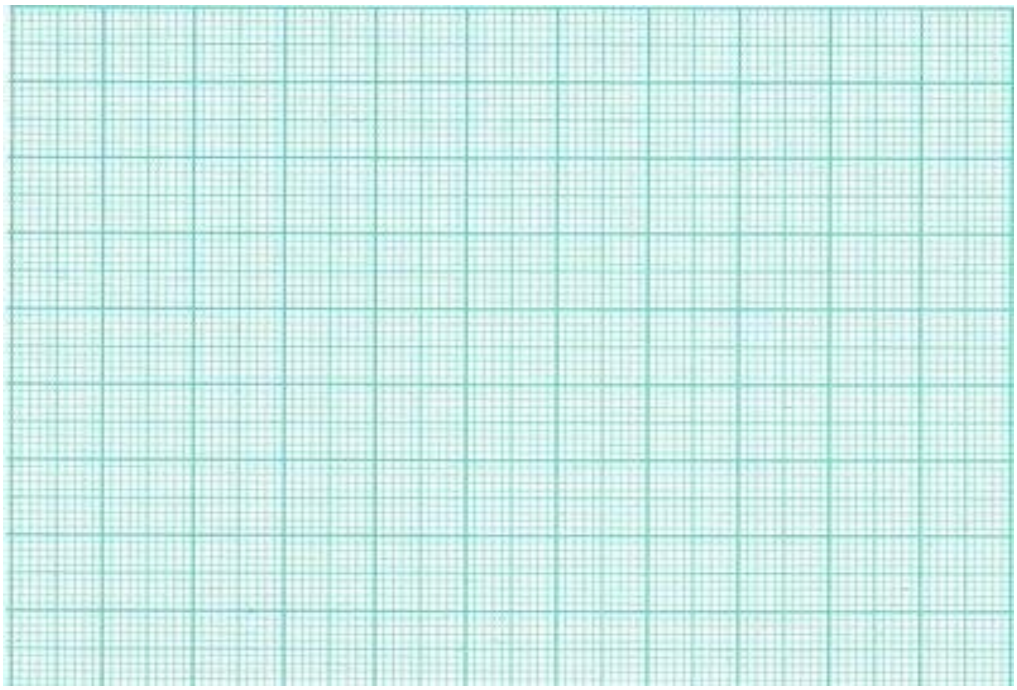
Table-2: Voltage & Current across PV module.

S.no	Voltage (V) V	Current (A) I	Power(W) P = V x I

Graph-3.

Refer your readings in table 2 and plot the I-V curve by considering the different load condition

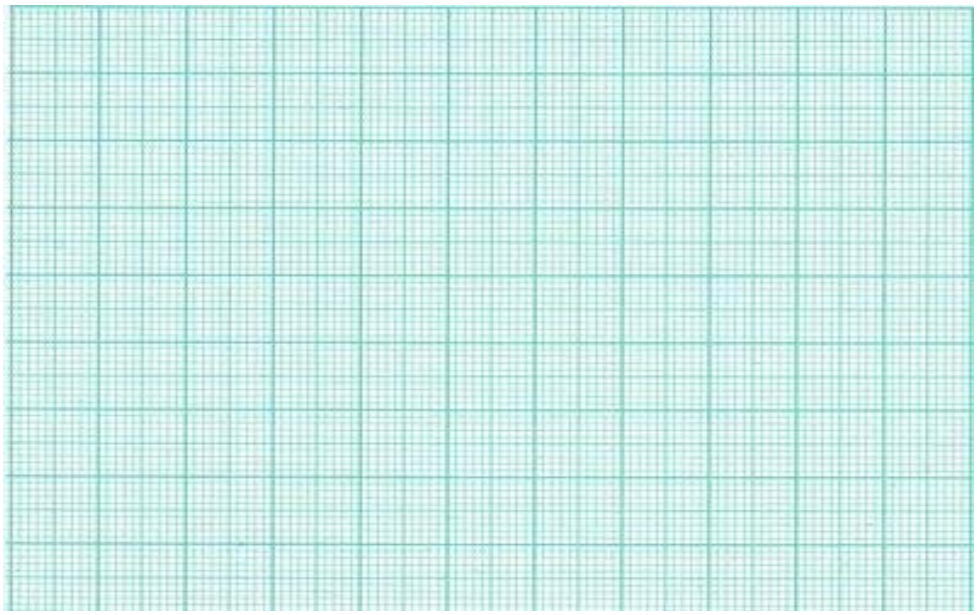
X-axis: Voltage(V) **Y-axis: Current(A)**



Graph-4.

Refer your readings in table 2 and plot the P-V curve by considering the different load condition

X-axis: Voltage(V) **Y-axis: Power(w)**



Calculate the Efficiency and Fill factor

$$\text{Efficiency} = \frac{P_m}{\text{Intensity}*\text{Area}}$$

$$\text{Fill Factor} = \frac{V_m * I_m}{V_{oc} * I_{sc}}$$

Conclusion:

3. To study the voltage and current characteristics of A-Si PV Module

Objectives:

- Measurement of operating parameters i.e. current and voltage of A-si PV module by considering PV module as a power source.

Expected Outcome of experiment:

- Ability to plot I-V Curve and find out P_{max}
- Ability to understand the power variation leading to different loads
- Ability to understand the maximum power extraction from PV Module.
- Ability to understand the efficiency of A-Si PV Module

Apparatus Required:

Sr. No.	Unit	Description/Rating	Quantity
1	Control Box		1
2	Rheostat	10A	1
3	Solar Panel A-Si	120Wp	1
4	Connecting wires		1 set

Methodology for measurement:

1. Initially before starting experiment ensure, all the switches are in 'OFF' position, and ensure no connection is connected in the system
2. Connect the solar panels connections using MC4 connectors
3. Now connect the system to 230V AC power supply and switch on system by pressing the switch to **ON** position
4. Now connect the rheostat, Vary the rheostat slowly and note down all the readings in table-3
5. Plot the I-V curve and P-V curve in the graph-5,6 using table-3

Observation Table:

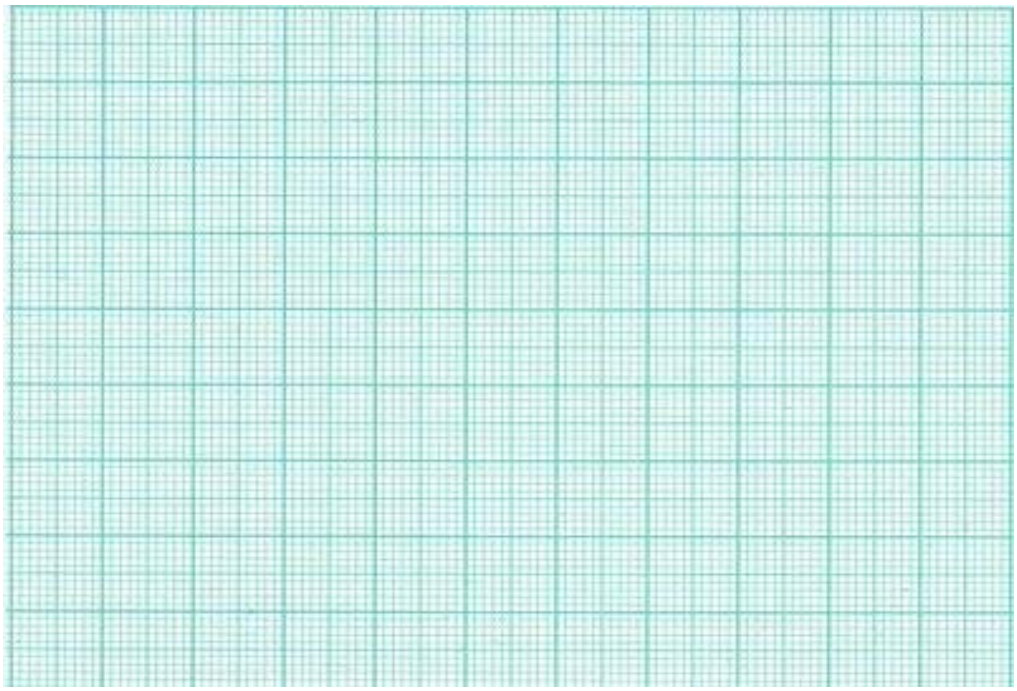
Table-3: Voltage & Current across PV module.

S.no	Voltage (V) V	Current (A) I	Power(W) P = V x I

Graph-5.

Refer your readings in table 3 and plot the I-V curve by considering the different load condition

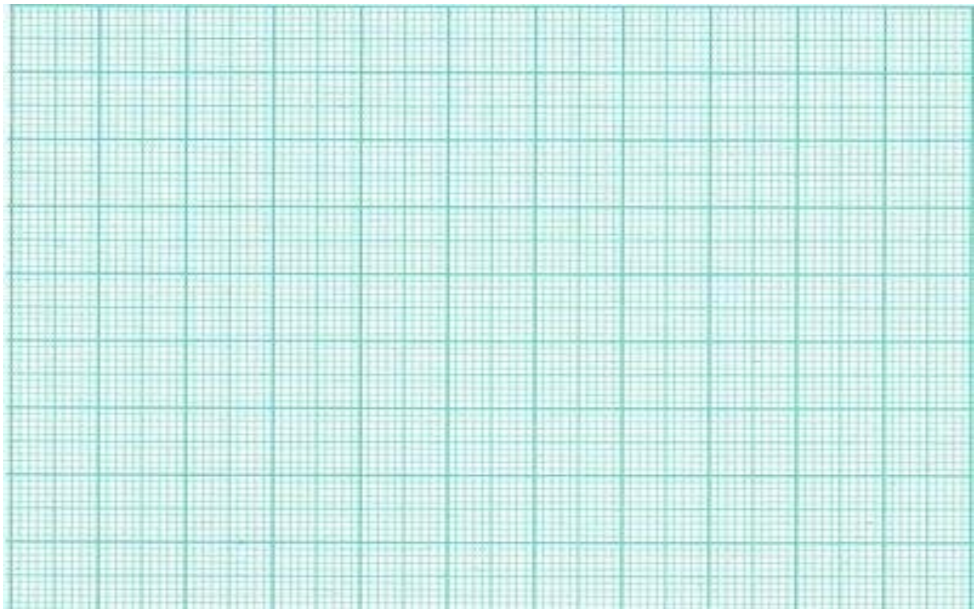
X-axis: Voltage(V) **Y-axis: Current(A)**



Graph-6.

Refer your readings in table 3 and plot the P-V curve by considering the different load condition

X-axis: Voltage(V) **Y-axis: Power(w)**



Calculate the Efficiency and Fill factor

$$\text{Efficiency} = \frac{P_m}{\text{Intensity}*\text{Area}}$$

$$\text{Fill Factor} = \frac{V_m * I_m}{V_{oc} * I_{sc}}$$

Conclusion:

4. To study the voltage and current characteristics of CdTe PV Module

Objectives:

- Measurement of operating parameters i.e. current and voltage of A-si PV module by considering PV module as a power source.

Expected Outcome of experiment:

- Ability to plot I-V Curve and find out P_{max}
- Ability to understand the power variation leading to different loads
- Ability to understand the maximum power extraction from PV Module.
- Ability to understand the efficiency of CdTe PV Module

Apparatus Required:

Sr. No.	Unit	Description/Rating	Quantity
1	Control Box		1
2	Rheostat	10A	1
3	Solar Panel CdTe	85Wp	1
4	Connecting wires		1 set

Methodology for measurement:

1. Initially before starting experiment ensure, all the switches are in 'OFF' position, and ensure no connection is connected in the system
2. Connect the solar panels connections using MC4 connectors
3. Now connect the system to 230V AC power supply and switch on system by pressing the switch to **ON** position
4. Now connect the rheostat, Vary the rheostat slowly and note down all the readings in table-4
5. Plot the I-V curve and P-V curve in the graph-7,8 using table-4

Observation Table:

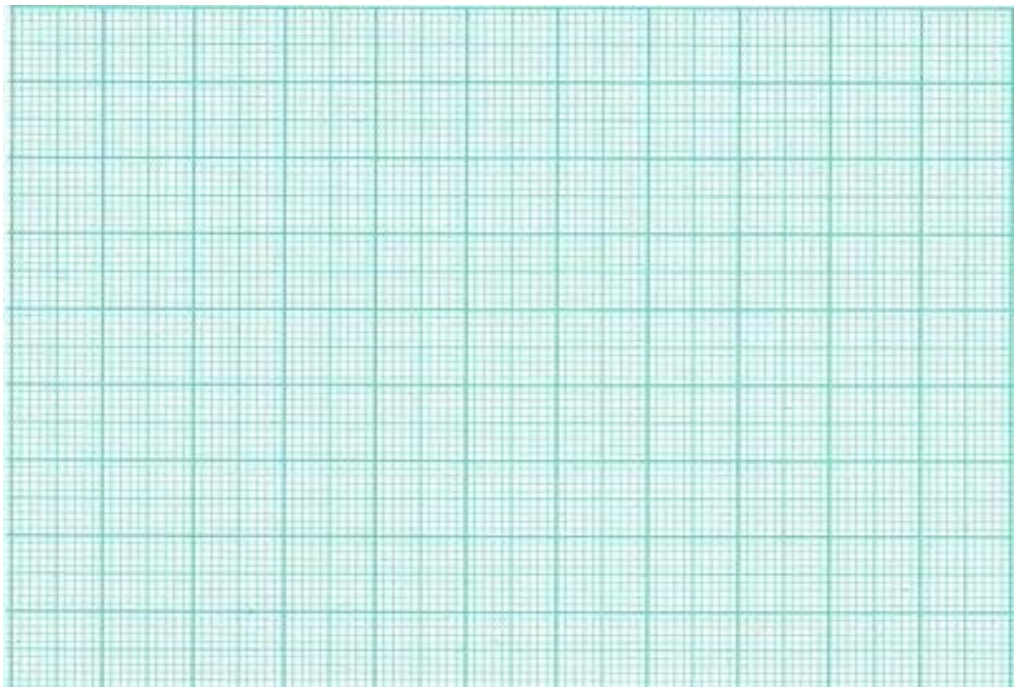
Table-4: Voltage & Current across PV module.

S.no	Voltage (V) V	Current (A) I	Power(W) P = V x I

Graph-7.

Refer your readings in table 4 and plot the I-V curve by considering the different load condition

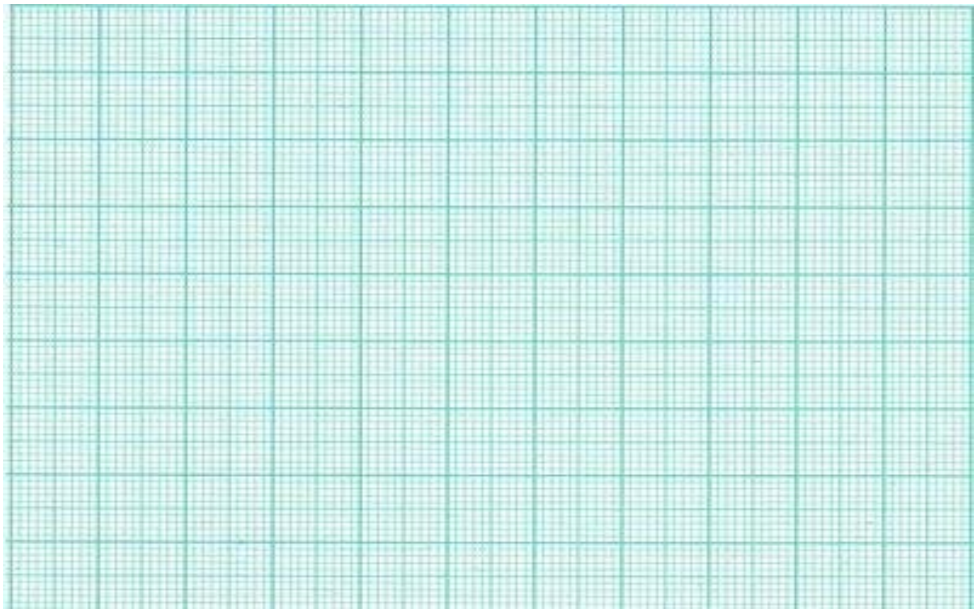
X-axis: Voltage(V) **Y-axis: Current(A)**



Graph-8.

Refer your readings in table 4 and plot the P-V curve by considering the different load condition

X-axis: Voltage(V) Y-axis: Power(w)



Calculate the Efficiency and Fill factor

$$\text{Efficiency} = \frac{P_m}{\text{Intensity}*\text{Area}}$$

$$\text{Fill Factor} = \frac{V_m * I_m}{V_{oc} * I_{sc}}$$

Conclusion:

Questions

1. Compare and comment on the fill factor values for the various panels.
2. Compare and comment on the efficiency values for the various panels.
3. Is it direct, diffuse, reflected, global, or any other value of radiation that is used as “Intensity” in the efficiency calculation? What difference will it make if it is one or another?