

EE 236 Devices Lab

Lab - 05

Anupam Rawat, 22b3982

08th September, 2024

Temperature Dependence of Solar Cell I/V Characteristics

1 Dark forward characteristics at different temperatures

1.1 Aim of the experiment

Observe the I-V Characteristics of the Solar Cell in forward bias and in dark conditions.

1.2 Design

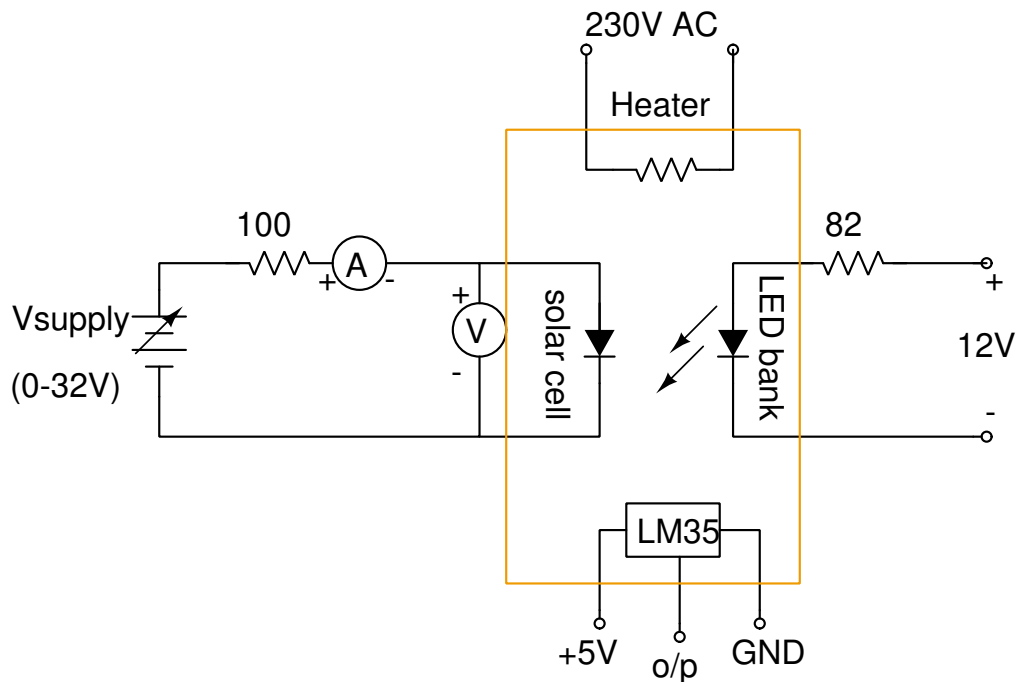


Figure 1: Caption

1.3 Simulation

1.3.1 Code

```
IV characteristics of Solar Cell
Solar Cell description was given in a file format
.include "../solar_cell.txt"
Vin 1 0 dc 0
X1 1 2 solar_cell
r1 2 0 100

.dc Vin -2 2 0.01
.temp 35
.control
run
plot -i(vin) vs {v(1)-v(2)}
wrdata dark_35C.txt -i(vin) {v(1)-v(2)}
.endc
.end
```

1.3.2 Results

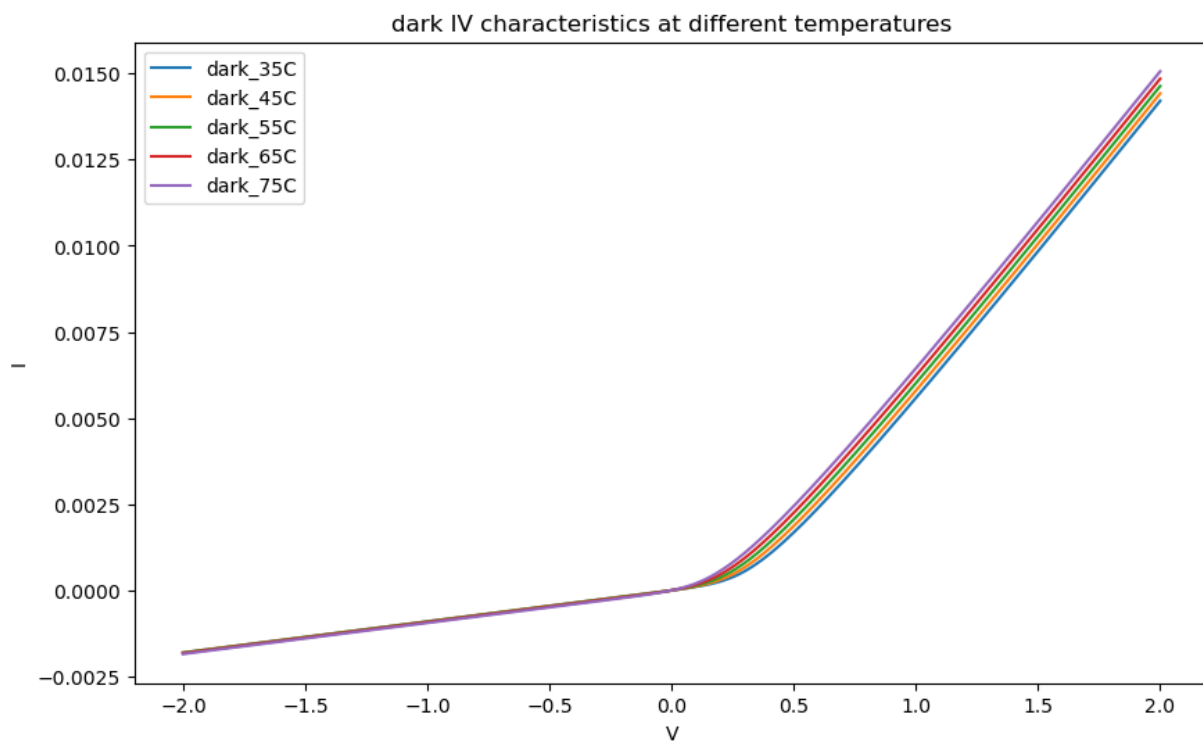


Figure 2: Dark I/V Characteristic across various temperatures - Simulation

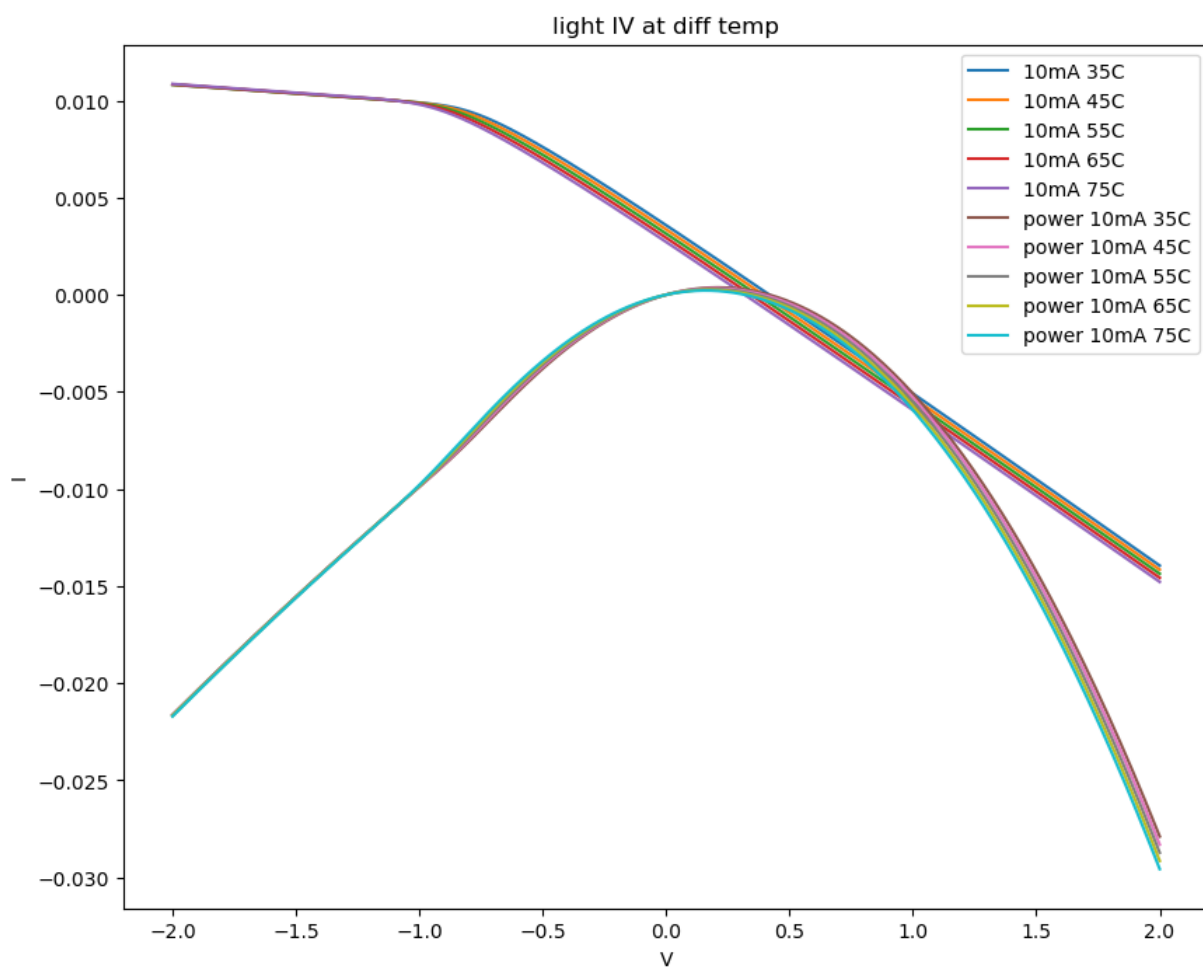


Figure 3: Illuminated I/V Characteristic across various temperatures - Simulation

1.3.3 Simulation Results

The values of fill factors are obtained using this equation:

$$\text{Fill Factor} = \frac{V_{MP} \times I_{MP}}{V_{OC} \times I_{SC}}$$

Table 1: Photovoltaic Cell Data at Different Temperatures

Condition	Isc (mA)	Voc (V)	Im (mA)	Vm (V)	FF
light_35C	0.40	0.40	0.297	0.198	0.371
light_45C	0.36	0.36	0.297	0.198	0.458
light_55C	0.33	0.33	0.297	0.198	0.545
light_65C	0.30	0.30	0.297	0.198	0.660

1.4 Experiment

1.4.1 Individual Plots

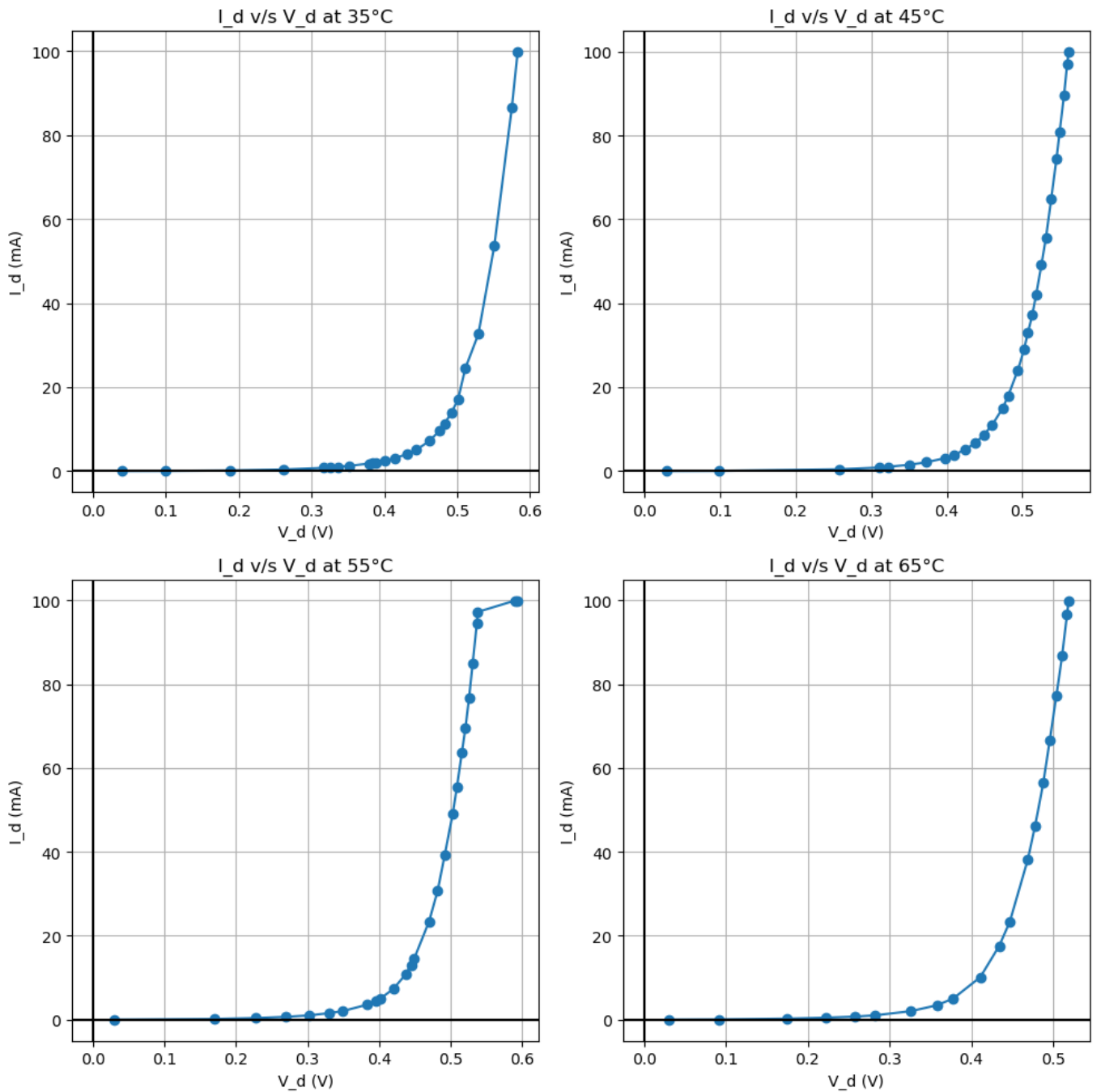


Figure 4: I_d v/s V_d Dark Characteristics for all Temperatures

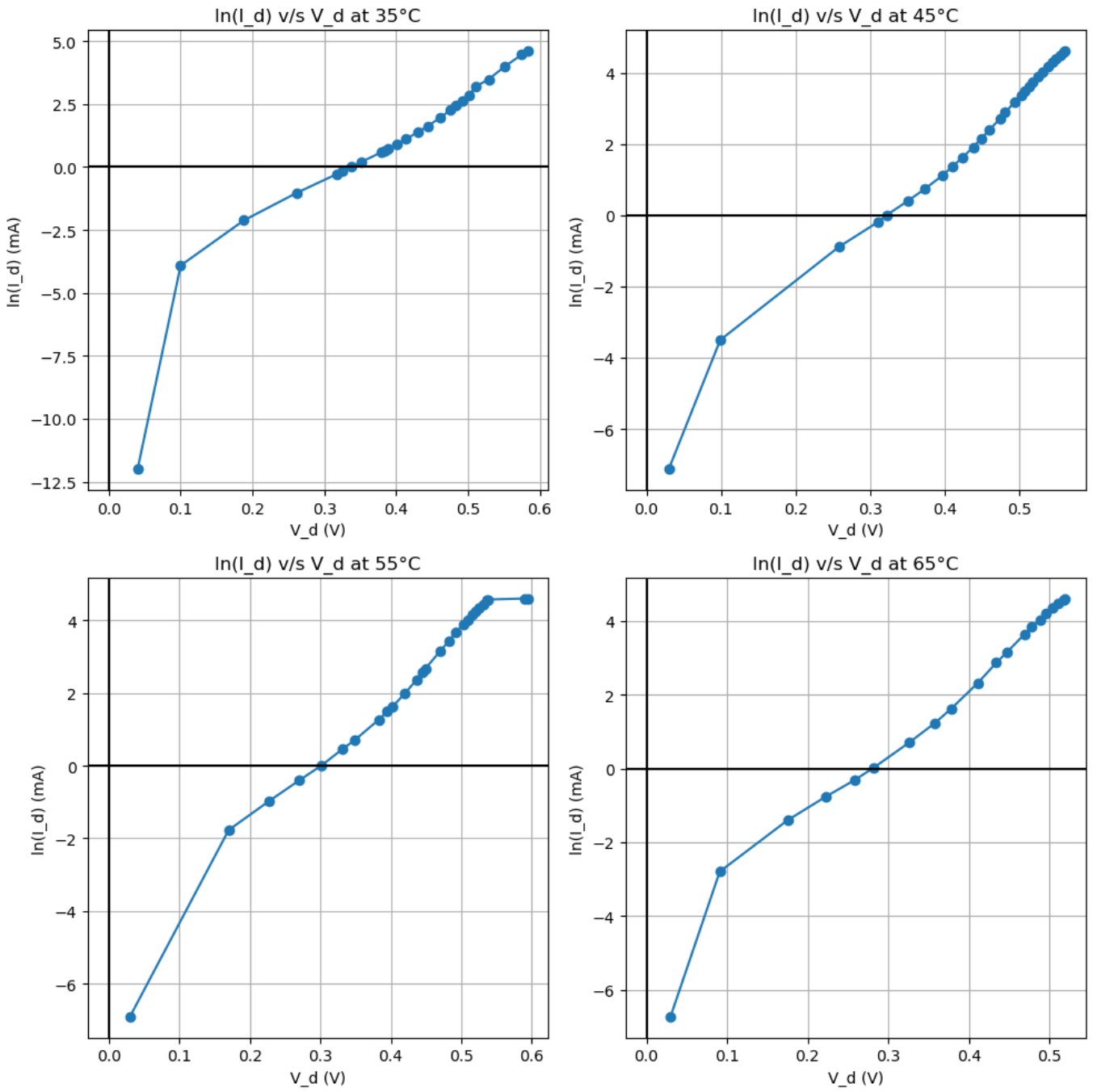


Figure 5: $\ln(I_d)$ v/s V_d Dark Characteristics for all Temperatures

1.4.2 Observation Table

Temperature	Vd for Id =1mA	Vd for Id =2mA	Vd for Id =5mA	η for low forward bias	η for high forward bias
35	0.337	0.388	0.444	1.88	1.93
45	0.322	0.373	0.424	2.33	1.99
55	0.302	0.349	0.402	2.76	1.97
65	0.282	0.326	0.378	2.32	2.15

Table 2: Observations for Experiment 1

1.4.3 Combined Plots

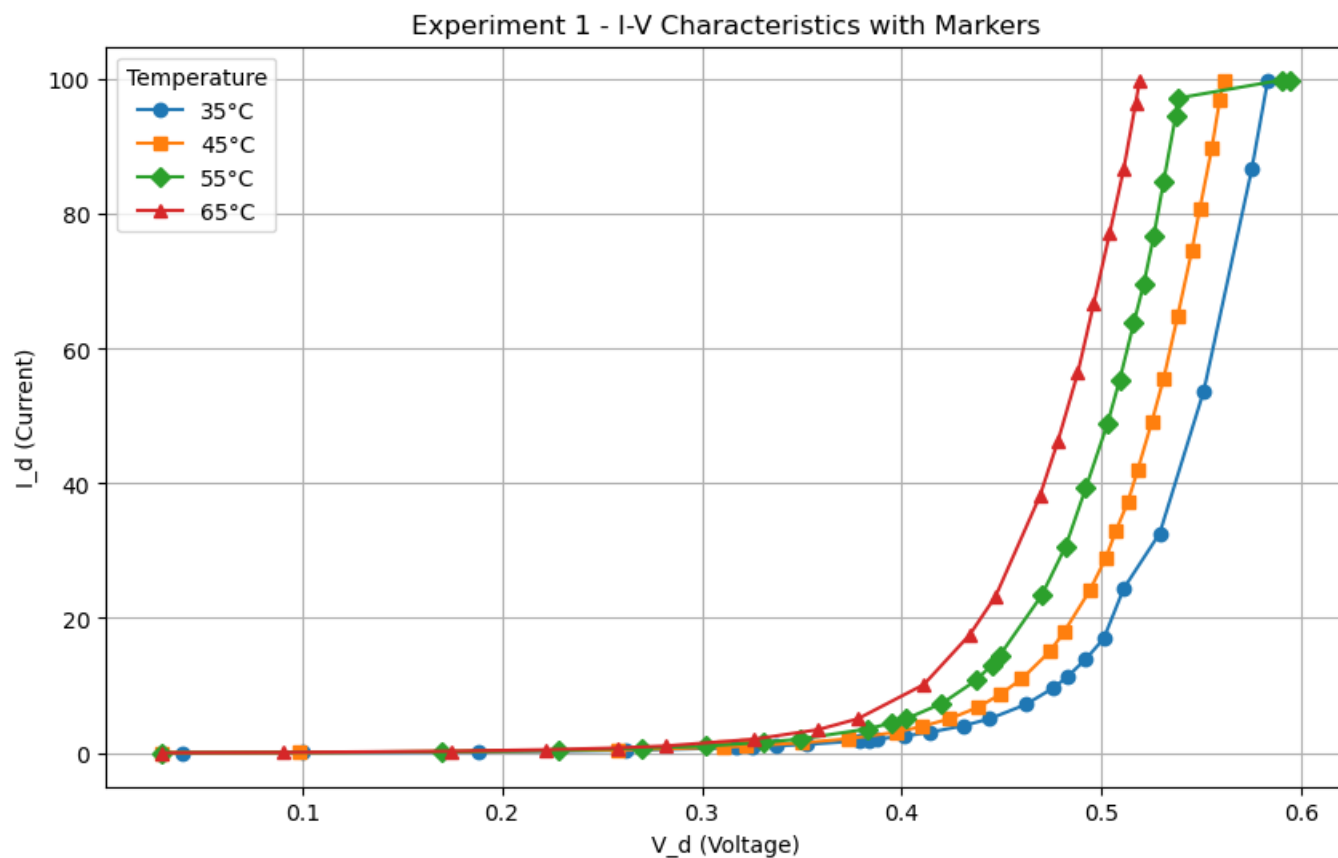


Figure 6: I_d v/s V_d Dark Characteristics for all Temperatures

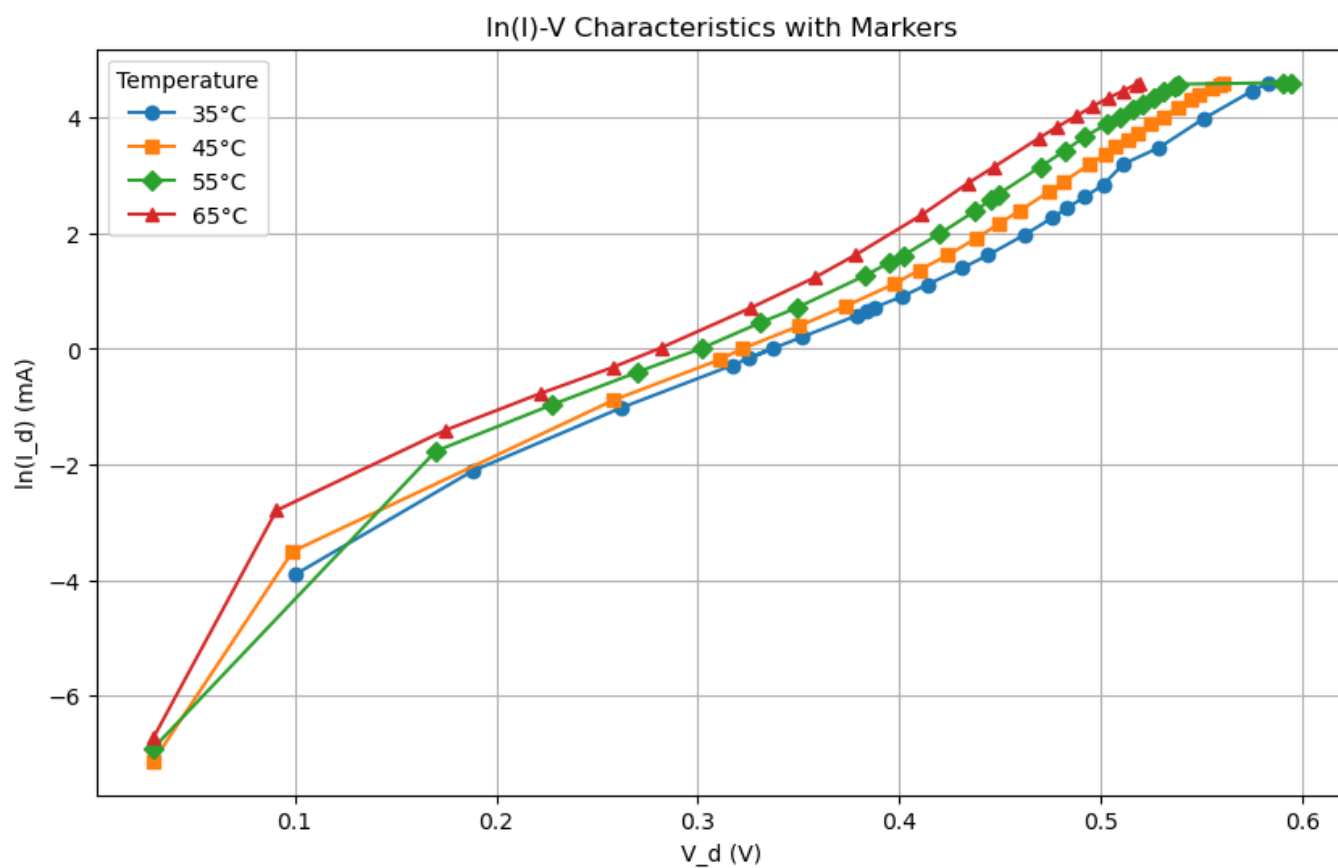


Figure 7: Combined plot of $\ln(I_d)$ v/s V_d Dark Characteristics for all Temperatures

2 Lighted I/V at different temperatures

2.1 Aim of the Experiment

Measure I/V at different temperatures in lighted conditions. Also calculate, Fill Factor at different temperatures.

2.2 Design

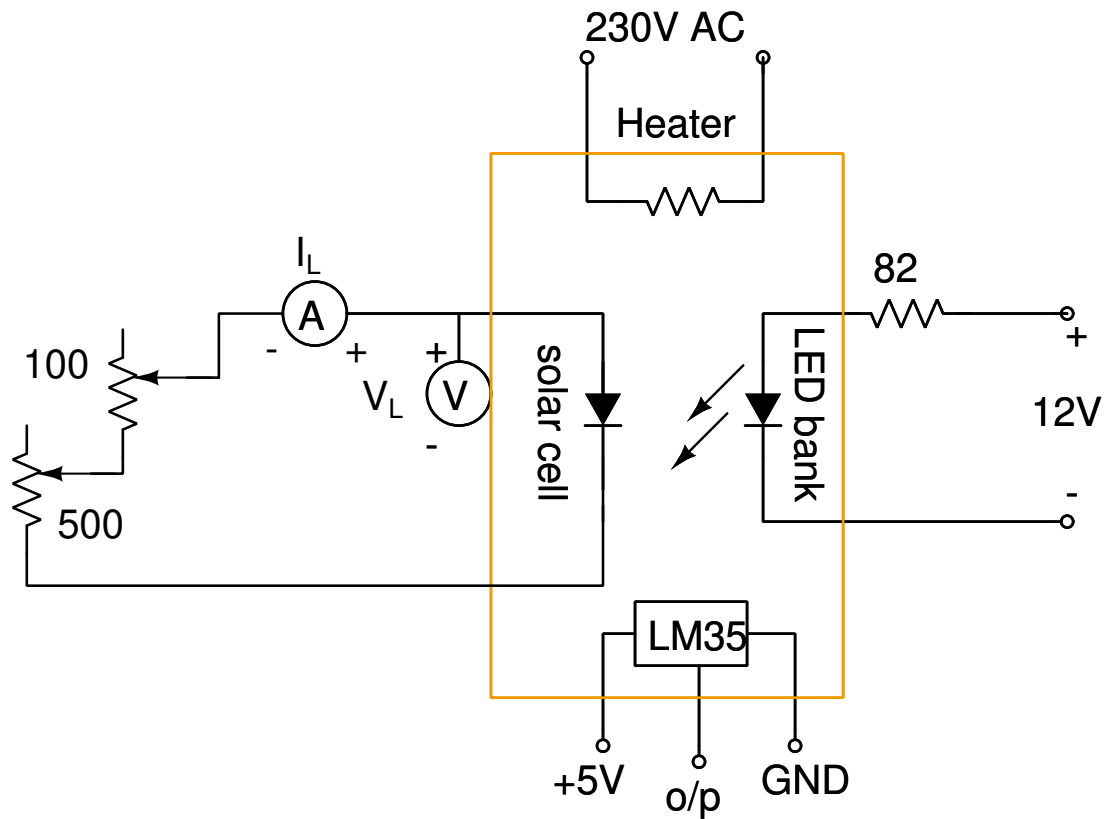


Figure 8: Caption

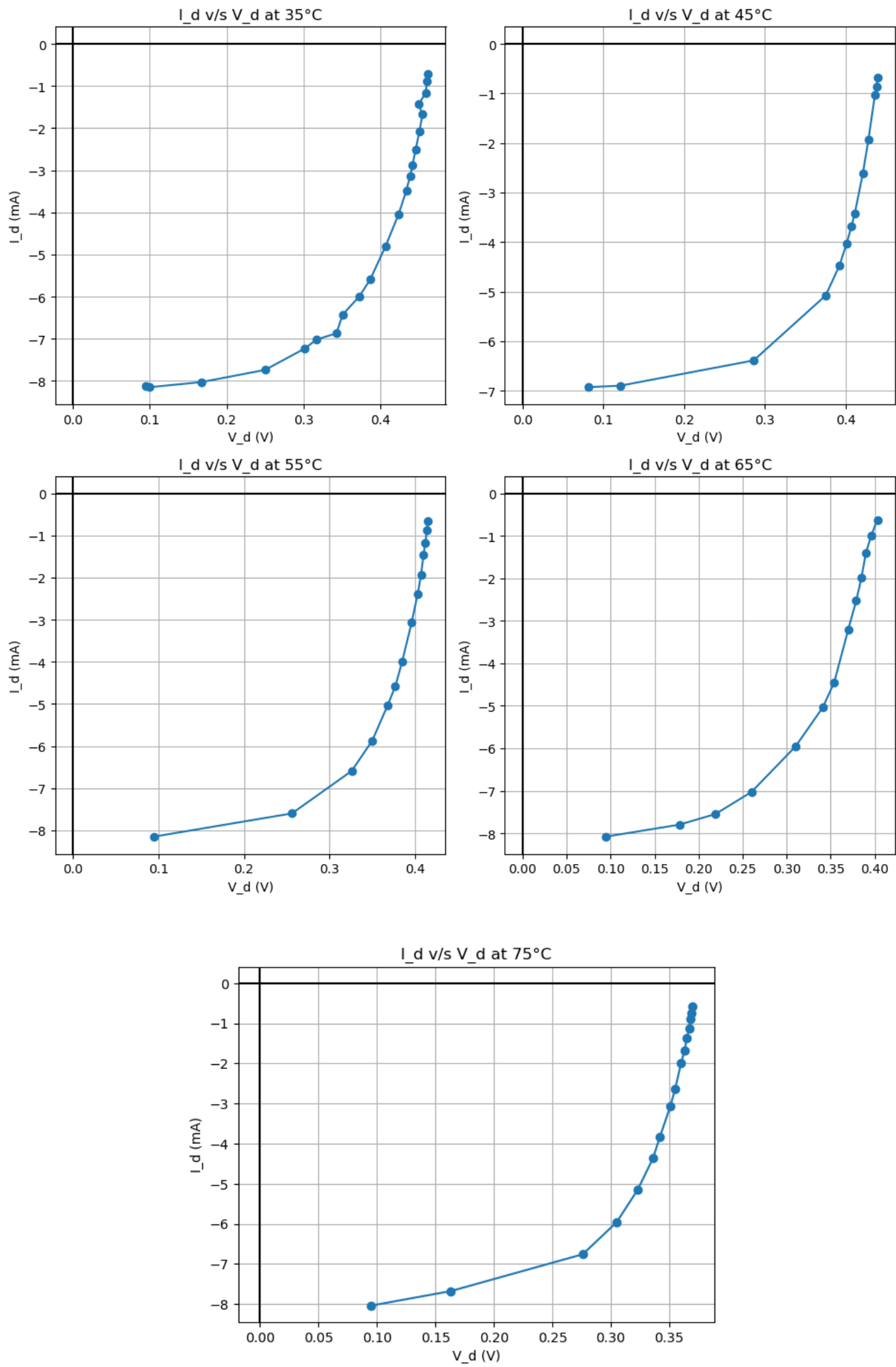
2.3 Simulation

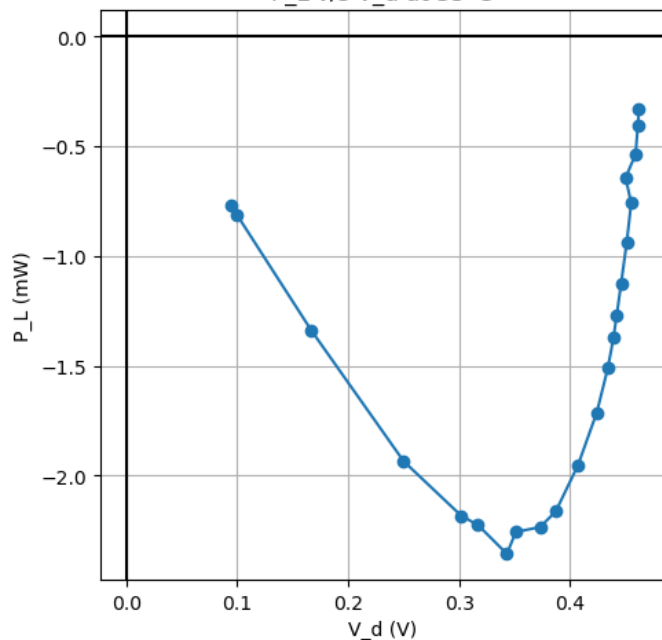
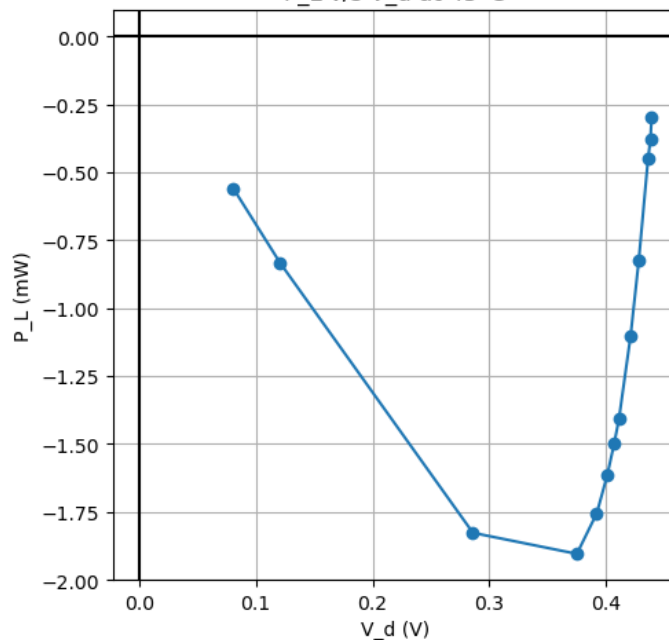
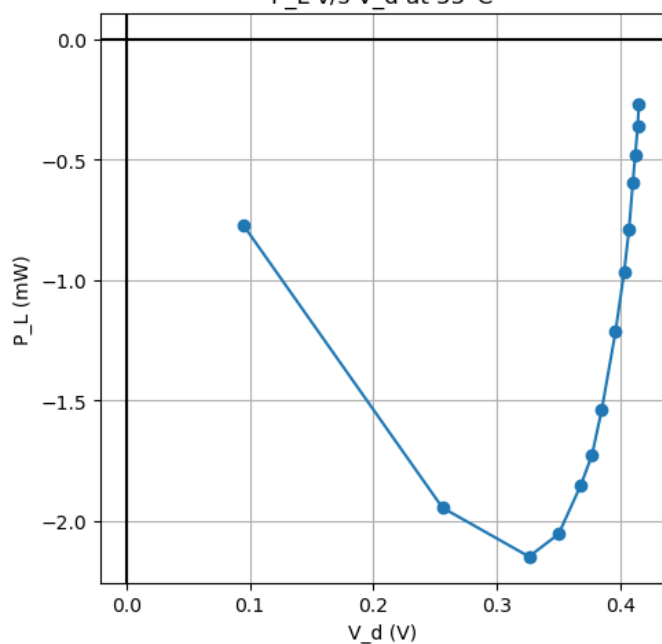
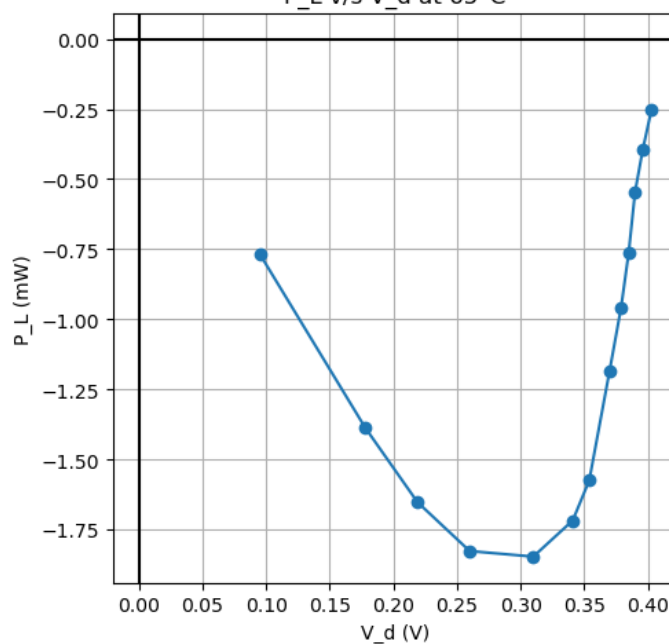
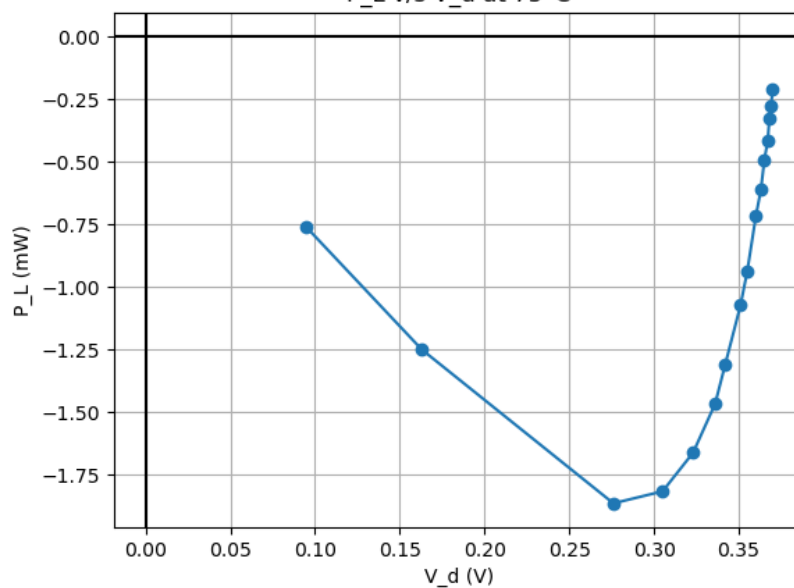
2.3.1 Code, Plots, Results

Included on Page 1, Page 2 and Page 3 respectively.

2.4 Experiment

2.4.1 Individual Plots



P_L v/s V_d at 35°CP_L v/s V_d at 45°CP_L v/s V_d at 55°CP_L v/s V_d at 65°CP_L v/s V_d at 75°C

2.4.2 Combined Plots

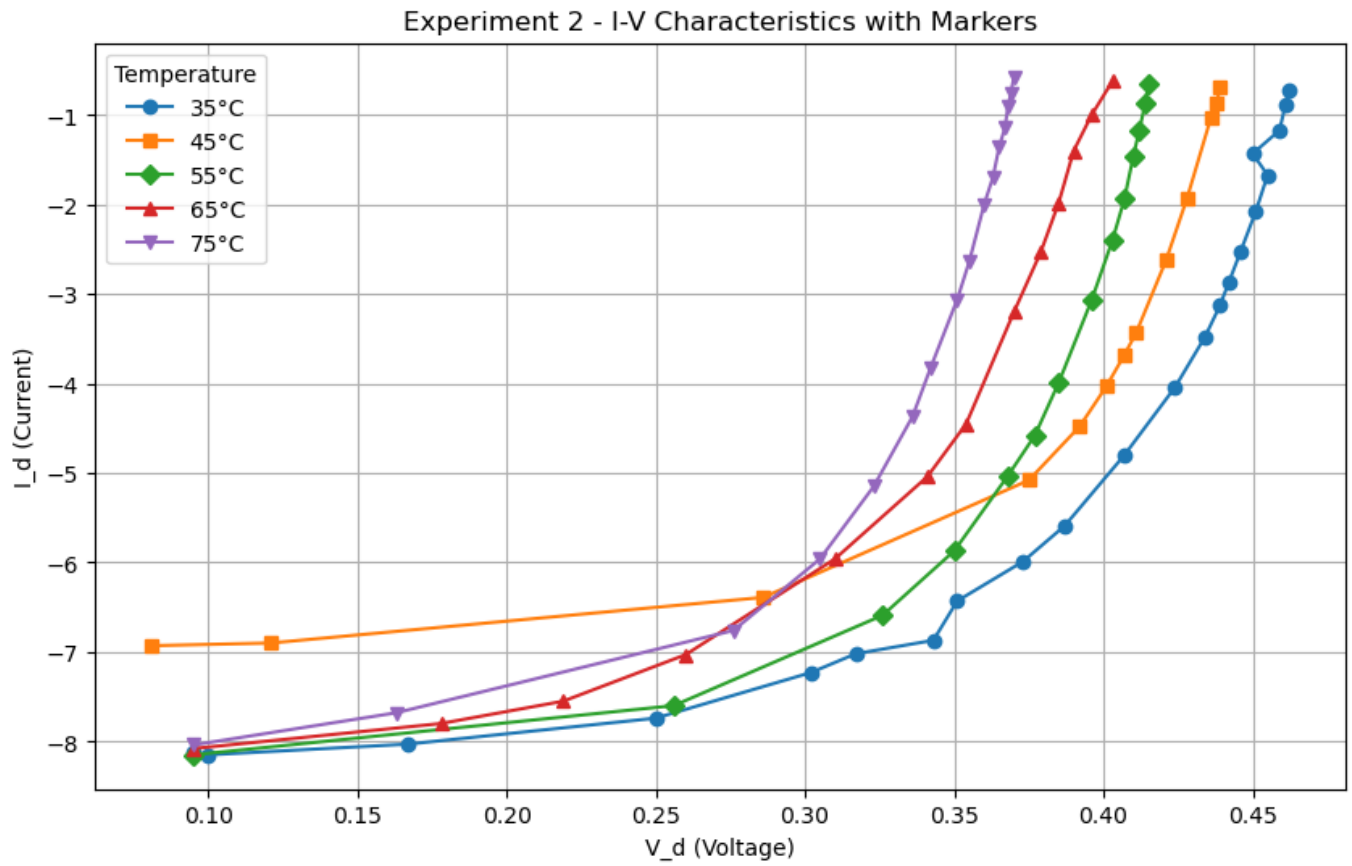


Figure 9: Combined Plot of I_L v/s V_L

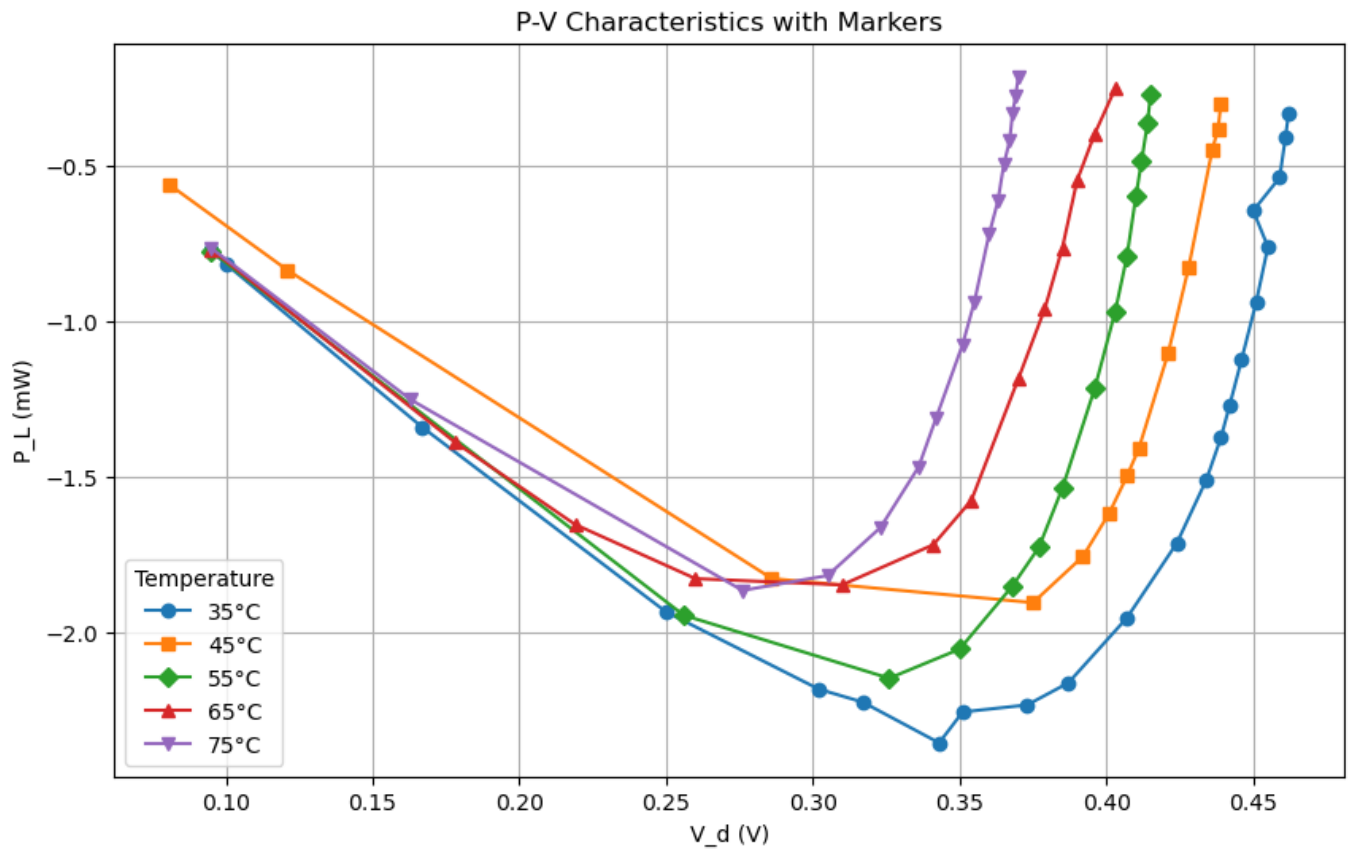


Figure 10: Combined Plot of P_L v/s V_L

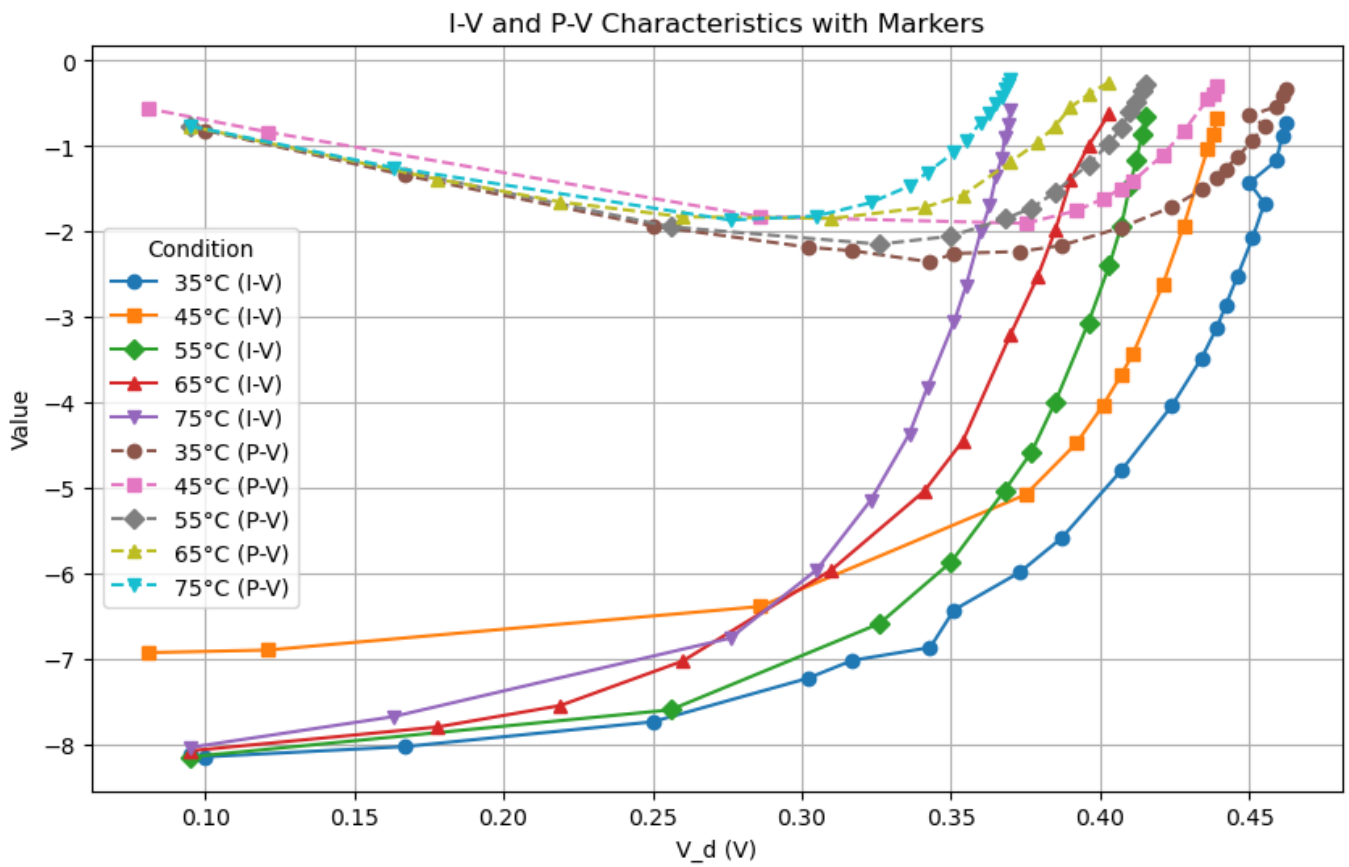


Figure 11: Combined Plot of I_L v/s V_L and P_L v/s V_L

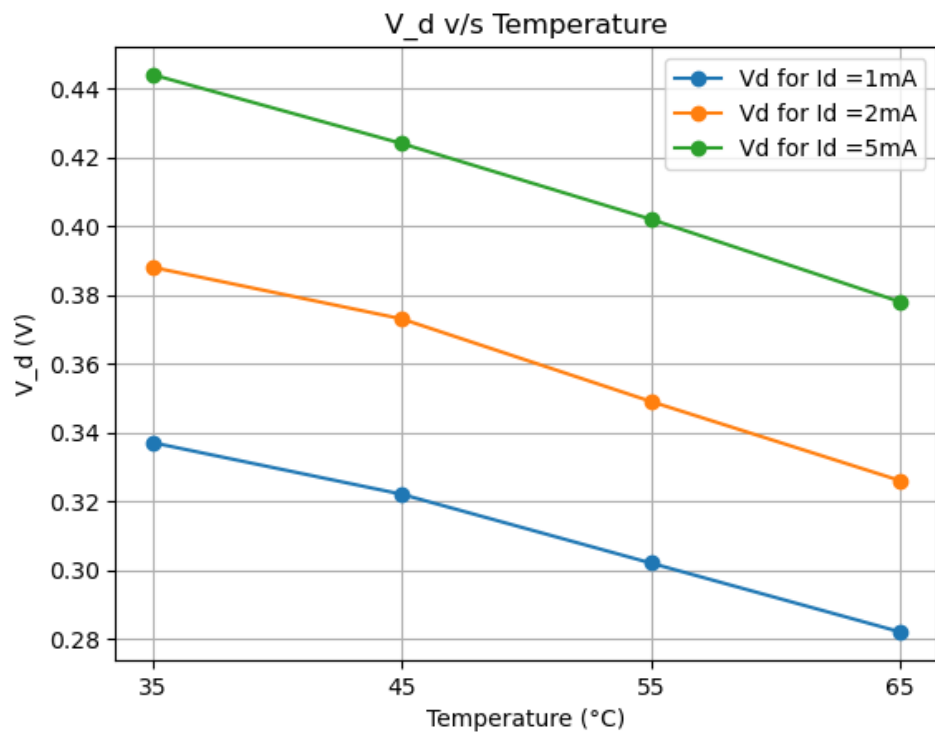


Figure 12: Combined Plot of V_d v/s Temperature

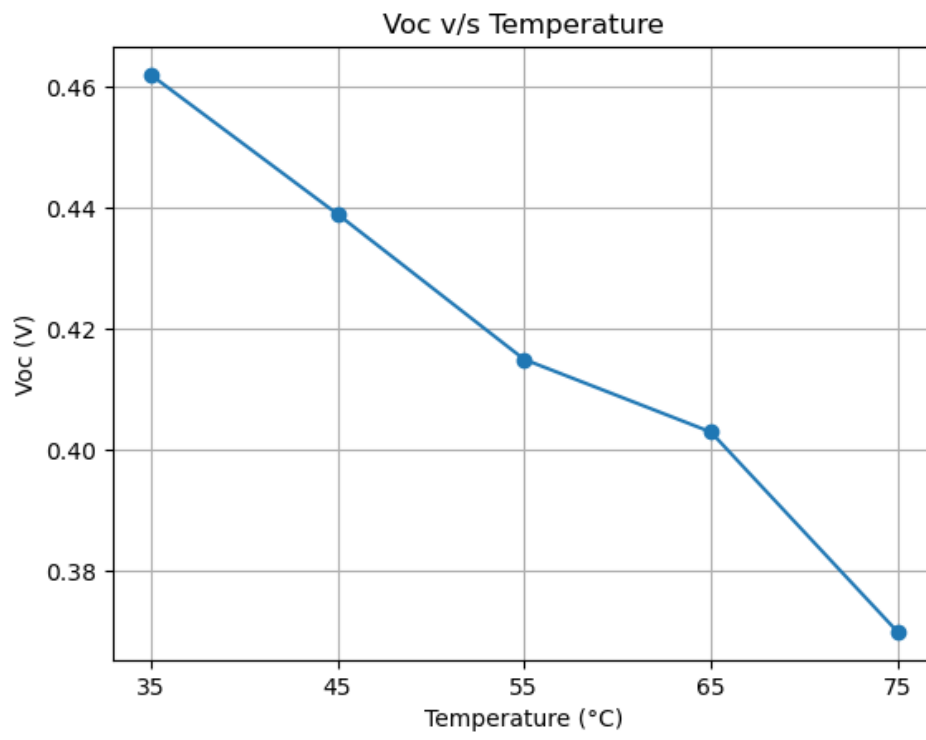


Figure 13: Combined Plot of V_{oc} v/s Temperature

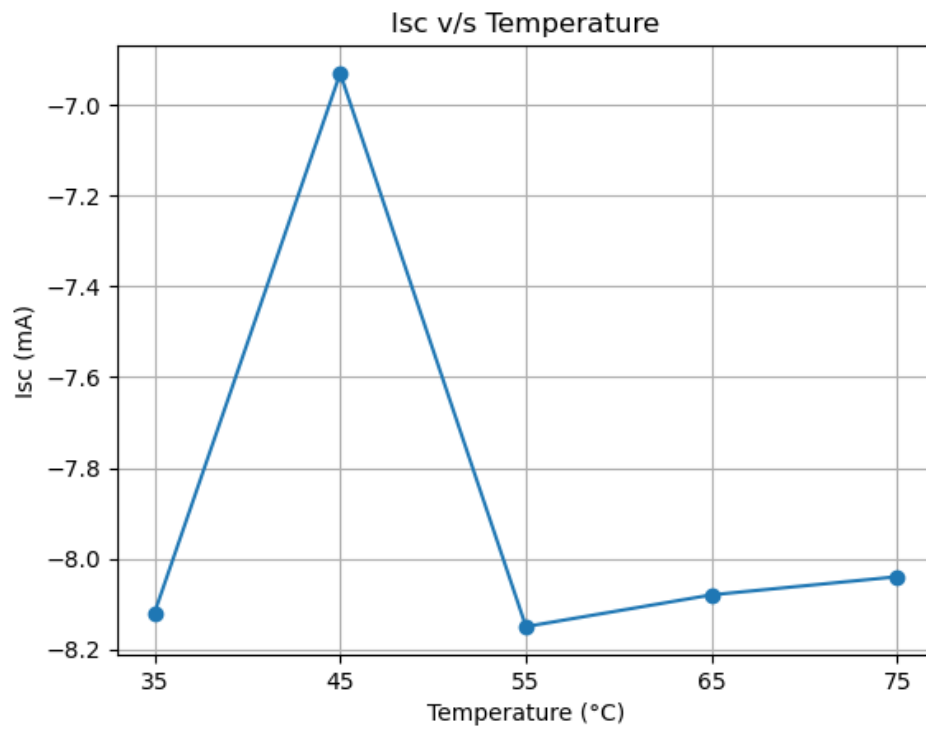


Figure 14: Combined Plot of I_{sc} v/s Temperature

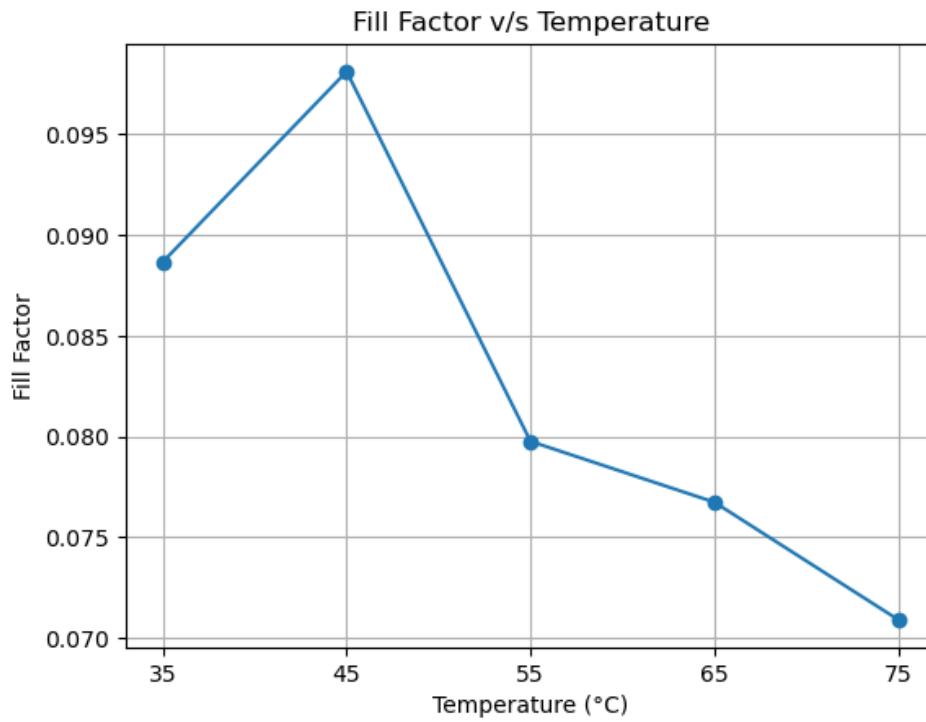


Figure 15: Combined Plot of Fill Factor v/s Temperature

2.5 Observations

It can be clearly concluded from the last 3 graphs, that as the temperature increases,

- V_d decreases
- V_{oc} decreases
- I_{sc} increases
- Fill Factor decreases

The jump at 45 ° Celsius can be attributed to fault in experimental devices or the measuring devices, since we're measuring these things at a very minute scale, where noise can affect our experiments.

Temp (°C)	Isc (mA)	Voc (V)	Im (mA)	Vm (V)	ff
35	-8.12	0.462	-6.87	0.343	0.6281348
45	-7.93	0.439	-5.80	0.375	0.6247720
55	-8.15	0.415	-6.59	0.326	0.6351807
65	-8.08	0.403	-5.96	0.310	0.5674029
75	-8.04	0.370	-6.76	0.276	0.6271884

Table 3: Observation Table for Different Temperatures

3 Completion Status

All the Experiments were completed successfully during lab hours.