EE 236 Devices Lab
Lab - 04

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I/V Characteristics of a Solar Cell

1 Measurement of I-V Characteristics

1.1 Aim of the experiment

Measure the I-V Characteristics of the Solar Cell under different Illumination conditions.

1.2 Design

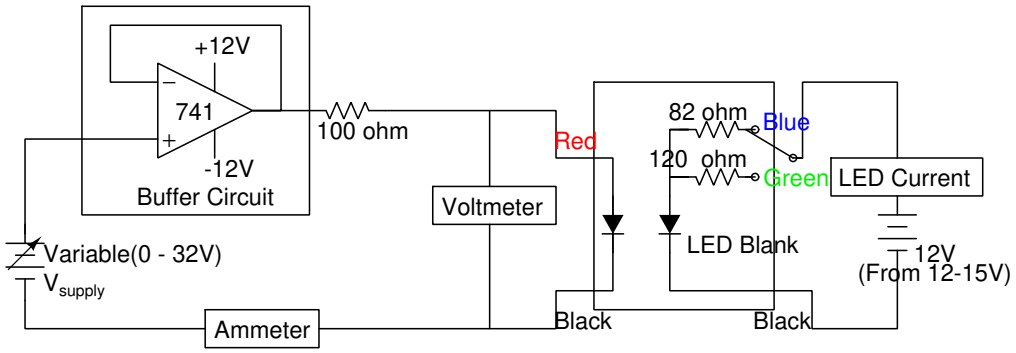

Figure 1: Caption

1.3 Dark I-V Conditions

Vd	Id	Vd	Id	Vd	Id
0.0073	0.1	0.295	1	0.348	2
0.234	0.4	0.312	1.2	0.355	2.3
0.255	0.5	0.329	1.5	0.358	2.5
0.28	0.8	0.333	1.6	0.366	2.8
0.341	1.8				

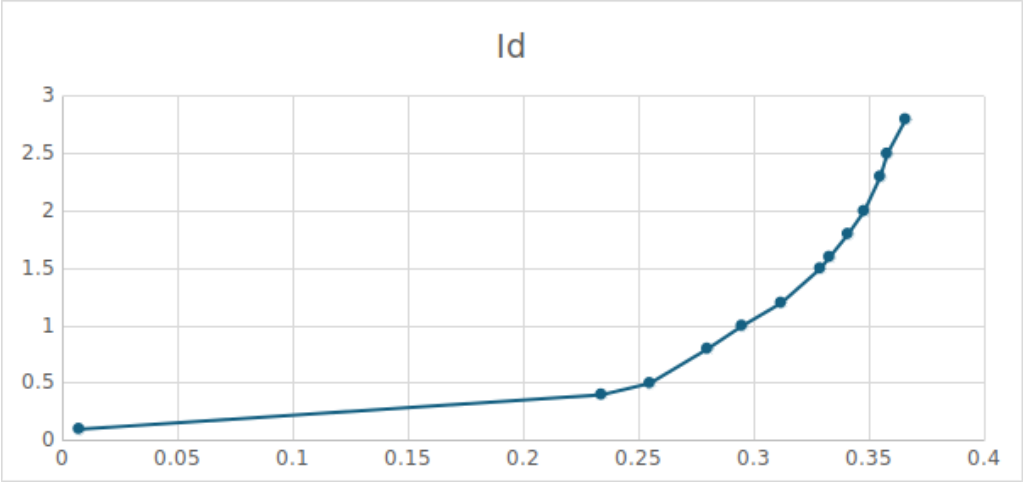

Figure 2: Dark I/V Characteristic

1.4 Green I-V Solar Cell Characteristics

V_d	I_d	V_d	I_d	V_d	I_d
0.426	0.1	0.448	3	0.465	6
0.43	0.8	0.453	3.9	0.468	6.5
0.436	1.4	0.46	4.7	0.469	6.8
0.445	2.6	0.463	5.4	0.471	7.3

Table 1: I-V characteristics data of Green LED

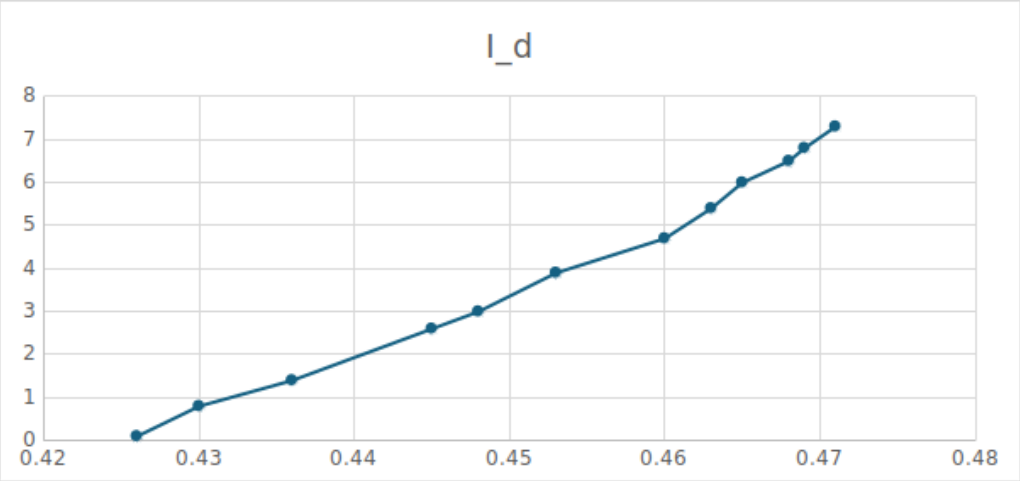

Figure 3: Green I/V Characteristic

1.5 Blue I-V Solar Cell Characteristics

V_d	I_d	V_d	I_d	V_d	I_d
0	0	0.35	2.7	0.41	6.2
0.09	0.1	0.38	3.9	0.42	6.9
0.3	1	0.39	4.7	0.434	7.6
0.33	1.7	0.4	5.5		

Table 2: I-V characteristics data of Blue LED

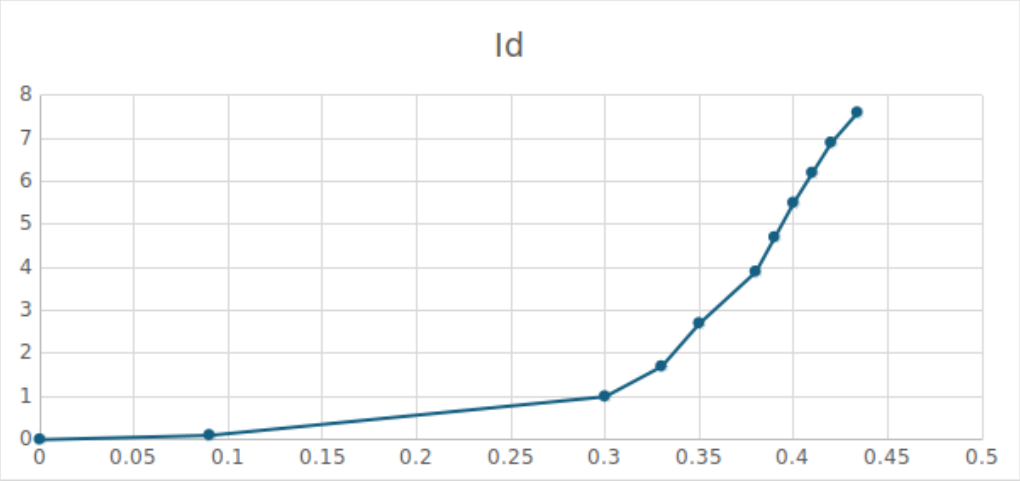

Figure 4: Blue I/V Characteristic

2 Solar cell as power source

2.1 Aim of the Experiment

Investigate the use case of Solar Cell as a power source for different intensities namely I_1 for Green and I_2 for Blue.

2.2 Design

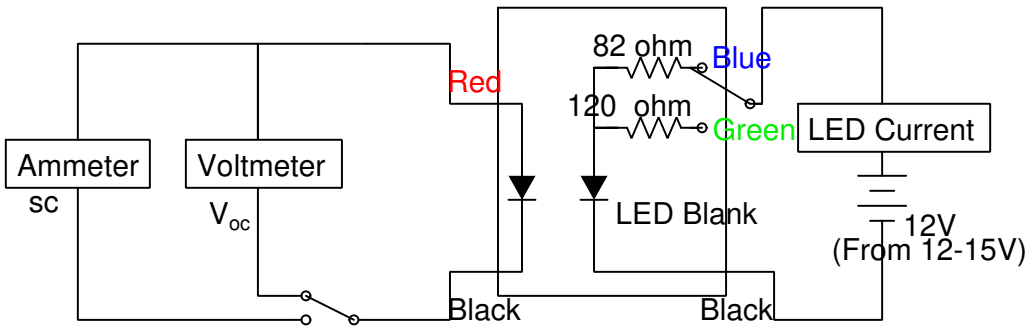

Figure 5: Caption

2.3 Simulation

2.3.1 Code

```
Solar Cell description was given in a file format
.inclue "./solar_cell.txt"
Vs 0 1 dc 0
r1 2 0 100
x1 1 2 solar_cell
.dc Vs -2 2 0.01
.control
run
plot V(2)/100 vs V(1) - V(2), (V(1) - V(2))*V(2)/100  vs V(1) - V(2)
.endc
.end
```

2.3.2 Results

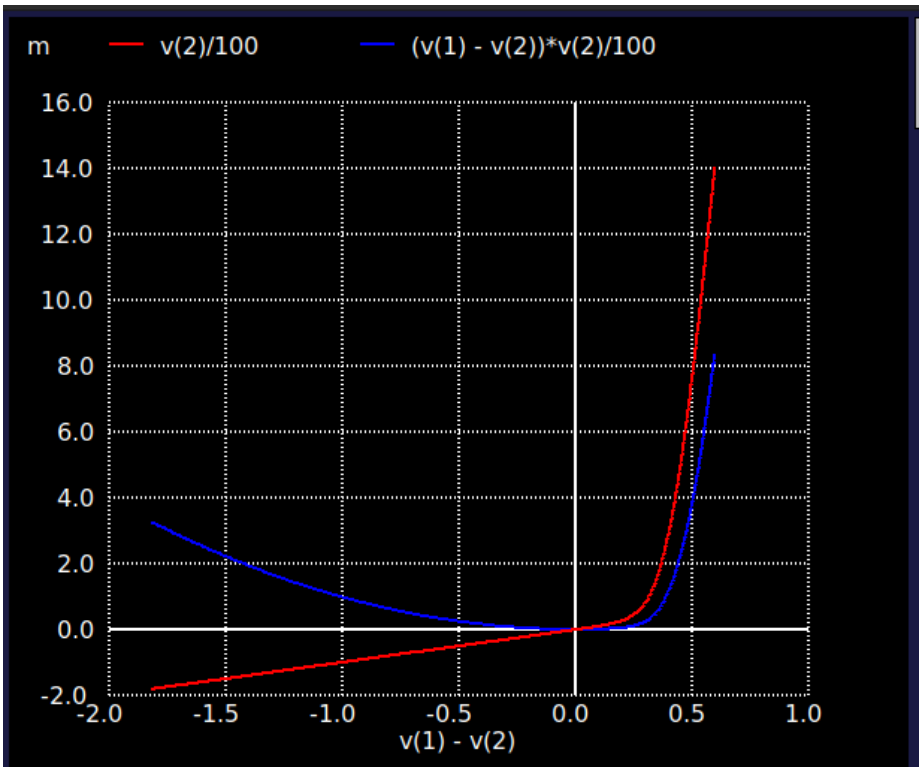

Figure 6: Simulation Results of Dark I-V Characteristics

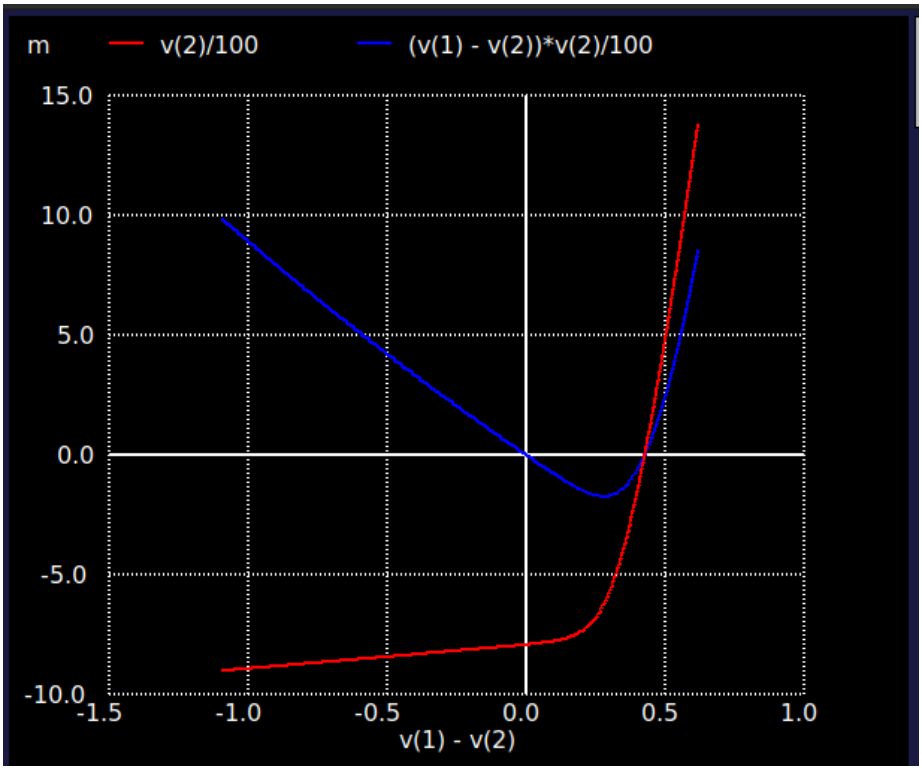

Figure 7: Simulation Results of Illumination 1 (Green) I-V Characteristics

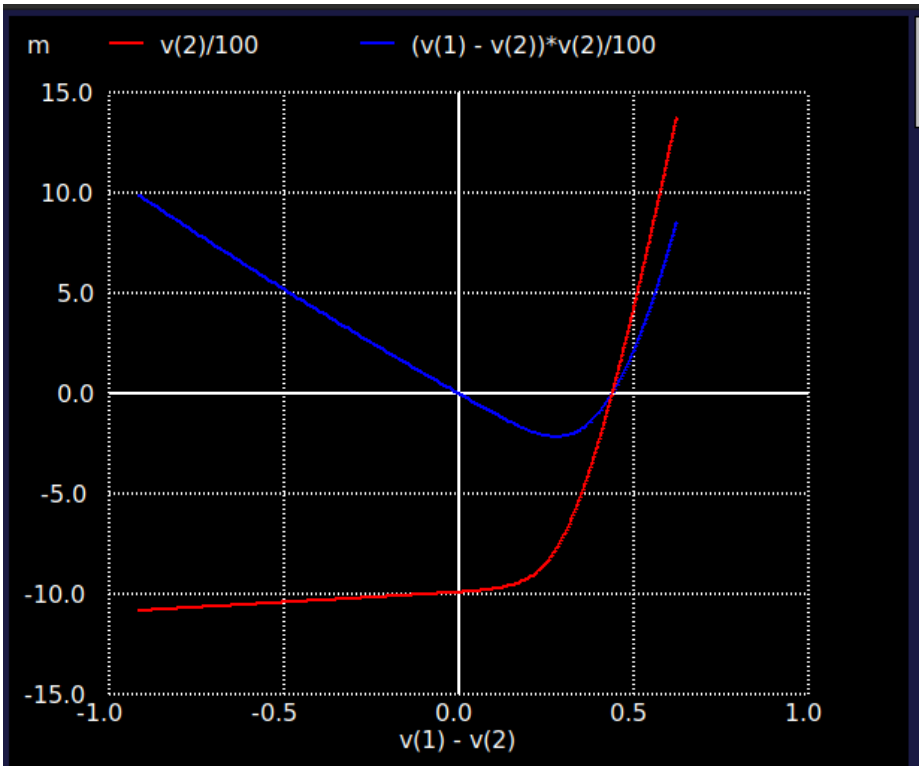

Figure 8: Simulation Results of Illumination 2 (Blue) I-V Characteristics

2.4 Experimental Results

$\mathbf{V_L}$	$\mathbf{I_L}$	$\mathbf{V_L}$	$\mathbf{I_L}$	$\mathbf{V_L}$	$\mathbf{I_L}$
0.084	6.43	0.282	5.85	0.346	4.83
0.152	6.38	0.307	5.59	0.382	3.62
0.228	6.2	0.323	5.32	0.395	3.03
0.255	6.07	0.336	5.02	0.402	2.61
0.407	2.13	0.412	1.93	0.45	1
0.46	0.05				

Table 3: Using Solar Cell as a power source for Intensity I_1 Green

V_L	I_L	V_L	I_L	V_L	I_L	V_L	I_L
0.131	10.33	0.314	9.29	0.402	6.2	0.442	2.54
0.212	10.15	0.334	8.91	0.611	5.62	0.447	1.92
0.259	9.9	0.362	8.16	0.421	4.84	0.434	3.56
0.289	9.65	0.377	7.5	0.429	4.03	0.447	1.8
0.297	9.52	0.391	6.82	0.439	2.94		

Table 4: Using Solar Cell as a power source for Intensity I_2 Blue

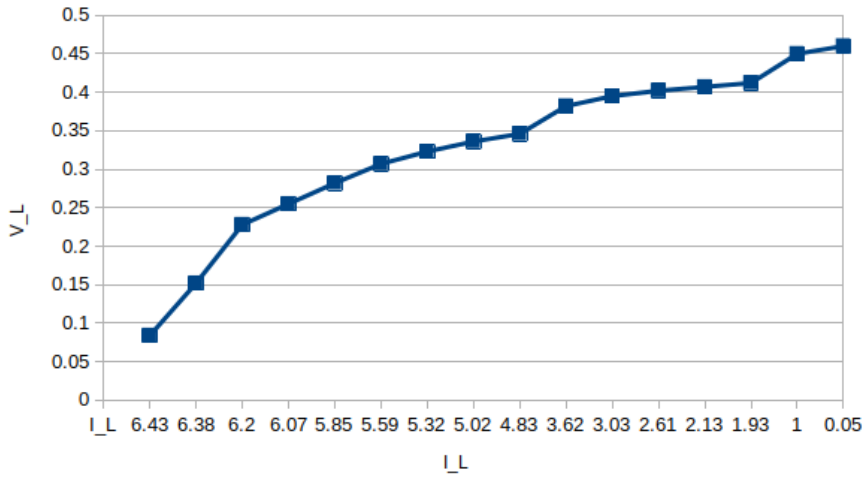

Figure 9: Experimental Results of Illumination 1 (Green) I-V Characteristics

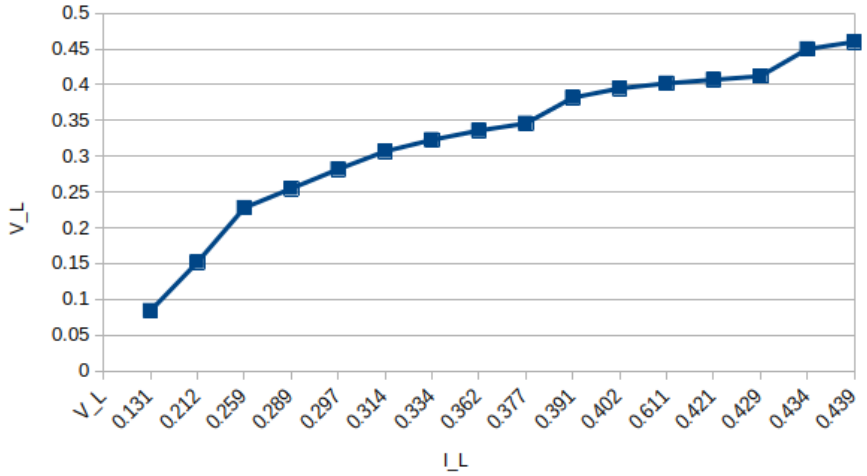

Figure 10: Experimental Results of Illumination 1 (Blue) I-V Characteristics

2.5 Equations and Formulas

The Fill Factor for a Solar Cell is given by the ratio of maximum power to the product of Short Circuit Current (I_{sc}) and Open Circuit Voltage (V_{oc})

$$FF = \frac{I_{MP} \times V_{MP}}{I_{sc} \times V_{oc}} \tag{1}$$

2.6 Results

	(Sim) I_{sc}	(Sim) V_{oc}	(Sim) P_{max}	(Exp) I_{sc}	(Exp) V_{oc}	(Exp) P_{max}	(Sim) FF	(Exp) FF
Green	-0.003571 mA	1 V	0.47619 μW	6.43 mA	0.46 V	1.71836 mW	0.133	0.581
Blue	-0.003839 mA	0.440678 V	0.44643 μW	10.33 mA	0.447 V	3.43382 mW	0.264	0.744

Table 5: Comparison of Simulated and Experimental Data for Different Illumination Intensities

3 Measurement of V_{OC} and I_{SC} at different illumination levels

3.1 Circuit Design

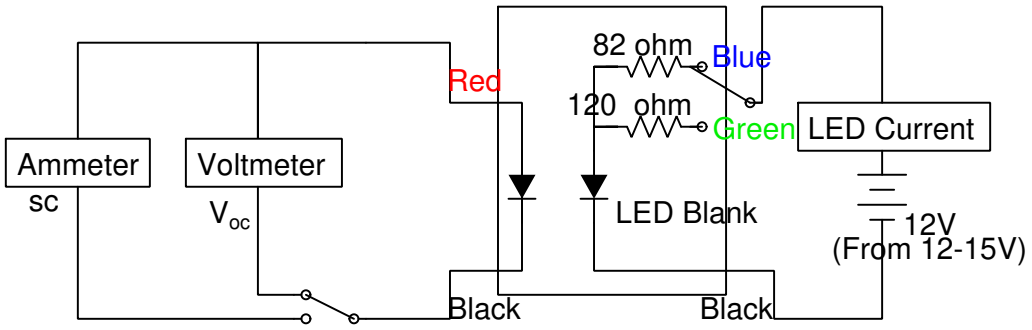

Figure 11: Experiment 3

3.2 Experimental Results

Vsupply (V)	**I_{led} (mA)**	**V_{oc} (V)**	**I_{sc} (mA)**
6.28	10	0.36	1.84
7.49	20	0.41	3.78
8.67	30	0.43	5.74
9.83	40	0.44	8.01
10.98	50	0.46	9.88

Table 6: Vsupply, I_{led}, V_{oc}, and I_{sc} measurements