EE 236 Devices Lab
Lab - 03

Anupam Rawat, 22b3982

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Temperature and material dependence of PN diode, IV characteristics

1 Dark I-V Characteristics of Photodiode

1.1 Aim of the experiment

Obtain the dark I-V characteristics of the given photodiode for forward as well as reverse bias

1.2 Design

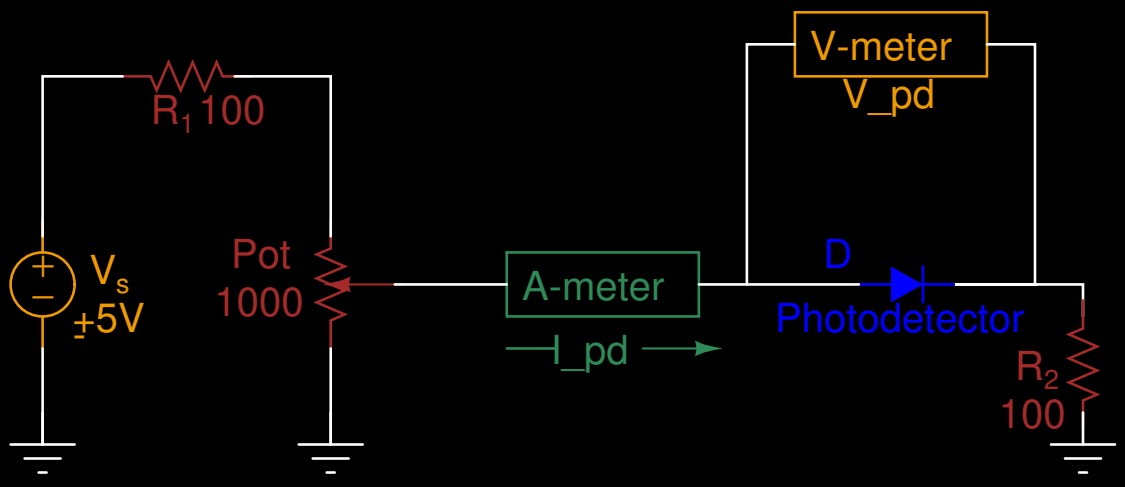


Figure 1: Caption

1.3 Forward Bias

Vpd	Ipd	log(abs(I_pd))	Vpd	Ipd	log(abs(I_pd))
0.50	1.00E-12	-12	0.75	6.6	0.8195
0.51	0.1	-1	0.76	7	0.8451
0.53	0.1	-1	0.77	8.2	0.9138
0.55	0.3	-0.5229	0.78	8.6	0.9345
0.56	0.4	-0.3979	0.79	9.9	0.9956
0.59	0.8	-0.0969	0.80	11	1.0414
0.60	1	0	0.81	11.8	1.0719
0.62	1.4	0.1461	0.82	12.9	1.1106
0.64	1.9	0.2788	0.83	13.9	1.1430
0.65	2.2	0.3424	0.835	14.1	1.1492
0.66	2.7	0.4314	0.84	16.2	1.2095
0.67	3.2	0.5051	0.85	17.77	1.2497
0.69	3.6	0.5563	0.86	19.4	1.2878
0.70	4	0.6021	0.87	21.4	1.3304
0.71	4.5	0.6532	0.88	22	1.3424
0.72	5	0.6990			
0.73	5.6	0.7482			
0.74	5.8	0.7634			

Table 1: V_{pd} v/s I_{pd}

Parameter	Value
slope	12.1790547
intercept	-7.2826286
η	3.1580069

Table 2: Slope, Intercept and Ideality Factor for Forward Bias

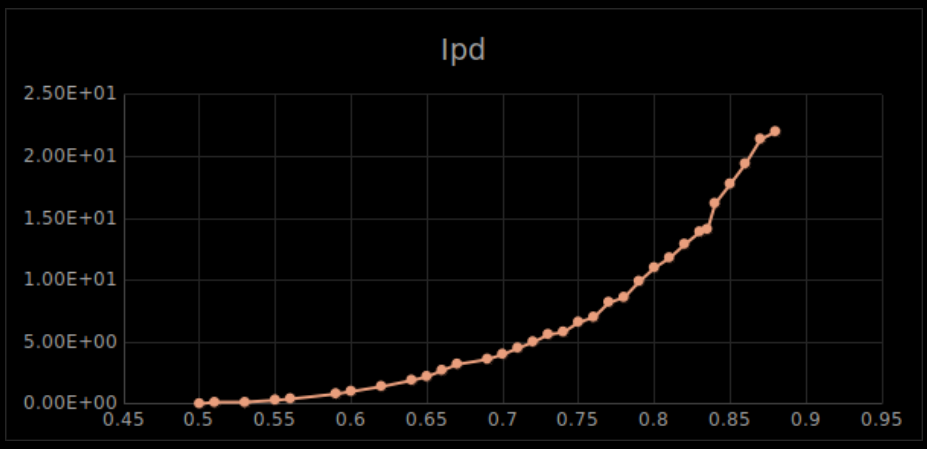


Figure 2: I/V Characteristic Linear Scale

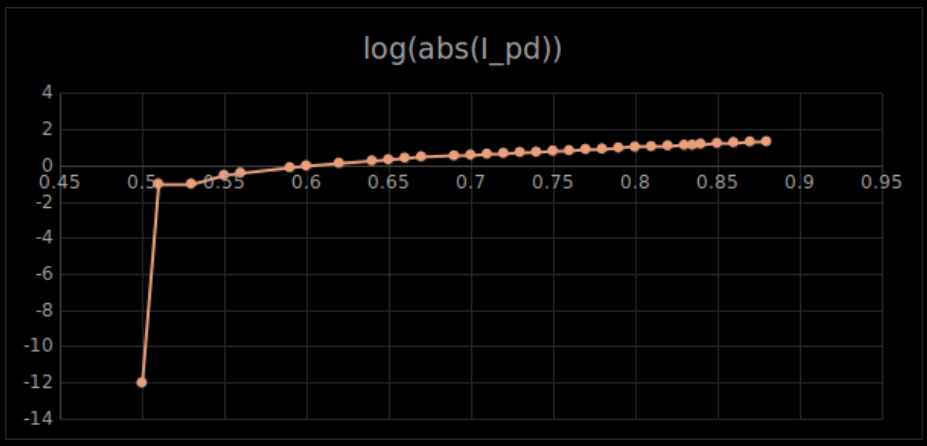
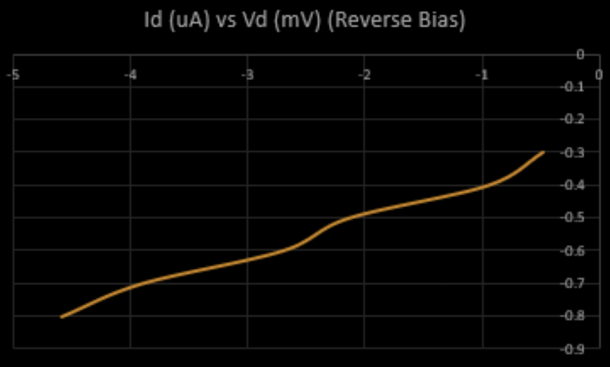


Figure 3: I/V Characteristic Log Scale

1.4 Reverse Bias

Vd (mV)	**Id (µA)**	**ln(abs(Id))**
-0.48	-0.3	-1.204
-0.94	-0.4	-0.916
-2.13	-0.5	-0.693
-2.7	-0.6	-0.511
-3.9	-0.7	-0.357
-4.58	-0.8	-0.223

Table 3: Measurements of Vd, Id, and ln(abs(Id))



2 Photodiode response to lights of different intensities and wavelengths

2.1 Aim of the Experiment

Investigate the response of a photodiode to different intensities and wavelengths of light emitted by various LEDs and calculate the efficiency of each LED.

2.2 Design

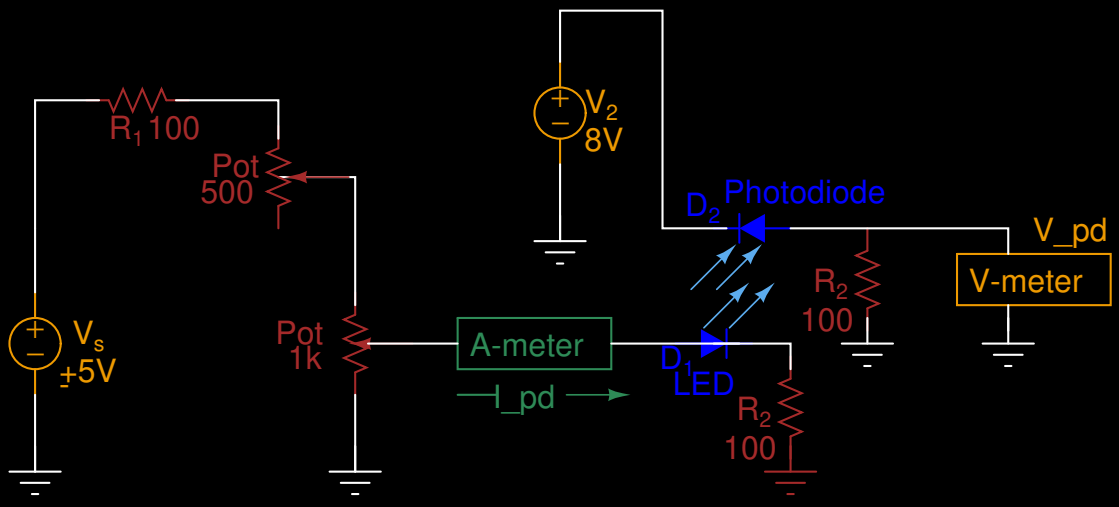


Figure 4: Caption

2.3 V_{out} and I_{out} of LEDs at different intensities

Red LED (750 nm)			Blue LED (450 nm)		
I_out (mA)	**V_out (mv)**	**Intensity**	**I_out (mA)**	**V_out (mV)**	**Intensity**
2	0.24	1000	0.301	13.9	1000
3	0.32	1500	0.416	19.3	1500
4	0.38	2000	0.572	28.1	2000
Green LED (520 nm)			**IR LED (950 nm)**		
I_out	**V_out (mV)**	**Intensity**	**I_out**	**V_out**	**Intensity**
0.188	33.2	1000	4.51	0.303	1000
0.294	52.4	1500	5.17	0.359	1500
0.371	66.6	2000	6.28	0.456	2000

Table 4: Photodiode response to different LEDs at various intensities

Red LED (750 nm)		IR LED (950 nm)	
Intensity	**Efficiency**	**Intensity**	**Efficiency**
1000	12	1000	6.72
1500	10.67	1500	6.94
2000	9.5	2000	7.26

Table 5: Response of Red and IR LEDs at various intensities

Green LED (520 nm)		Blue LED (450 nm)	
Intensity	**Efficiency**	**Intensity**	**Efficiency**
1000	17.66	1000	4.62
1500	17.82	1500	4.64
2000	17.95	2000	4.91

Table 6: Response of Green and Blue LEDs at various intensities

Figure 5: V_{out} v/s Intensity for each LED

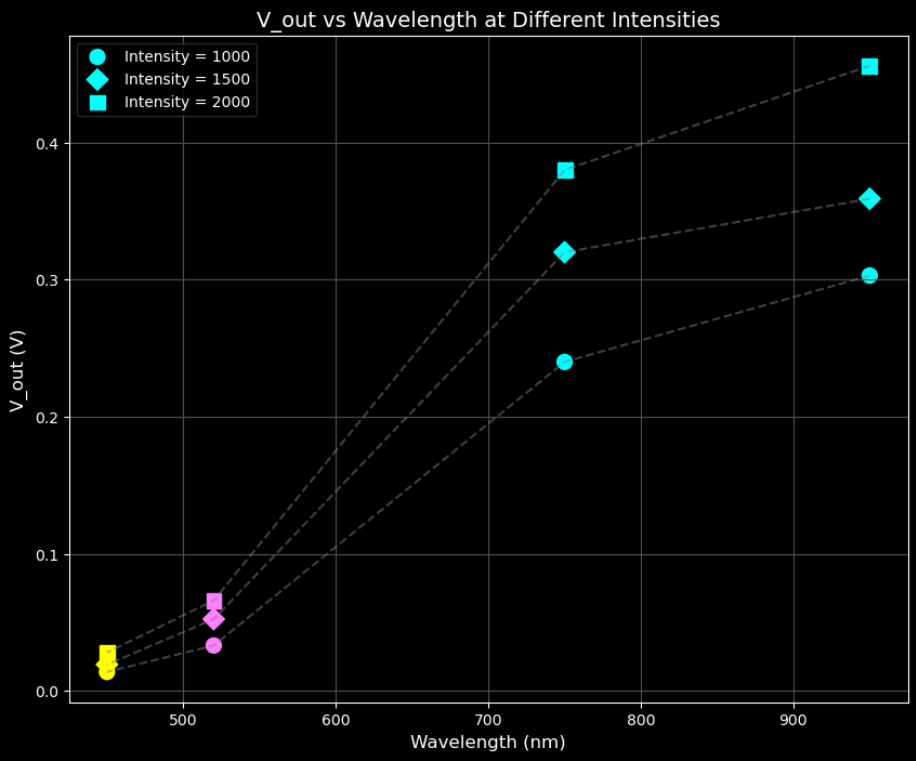


Figure 6: V_{out} v/s Wavelength for each intensity

3 Application of photodiode as optical signal sensor

3.1 Circuit Design

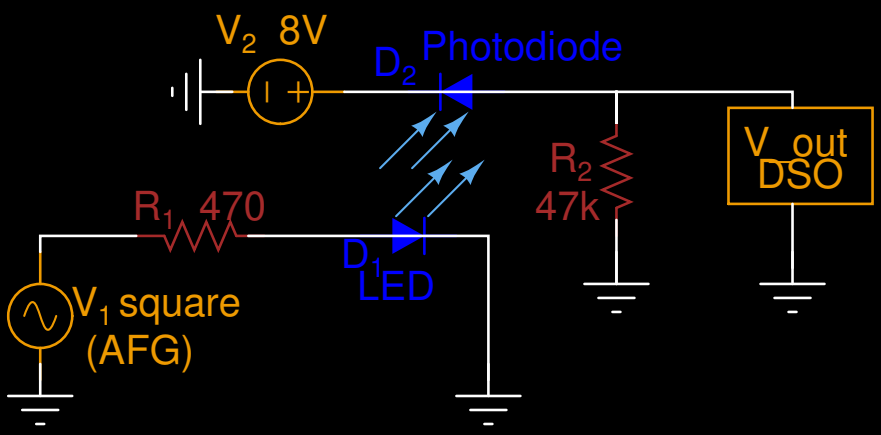


Figure 7: Experiment 3

3.2 Rise time and Fall time for different Frequencies

Frequency (kHz)	Rise Time (µs)	Fall Time (µs)
1	5.070	3.957
5	3.985	2.404
10	3.393	2.021
15	2.631	1.540
20	2.411	1.321
25	2.938	1.707
30	2.307	2.141
35	2.442	1.427

Table 7: Rise and Fall Times at Various Frequencies

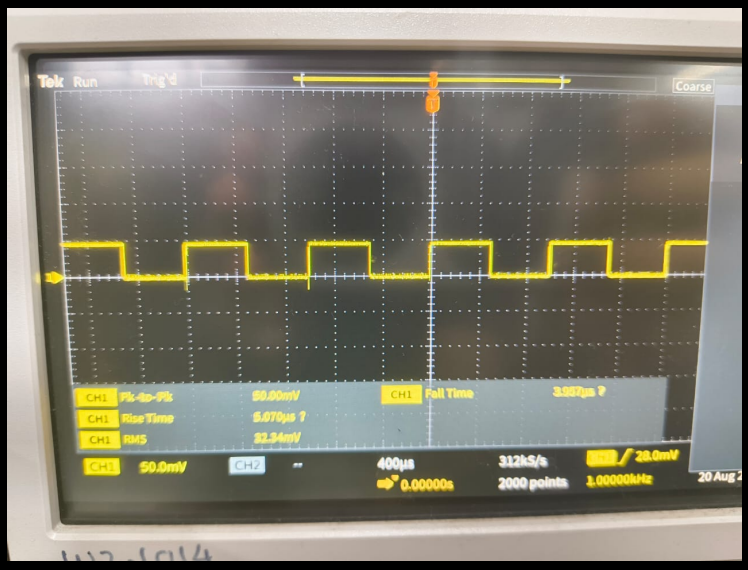


Figure 8: For 1KHz

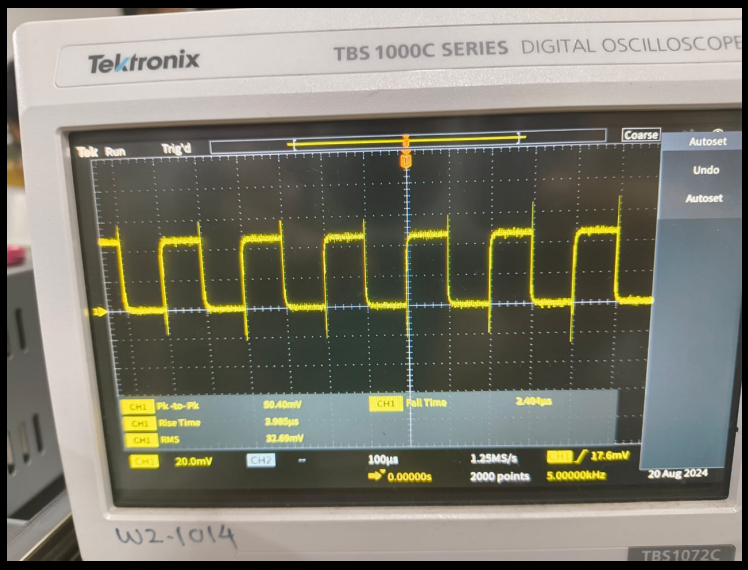


Figure 9: For 5KHz

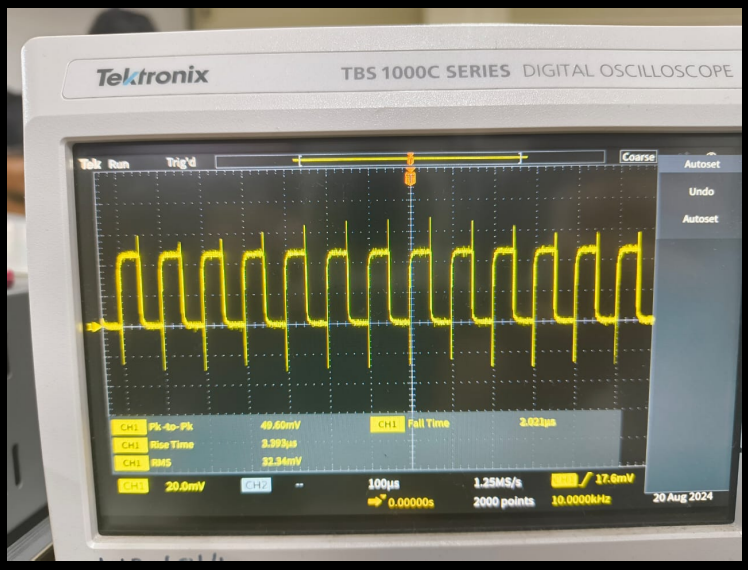


Figure 10: For 10KHz

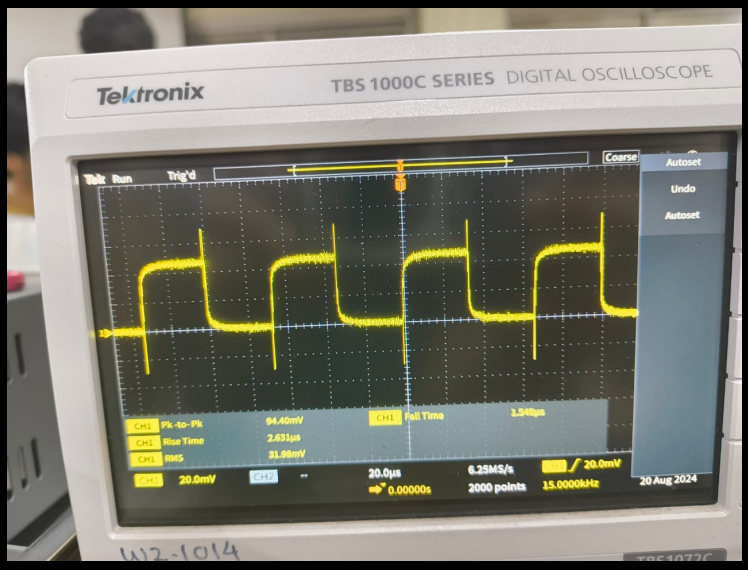


Figure 11: For 15KHz

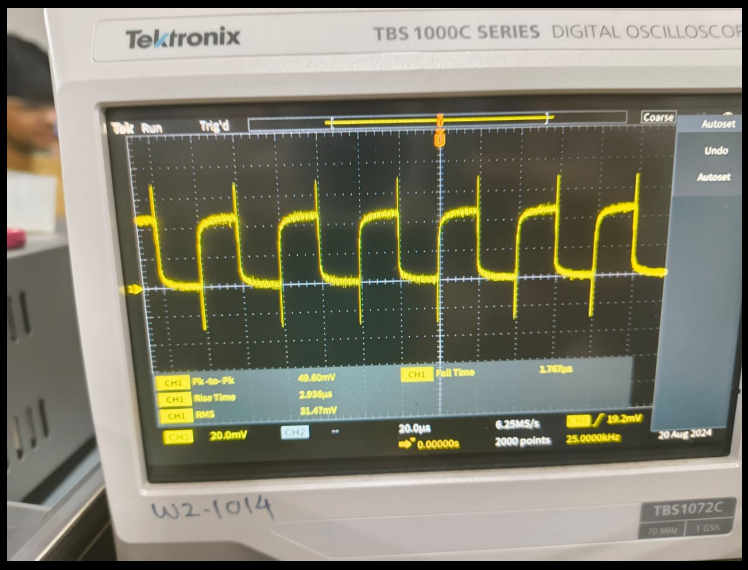


Figure 12: For 25KHz

Figure 13: For 30KHz

Figure 14: For 35KHz