EE236: Experiment 3

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1 Overview of the experiment

1.1 Aim of the experiment

The aim of this experiment was to understand the workings of solar cells under different illuminations.

1.2 Report Pattern

Instead of following the template, I have split the report into sections based on the questions/simulations. Each section is based on one question/simulation, and all associated details are in that section only.

2 IV characteristics of solar cell

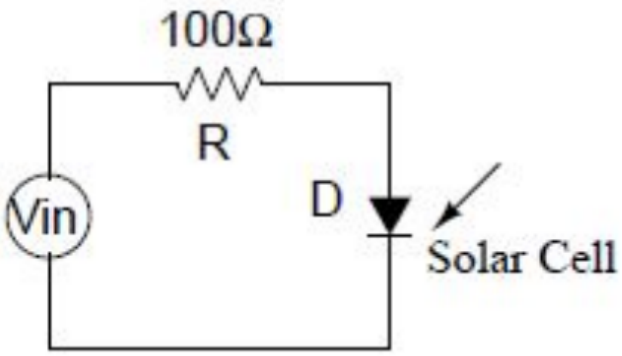

Figure 1: Circuit used

Netlist used:

```
19D070052 Sheel Shah Solar IV
.include Solar_Cell.txt

v_dc 1 0

r1 1 21 100
x1 21 31 solar_cell IL_val = 0e-3
v_dummy1 31 0 0

r2 1 22 100
x2 22 32 solar_cell IL_val = 8e-3
v_dummy2 32 0 0

r3 1 23 100
x3 23 33 solar_cell IL_val = 10e-3
v_dummy3 33 0 0
** 1: dark, 2: 8mA, 3: 10mA
.dc v_dc 0.5 2 0.01
```

```
* start control
.control
set color0 = rgb:f/f/e
set color1 = rgb:1/1/1

run

plot log(i(v_dummy1)) vs v(21)-v(31), log(i(v_dummy2)) vs v(22)-v(32), log(i(v_dum
* plot i(v_dummy1) vs v(21)-v(31), i(v_dummy2) vs v(22)-v(32), i(v_dummy3) vs v(23
** dx/dy: 0.152159, 0.136435, 0.121013
** eta = (dx/dy)/V_t = 3.89, 3.27, 2.69


* end control
.endc

.end
```

Ideality factor calculation:
Step 1 was to calculate the slope of ln I vs V plot.
Step 2 was to calculate $\eta = 1/(slope * V_T)$
Ideality factors for $I_L = 0$, 8, 10 mA are 3.89, 3.27, 2.69 respectively.

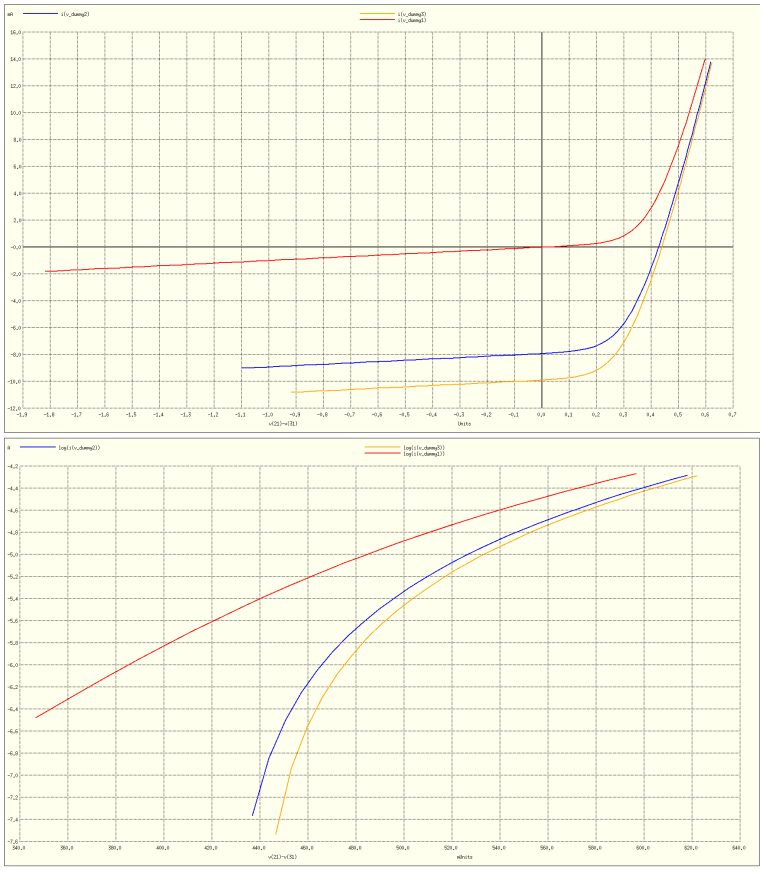

Figure 2: IV Characteristics and ln I vs V plot

3 I_{SC} and V_{OC} measurement, and fill factor calculation

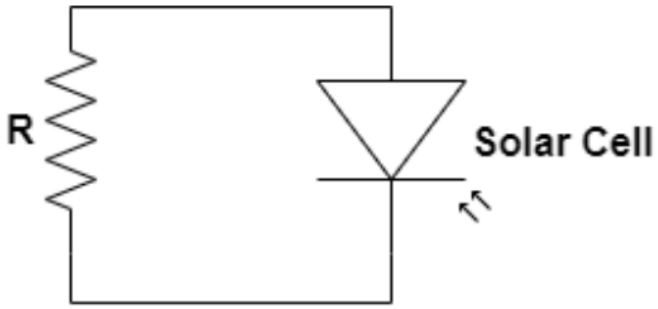

Figure 3: Circuit used

```
Netlist used:
19D070052 Sheel Shah Solar IV
.include Solar_Cell.txt

r2 0 22 100
x2 22 32 solar_cell IL_val = 8e-3
v_dummy2 0 32 0

r3 0 23 100
x3 23 33 solar_cell IL_val = 10e-3
v_dummy3 0 33 0
** 1: dark, 2: 8mA, 3: 10mA
* start control
.control
set color0 = rgb:f/f/e
set color1 = rgb:1/1/1

run
```

```
dc r2 1 500 1
let i1 = i(v_dummy2)
let v1 = v(22)-v(32)
let p1 = i1*v1

dc r3 1 500 1
plot dc1.i1 vs dc1.v1, i(v_dummy3) vs v(23)-v(33)
plot dc1.p1 vs dc1.v1, i(v_dummy3)*(v(23)-v(33)) vs v(23)-v(33)

** i_sc1 = 7.9mA, i_sc2 = 9.9mA
** v_oc1 = 411.6mV, v_oc2 = 425.3mV
** v_mp1 = 278mV, p_mp1 = 1.73mW
** v_mp2 = 278.6mV, p_mp2 = 2.15mW
** ff1 = 0.53
** ff2 = 0.51
* end control
.endc

.end
```

All measured values are mentioned in the code

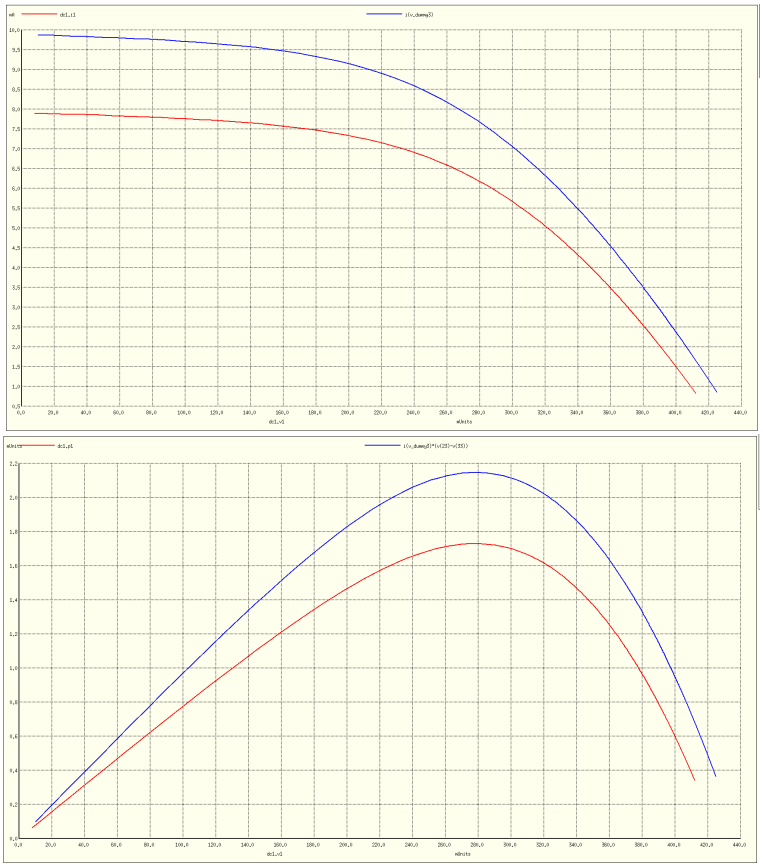

Figure 4: I vs V plot and P vs V plot

4 CV characteristics of solar cell

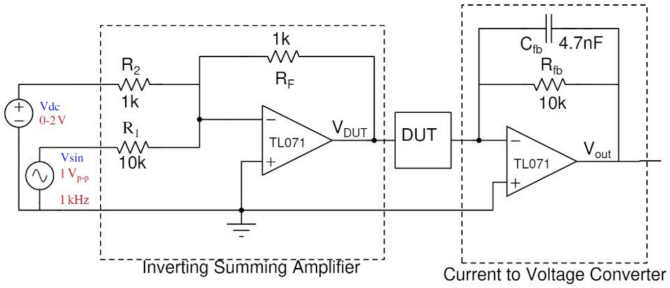

Figure 5: Circuit used

Netlist used:

```
19D070052 Sheel Shah CV plots
.include Solar_Cell.txt
.include TL071.txt


v_cc1 100 0 15
v_cc2 101 0 -15

v_dc 1 0
r1 1 2 1k
r2 2 3 10k
v_sin 3 0 sin(0 0.5 1k 0 0)
x_op1 0 2 100 101 4 TL071
r_f 2 4 1k

x_dut 4 5 solar_cell IL_val = 0e-3
x_op2 0 5 100 101 6 TL071
r_fb 5 6 100k
c_fb 5 6 4.7n

.dc v_dc 0 2 0.001
* start control
```

```
.control
set color0 = rgb:f/f/e
set color1 = rgb:1/1/1
run

let x = (1k*2*3.14*100k*4.7n)^2
let y = sqrt(1 + (1/x))
let c_dut = abs(v(6)/v(4)) * 4.7n * y

* plot 1/(c_dut * c_dut / (16 * 16)) vs v(4)
plot c_dut vs v(1)
** dx/dy = -6.48491e-17
** N_d = 7.86e14
** v_bi = -0.79V

* end control
.endc

.end
```

All measured values are mentioned in the code

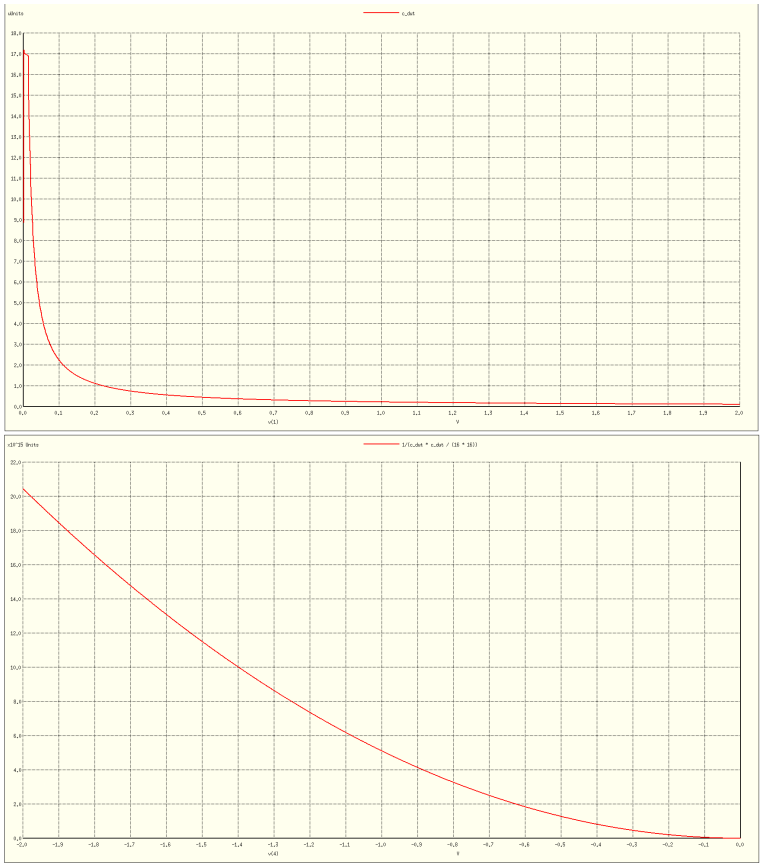

Figure 6: C_{dut} vs V_{in} and $1/C^2$ vs V_{DUT}

5 Experiment completion status

I was able to complete all parts of the experiment.