18/7/16 SOLAR CELL EXP - 1

AIM:

To draw the I-V characteristics of a solar cell and to find out its efficiency and fill factor.

APPARATUS REQUIRED:

Solar cell (p-n junction diode), light source (100 W bulb), Ammeter, Voltmeter, Load circuit, Connecting wires

FORMULA:

$$I = I_0 \left[\exp\left(\frac{eV}{nKT}\right) - 1 \right] - I_L$$

where I_0 = dark saturation current of the diode
V = Voltage across the diode
n = Ideality factor
K = Boltzman constant
T = Absolute temperature
I_L = light generated current

$$FF = \frac{V_{mp} I_{mp}}{V_{oc} I_{sc}}$$

where V_{mp} = Voltage at maximum power
I_{mp} = Current at maximum power
V_{oc} = Voltage at open circuit
I_{sc} = Current at short circuit

$$\eta = \frac{P_{max}}{A_c \Omega}$$

where A_c - Area of the solar cell
Ω - Incident intensity

$P_{max} = V_{mp} I_{mp}$

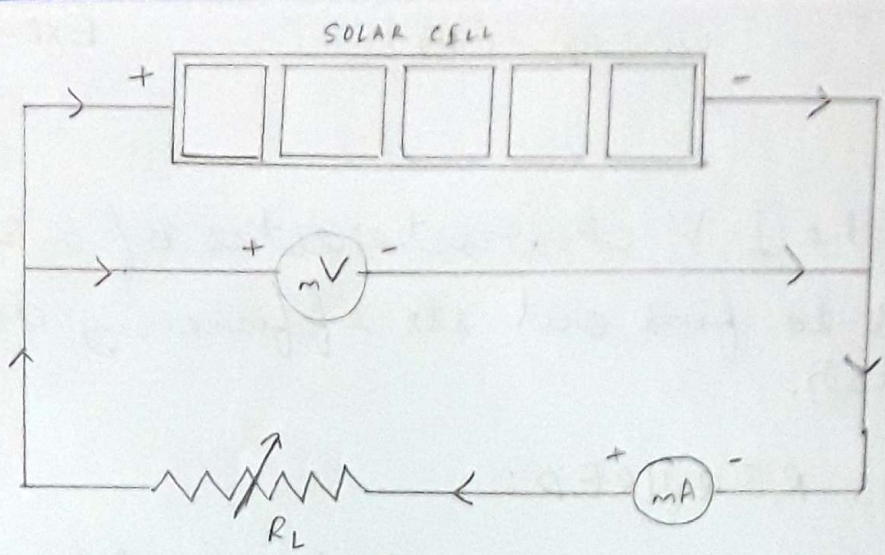


Fig I: Study of I-V characteristics of a solar cell

OBSERVATION TABLE (FOR I-V CHARACTERSTICS)

For distance = 3 cm

I_{SC} = 15 mA I_{OC} = 0 mA

V_{SC} = 40 mV V_{OC} = 410 mV

For distance = 7 cm

I_{SC} = 5.5 mA I_{OC} = 0 mA

V_{SC} = 0 mV V_{OC} = 340 mV

LEAD RESISTANCE (Ω)	DISTANCE (x) = 3 INTENSITY OF LIGHT = 130			DISTANCE (x) = 7 INTENSITY OF LIGHT = 90		
	CURRENT (mA)	VOLTAGE (mV)	POWER (μW)	CURRENT (mA)	VOLTAGE (mV)	POWER (μW)
10	14	150	2100	5.5	40	220
22	12	270	3240	5	100	500
47	7	340	2380	4	200	800
56	6	350	2100	3.5	220	770
68	5	360	1800	3	250	750
82	4	370	1480	3	260	780
100	3	370	1100	2.5	280	700
150	2	380	760	1.5	300	450
180	1.5	390	585	1	310	310
1000	0	400	0	0	330	0

OBSERVATION:

1. For distance ($x_1 = 3$ cm)

$I_{mp} = 12\ mA$

$V_{mp} = 270\ mV$

$P_{max} = 3240\ \mu W$

$I_{sc} = 15\ mA$

$V_{oc} = 410\ mV$

$\Omega = 130\ W/m^2$

$A_c = 2.43 \times 10^{-4}\ m^2$

2. For distance ($x_2 = 7$ cm)

$I_{mp} = 4\ mA$

$V_{mp} = 200\ mV$

$P_{max} = 800\ \mu W$

$I_{sc} = 5.5\ mA$

$V_{oc} = 340\ mV$

$\Omega = 90\ W/m^2$

$A_c = 2.43 \times 10^{-4}\ m^2$

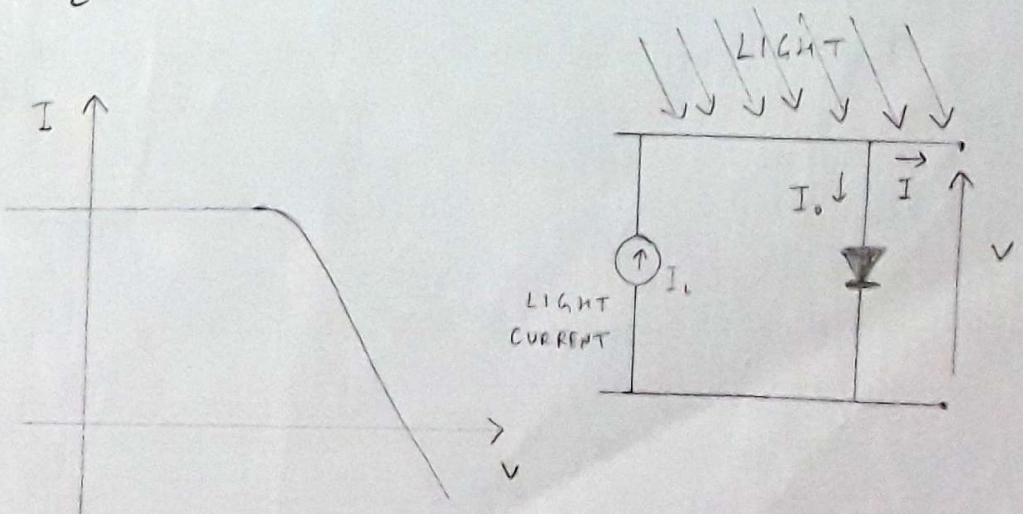
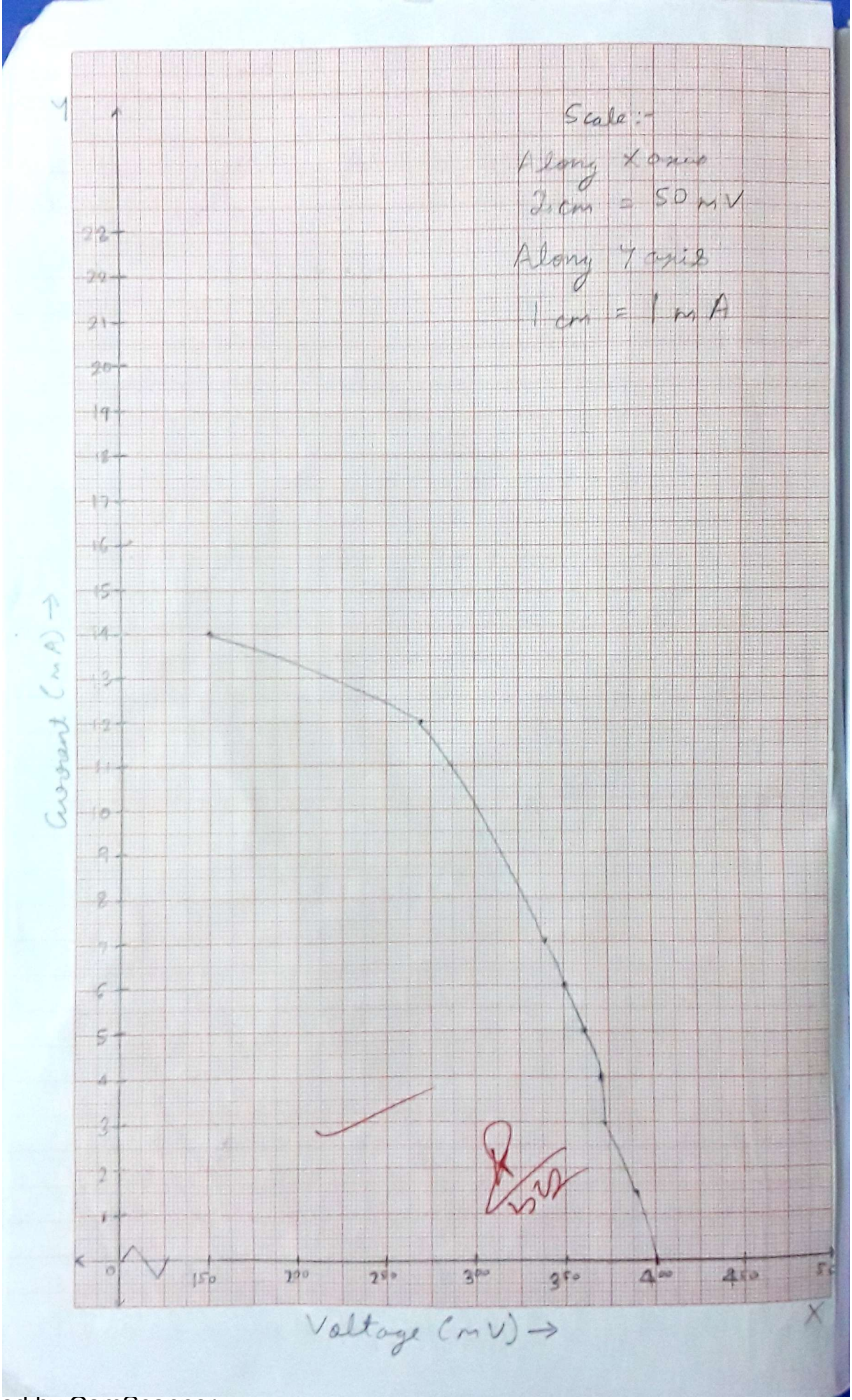
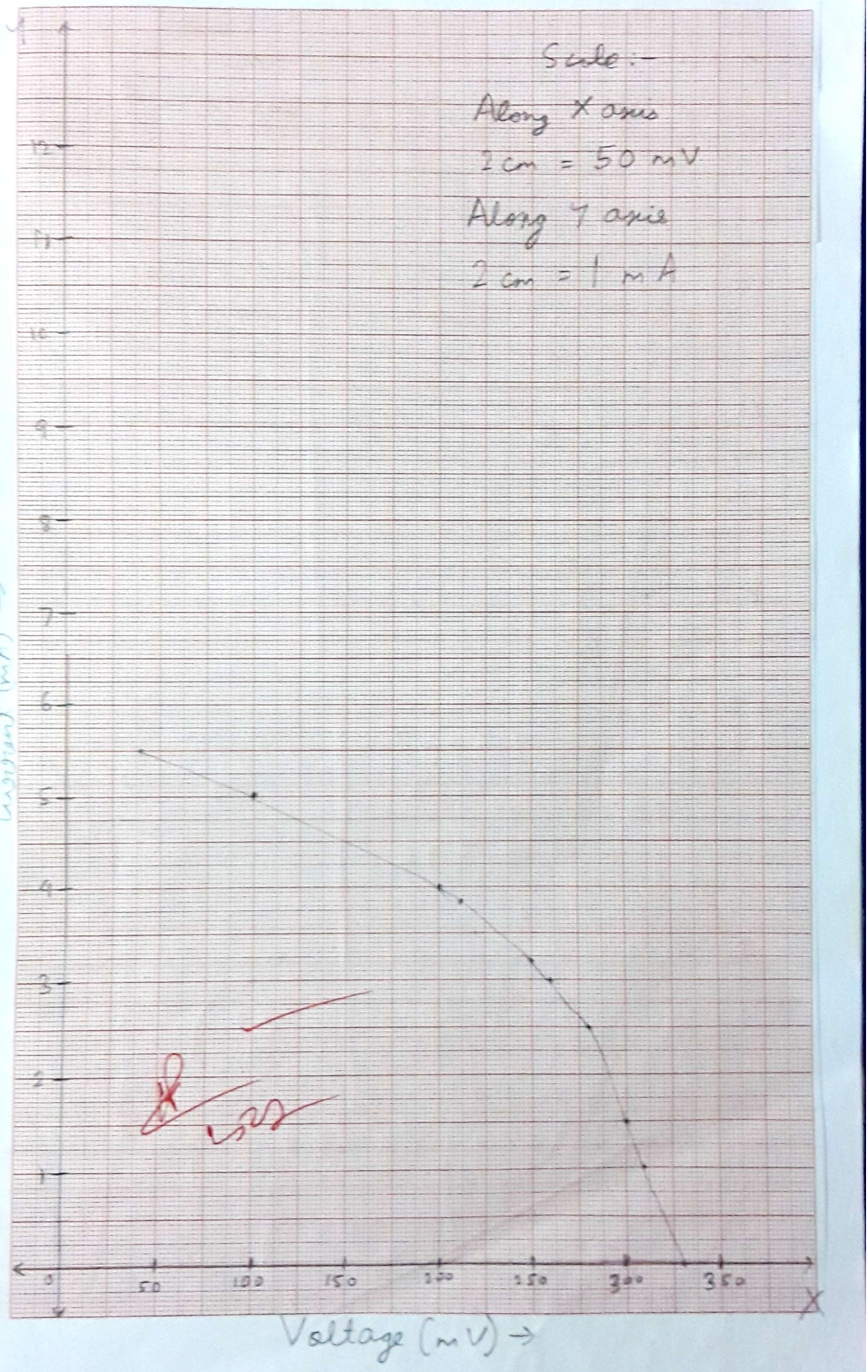


Fig II: I-V Characteristic of a solar cell





CALCULATIONS :-

(i) For $x = 3$ cm

$$\eta = \frac{P_{max}}{A_c \times \Omega} = \frac{3240 \times 10^{-6} W}{2.43 \times 10^{-4} m^2 \times 130 W/m^2} = 10.25 \times 10^{-2}$$

$$\eta \% = 10.25 \%$$

$$FF = \frac{V_{mp} I_{mp}}{V_{oc} I_{sc}} = \frac{270 \times 10^{-3} \times 12 \times 10^{-3}}{410 \times 10^{-3} \times 15 \times 10^{-3}} = 0.52$$

(ii) For $x = 7$ cm

$$\eta = \frac{P_{max}}{A_c \times \Omega} = \frac{800 \times 10^{-6} W}{2.43 \times 10^{-4} m^2 \times 90 W/m^2} = 3.6 \times 10^{-2}$$

$$\eta \% = 3.6 \%$$

$$FF = \frac{V_{mp} I_{mp}}{V_{oc} I_{sc}} = \frac{200 \times 10^{-3} \times 4 \times 10^{-3}}{340 \times 10^{-3} \times 5.5 \times 10^{-3}} = 0.42$$

RESULT :-

IV characteristics of the solar cell were studied and the maximum power generated, FF and efficiency were calculated for two different source cell distances.

For $x = 3$ cm, $P_{max} = 3240 \mu W$, $\eta \% = 10.25 \%$,
(maximum Power) (Efficiency)

$FF = 0.52$
(Fill Factor)

For $x = 7$ cm, $P_{max} = 800 \mu W$, $\eta \% = 3.6 \%$,
(maximum Power) (Efficiency)

$FF = 0.42$
(Fill Factor)