Course: Sustainable Energy Technology -1
12150310

Title: PV Technology-L2

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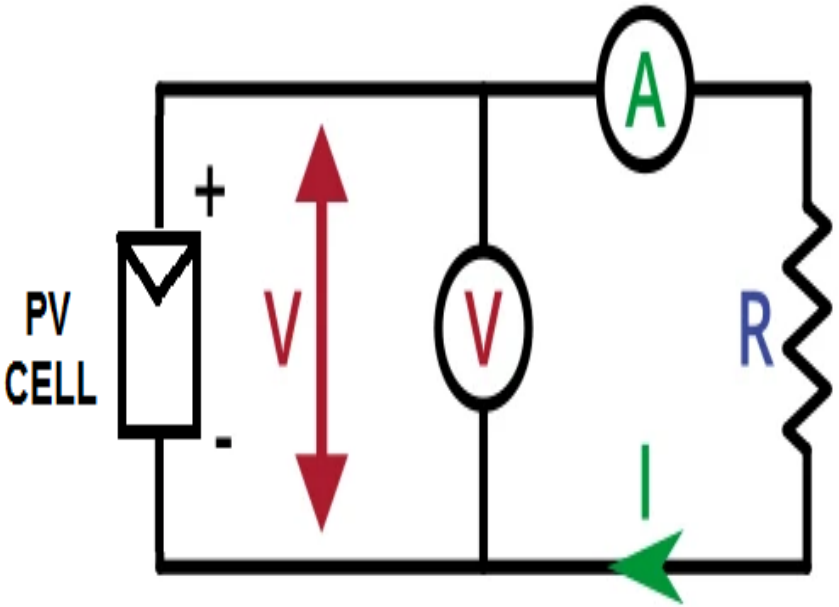
Photovoltaics Characteristics

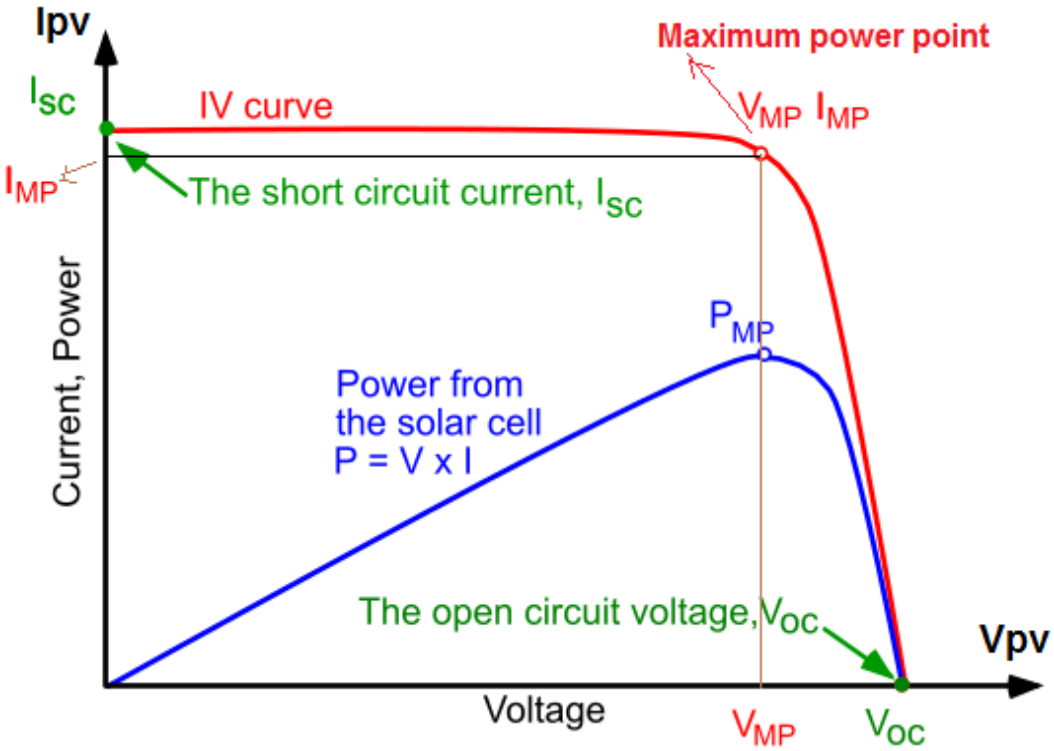
IV Characteristics:

Pmax = Vmp * Imp ///// ηmax = Pout max / Pin

= Vmp * Imp / G * Apvcell

Fill Factor (FF) = (Vmp * Imp)/ (Voc * Isc)





Photovoltaics Characteristics

Example:

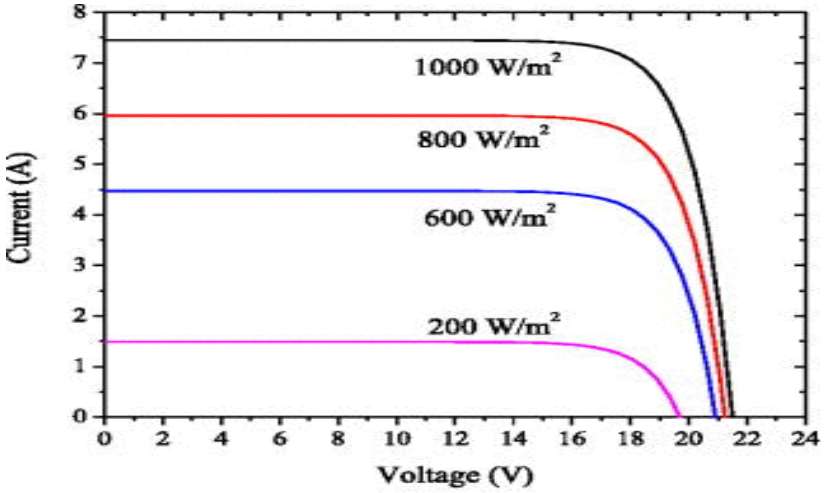
A PV cell area 100 cm2; Vmp = 0.47 v, Imp = 2.9 A; Voc = 0.62 V; Isc = 3 A. At G = 1000 W/cm2 find Efficiency and fill factor

$\eta = 0.47 * 2.9 / 1000 * (100/10000) = 13.6\%$

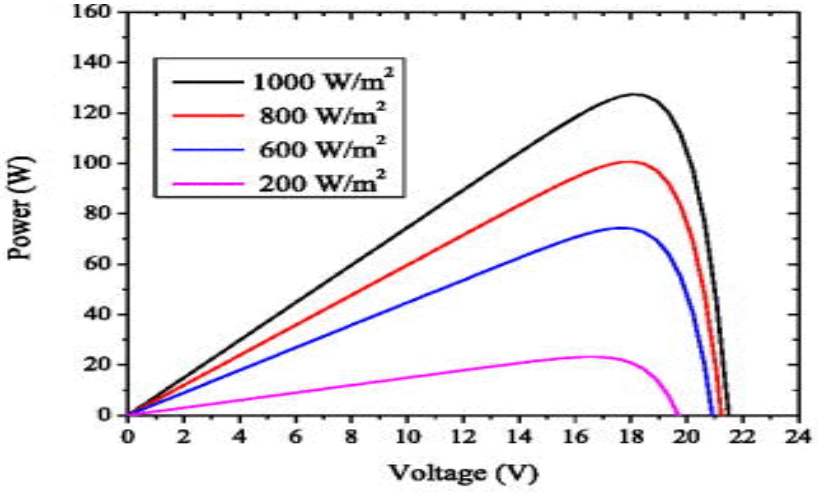
$FF = 0.47 * 2.9 / (0.62 * 3) = 73\%$

Photovoltaics Characteristics

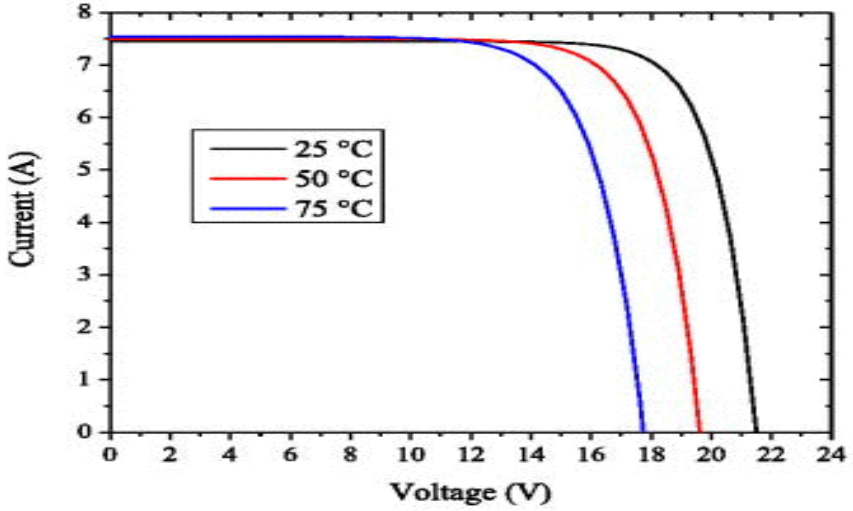
Effect of solar radiation and temperature change on IV curve:



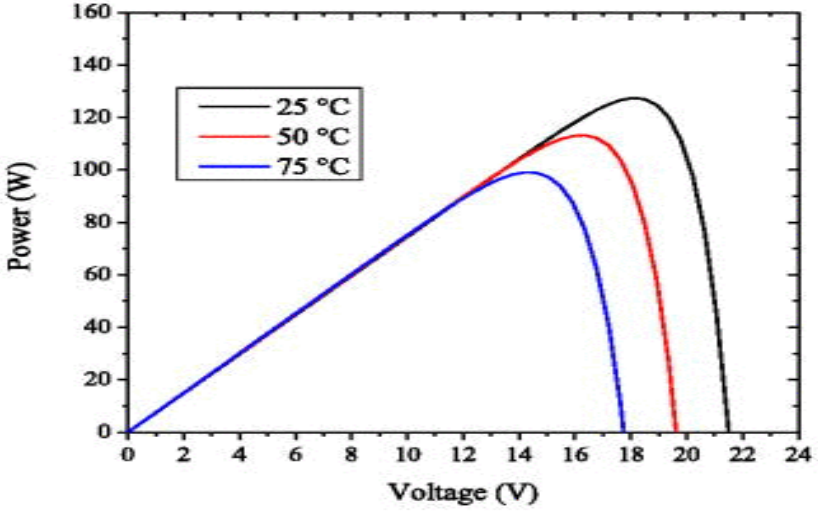
(a) I-V characteristics of the module at different insolation levels



(b) P-V characteristics of the module at different insolation levels



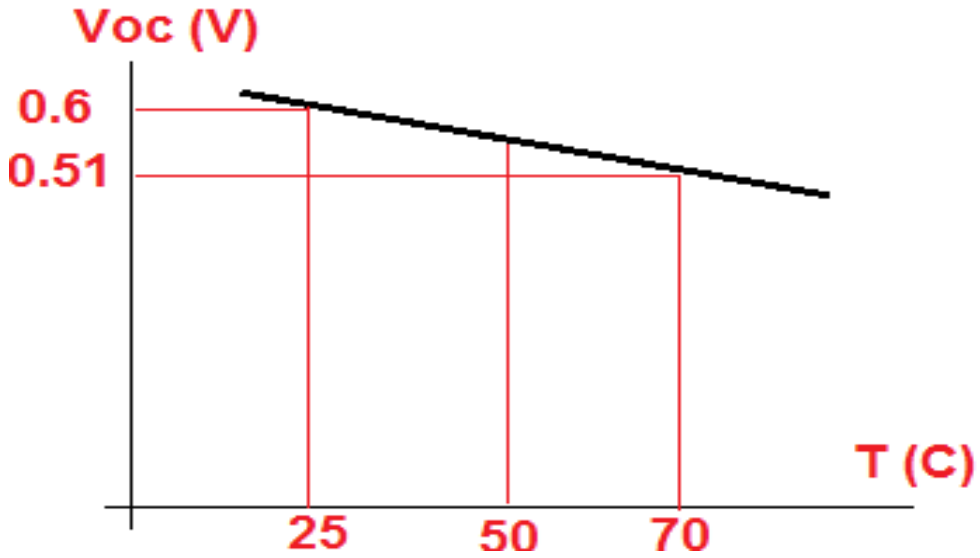
(c) I-V characteristics of the module at different temperature values

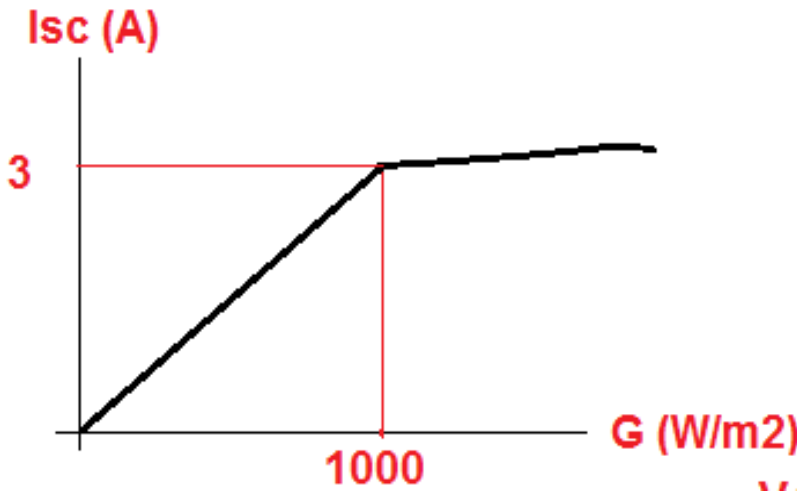


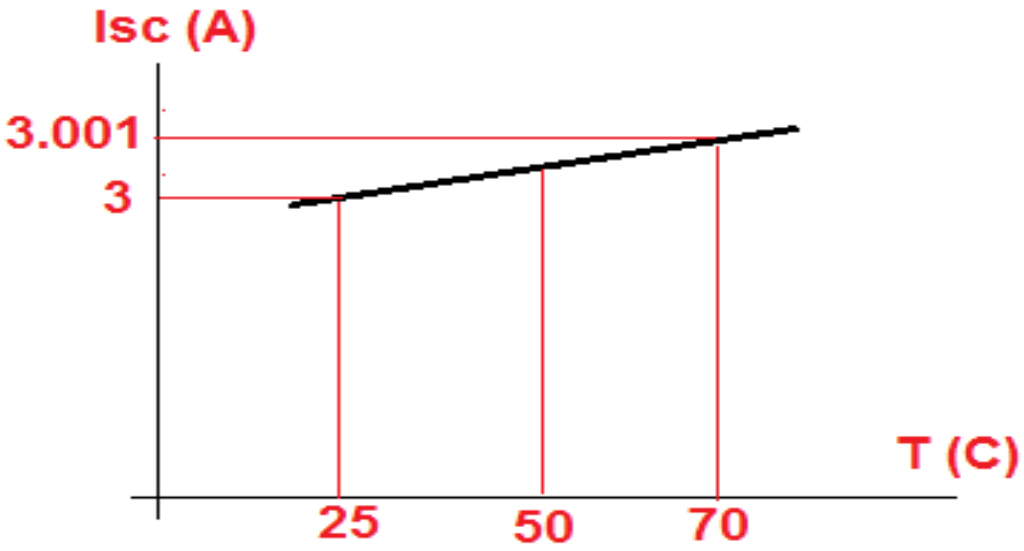
(d) P-V characteristics of the module at different temperature values

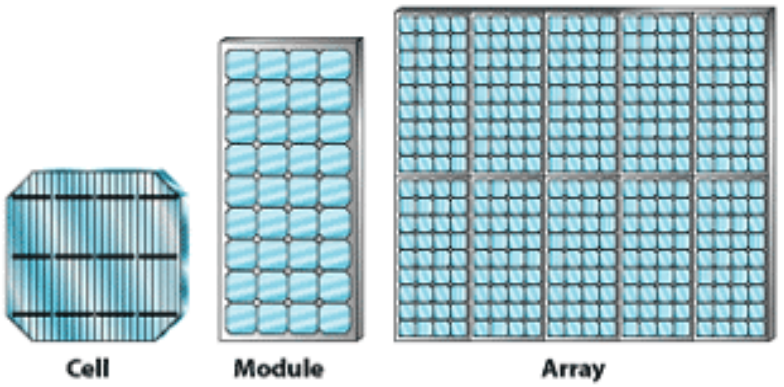
Photovoltaics Characteristics

Effect of solar radiation and temperature change on IV curve









Photovoltaics Characteristics

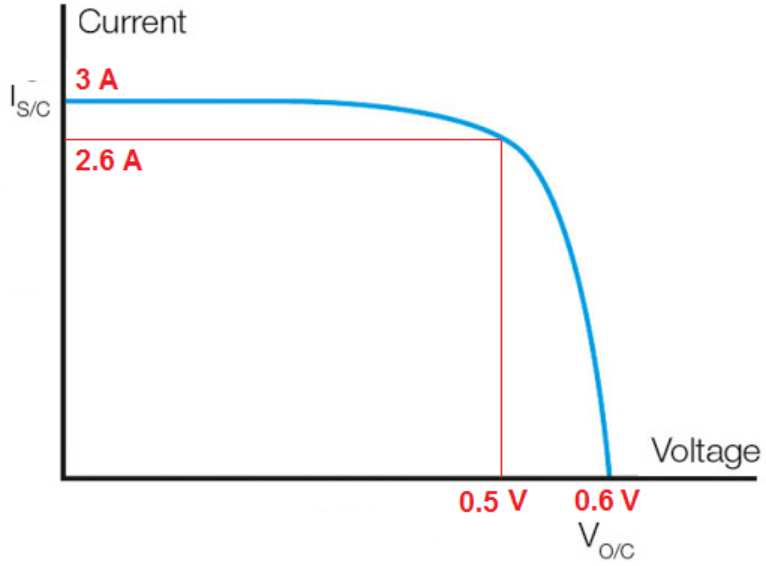
Example: (PV module of cells)

A PV module is constructed of 6 pV cells each has Isc = 3 A, Imp = 2.6 A, Voc = 0.6 V, Vmp = 0.5 V. Find Efficiency and fill factor of this PV module at G= 1000 W/m2 and the area of each cell = 100 cm2.

Eff. Max = (0.5*6) * (2.6)/ (1000*6*(100/10000))

= 13%

FF = [3*2.6 / (3.6*3)] = 72.2%



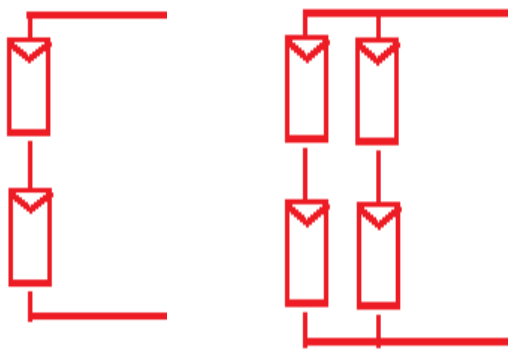
Photovoltaics Characteristics

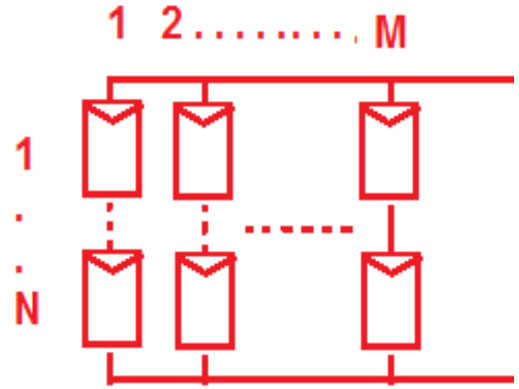
Example: (PV module of cells & PV array of modules)

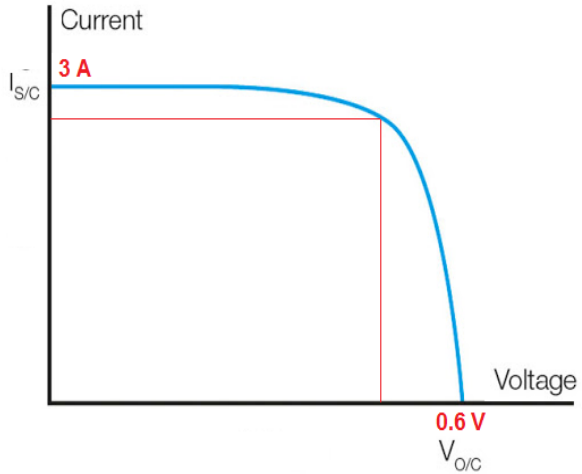
A mono crystalline module is constructed of 36 cells connected in series each has the I-V curve as shown.

1- Draw the I-V curve of the module

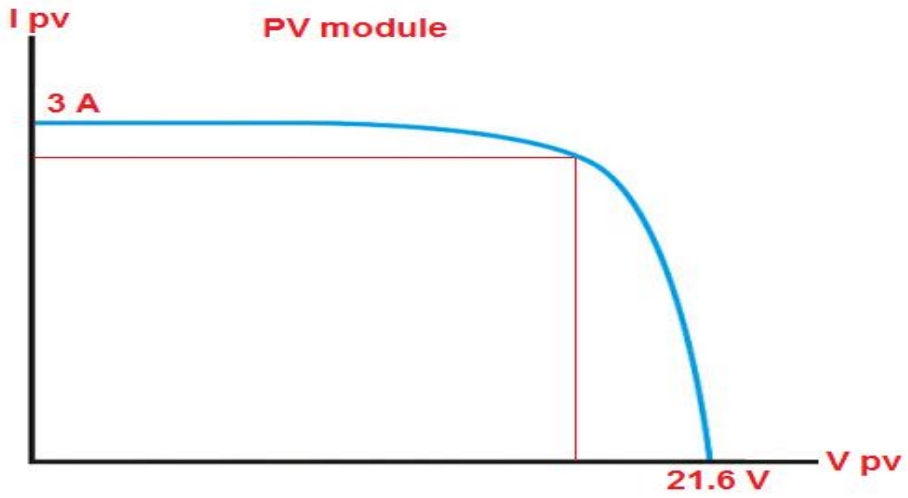
2- Draw the I-V curve of the following array configurations.

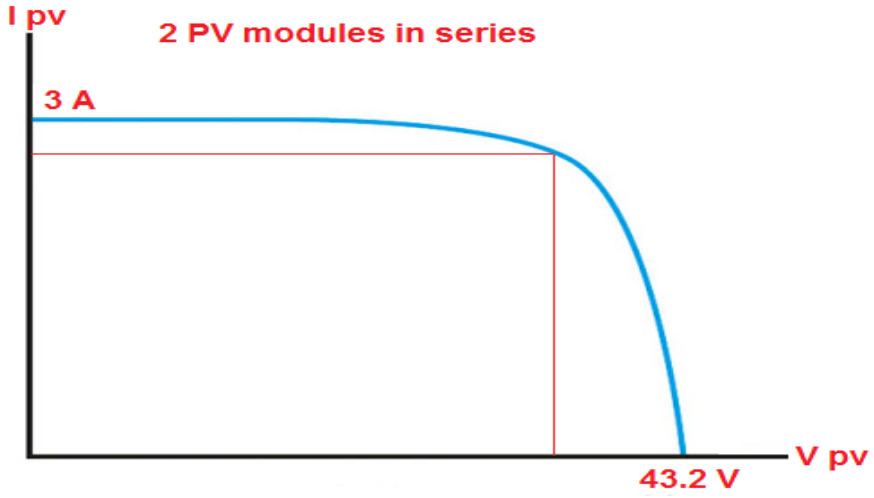


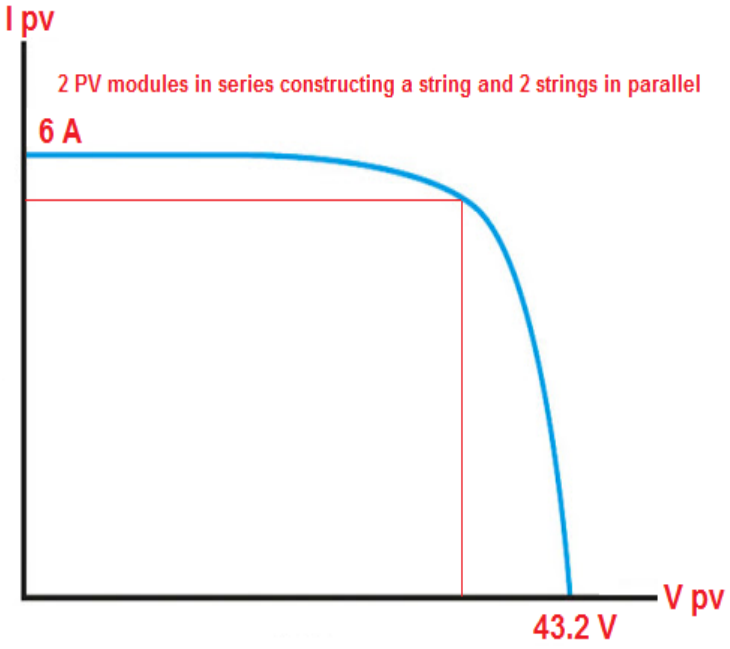


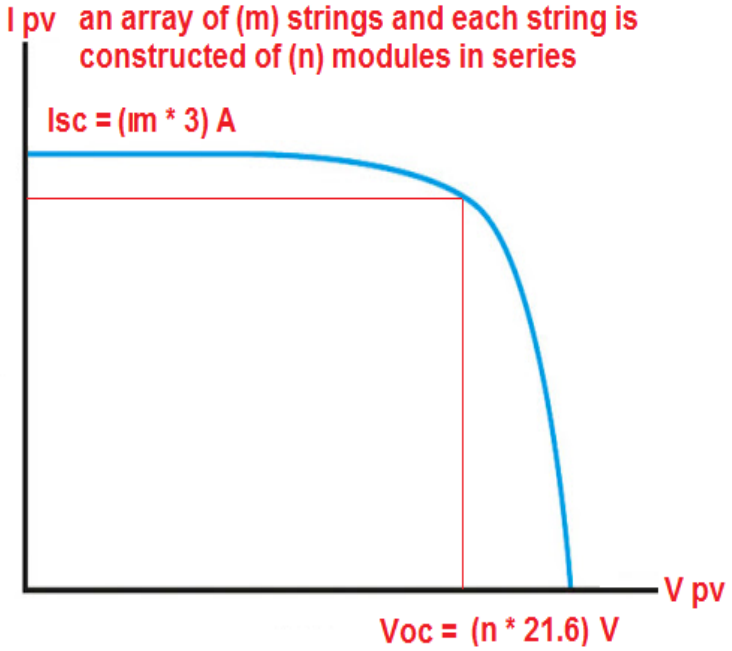


Photovoltaics Characteristics



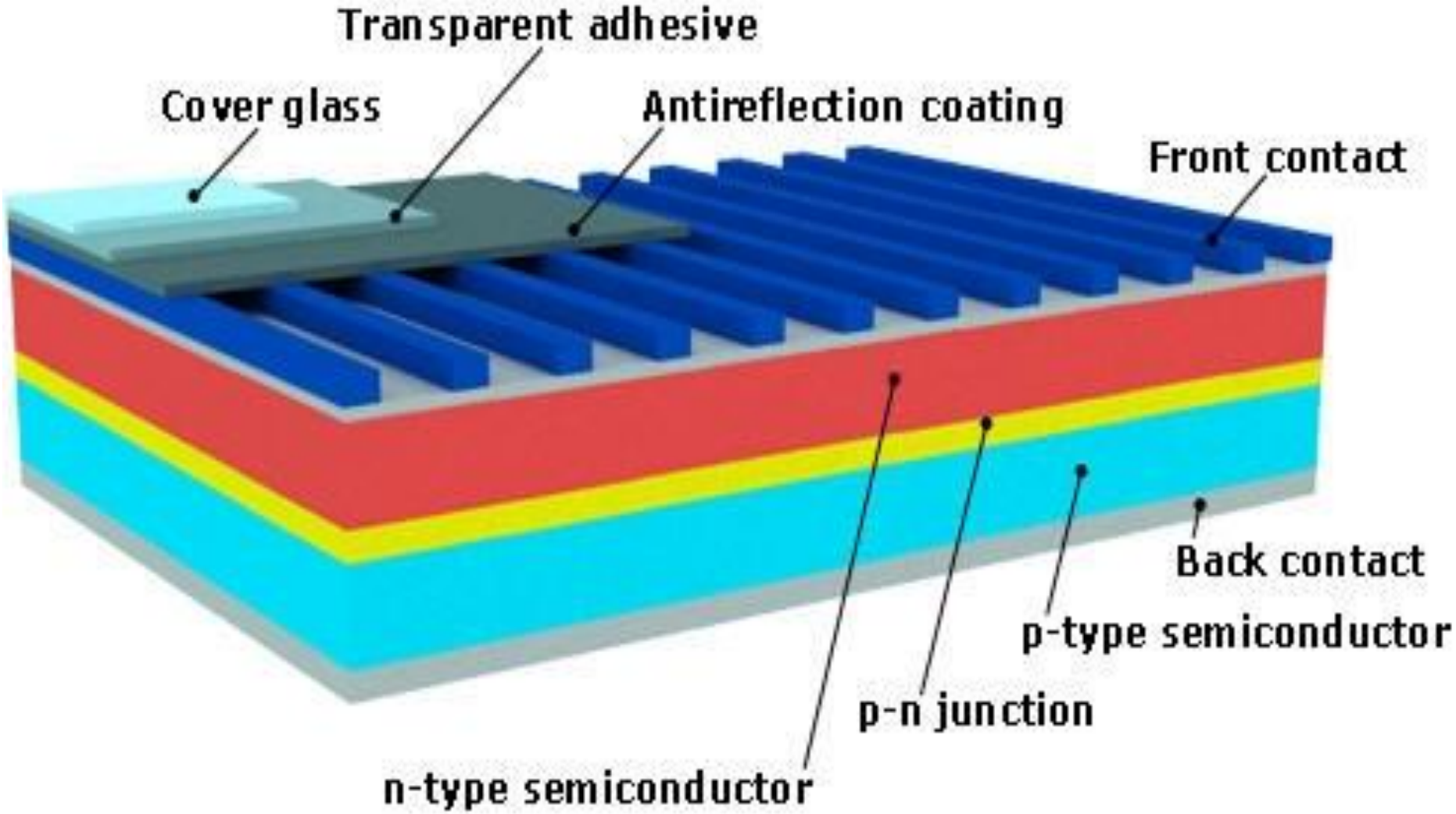






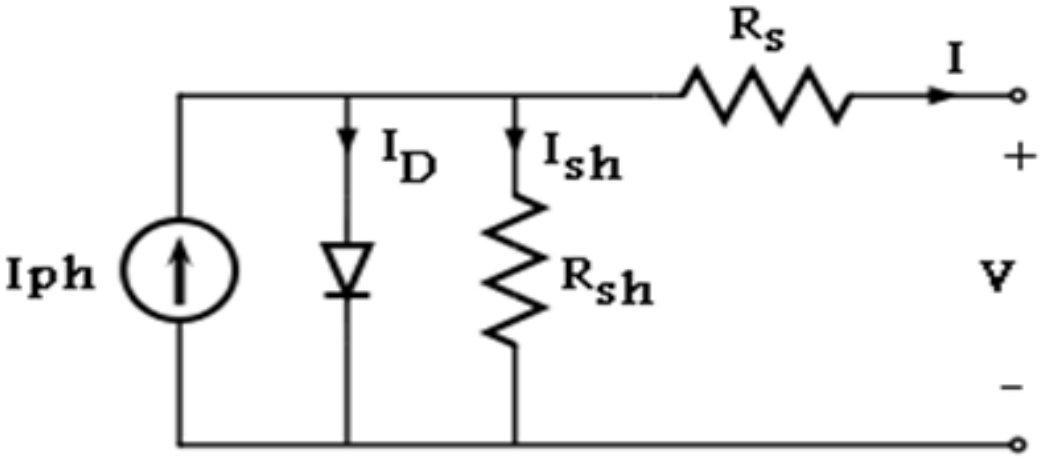
Photovoltaics Characteristics

PV Construction:



Photovoltaics Characteristics

PV Equivalent circuit:



$$I_{pv} = I_{ph} - I_{o}\left[\exp\left(\frac{V_{pv} + R_s \quad I_{pv}}{a\ V_T}\right) - 1\right] \quad - \quad \left(\frac{V_{pv} + R_s \quad I_{pv}}{R_{sh}}\right)$$

$$V_T = (Ns * K * T) / q$$

Ns is number of cells in series

K is Boltzman constant = $1.38 * 10^{-23}$ J/K

T is cell temperature

q is the electron charge = $1.6 * 10^{-19}$ Coulombs

Photovoltaics Characteristics

PV module output power:

$$P_{PV\text{-}gen} = P_{mp\text{-}STC} \times (G/G_{STC}) \times [1 + K_T(T_{cell} - T_{STC})]$$

$$T_{cell} = T_{amb} + (((NOCT\text{-}20)/800) \times G)$$

Or $T_{cell} = T_{amb} + 0.0256 * G$

$P_{mp\text{-}STC}$ is the rated power of the PV module (given by manufacturer)

G_{STC} is the radiation at standard test conditions 1000 W/m2

T_{STC} is the temperature at standard test conditions 25 C

NOCT is the normal cell temperature (given by manufacturer)