Indian Institute of Science

Design of Photovoltaic Systems

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NPTEL Online Certification Course

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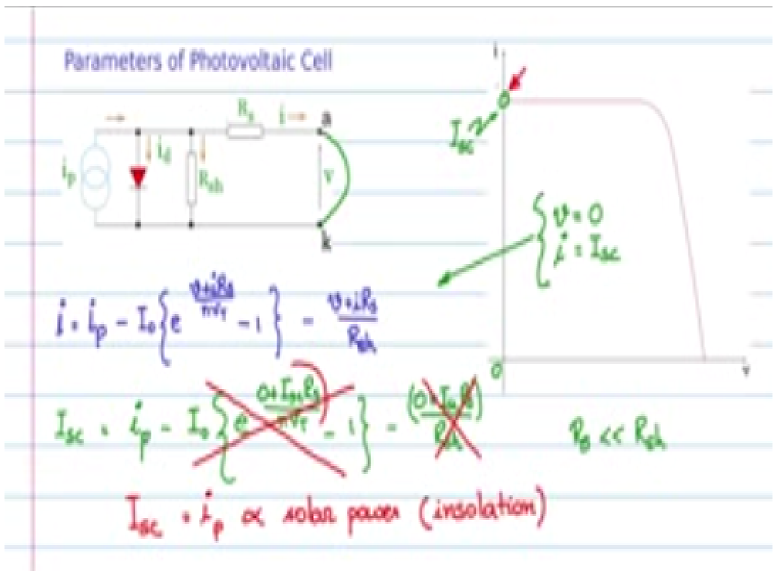

In this clip let us discuss the parameters of the photovoltaic cell for this let us have the model of the PV cell this is the equivalent circuit model of the PV cell we have the IT T photo current the diode part the shank non-ideality and the series non-idealities coming here and these are the terminal voltages and the currents of the PV cell let us have in place the IV characteristic of the PV cell 2 we will need this for our discussion.

Now let me put down for you the terminal current model of the PV cell that we discussed and developed in the last clip, so we know how the terminal current model of the PV cell also written down here now looking at the Interviewee: characteristic there are three significant points on the Interviewee: characteristic we will discuss all these three significant points one by one the first point is at the intersection here, so let me mark that so this is one point that we need to discuss.

And I will call this as the short circuit point shortly you will know why it is so I will call this one as Isc I short circuit now this is origin 0 the you will see that this point is intercept on the y axis when the voltage V = 0 which means the terminal voltage is short circuited it apparently would mean that the terminal voltage has been shorted like this, so at under such conditions you will get this Isc point which would mean that for this particular significant point V = I = Isc we are setting it to this Isc and if we apply these constraints to this equation we will see that the short-circuit current point Isc is given by IP – $I0^{0+nVt\ -1-}$

So this is the equation after having substituted V = 0 and I = Isc the terminal cards now we have to further constrain that Rs is very small compared to the shunt and is Isc Rs is tending towards 0 it is a very small value of Rs being very negligible, so which would mean that as a first step as an approximation so that we understand the relationship between the parameters this is negligible we can remove it from the equation.

This portion Isc Rs by nVT will tend to 0 so e^{0} is 1 and therefore this entire diet current portion let us remove from the equation and you will see that Isc = Ip the photocurrent which is proportional to the solar power which is incident this we would call insulation later on I will explain on this term insulation but for now understand that insulation is the incident solar power so the main take away from this critical point that we have been discussing is that that is the short circuit point occurring when the terminal voltage is short circuited. And the short circuit point is called Isc and this Isc is proportional to the incident solar power.

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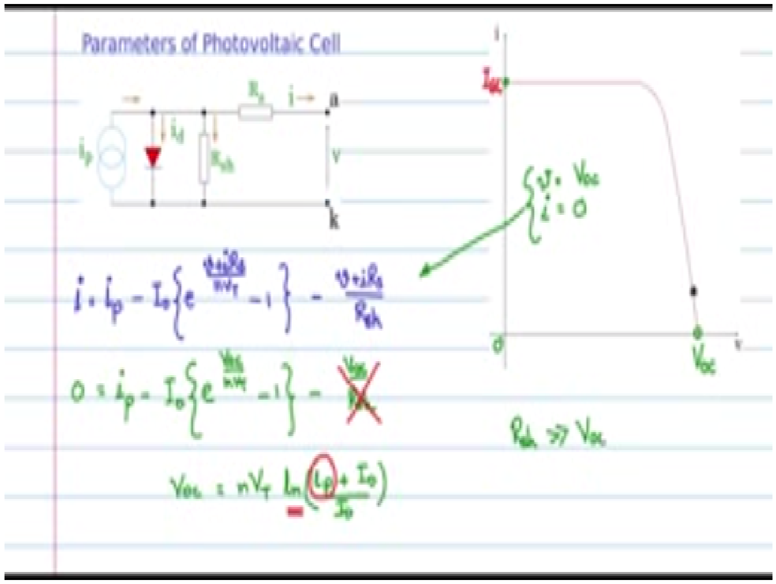

Next we shall discuss the second important operate a significant point in the Iv characteristic which is around this point and we will call that as Voc or the open circuit point, so this is the next important operating point that one has to consider this we will call it as Voc now note that at this point the current is 0 and the voltage thus obtained here is the open circuit voltage which means that here nothing is connected in the external circuit there is no current flowing through that current is 0 implying an open circuit character of PV cell.

Now for this the constraints are V will be set the voltage terminal voltage will be set to Voc and the current terminal current is 0, so likewise let us apply these currents to this equation and see what we obtained for the Voc terminal character, so you see that terminal current is 0 Ip – I0 x into all this expression Voc/ nV_T - 1 Voc/ R shunt I being 0, so this is the expression now here again we could say that R shunt is much greater numerically compared to Voc.

And therefore we could remove this from the equation without loss of generality so that we get a much better picture of what is happening and now repositioning these variables you Voc = nV_T logarithm of IP + I0 / I0 P so this would be the equation that you would obtain, so observe that there is a logarithm coming into the picture Voc is related to Ip the insulation but in a logarithmic way so that you have to keep in mind that if the insulation changes if the incident solar power changes the variation of Voc here will be in a logarithmic manner.

So if Ip increases due to increase in the solar radiation Voc will increase logarithmically whereas Isc will increase linearly with the incident solar power, so this is the difference between this significant point and this significant point here.

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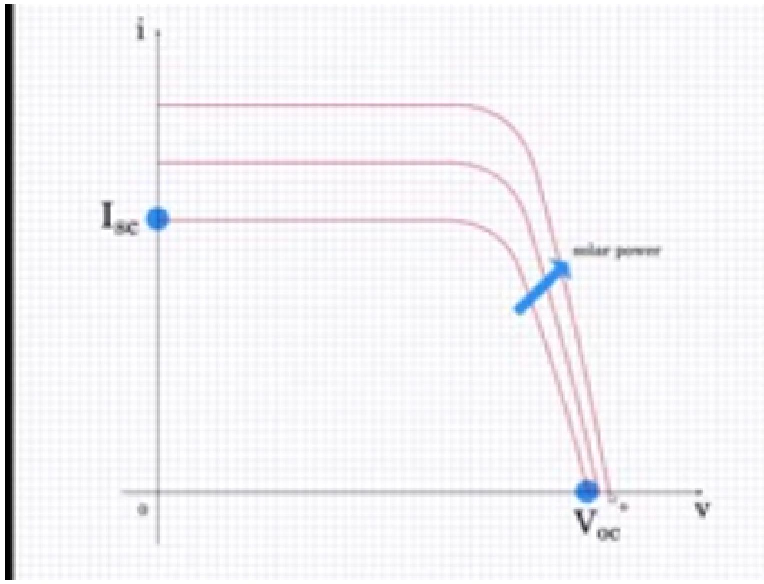

I have now assumed into the Pv cell Iv characteristic to show the effect of solar radiation change on the Ivcurve so this is Iv curve and we see that this is the short circuit Isc point is the open circuit voltage Voc point now suppose that the solar power is changing what happens to the characteristic if you take the readings of the Iv curve at a different solar incident power you will see something like that and at a still higher solar power you will see something like that and you see that the short circuit points are increasing linearly whereas the Voc points are increasing in a logarithmic way as we just saw from the equation that we just developed.

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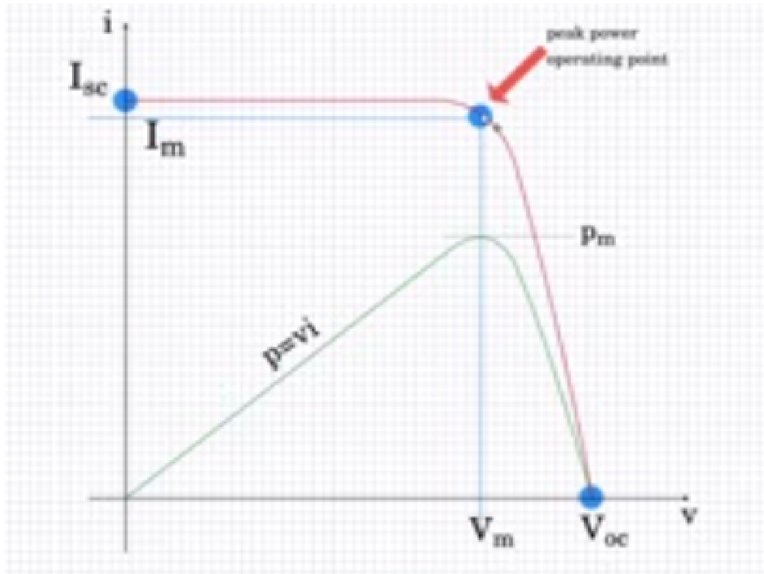

There is another important and significant point related to Iv characteristic of PV cell and this third significant point relates to the maximum power that can be transferred from the PV cell consider this Iv curve and let us retain the same x-axis that is let it be the voltage axis the y-axis we can include even the variable power variable P which is the product of P and I consider for example this point the origin where I = 0 and V = 0zero so there will be a power point which is P = VI0 and at this point P is Voc x I which is 0 and therefore power is 0 again here so somewhere in between current will be nonzero voltage will be nonzero and you will get a hill type of curve.

So if you look at the power curve it will be something like this having plotted this power curve using P = VI now this power curve is having a maximum at this point and let us denote it by Pm the max power that the photo light cell can generate now if you look at the projection of the max power point on to the Iv characteristic you will see that somewhere at this point it will intersect the Iv characteristic and we shall call that voltage corresponding to that maximum power –Vm and the current corresponding to the Iv point as I am.

And this point we shall call as the peak power operating point, so this is the point that is very important and the choice and selection of the PV scene to and we would like also to operate the PV cells at this operating point which means even the electronics the electronic load to the PV cell should behave in such a manner that the PV cell is most of the time operating in this region where it is capable of delivering the max power from the PV cell and thereby utilizing it to the so least.