Indian Institute of Science

Design of Photovoltaic Systems

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NPTEL Online Certification Course

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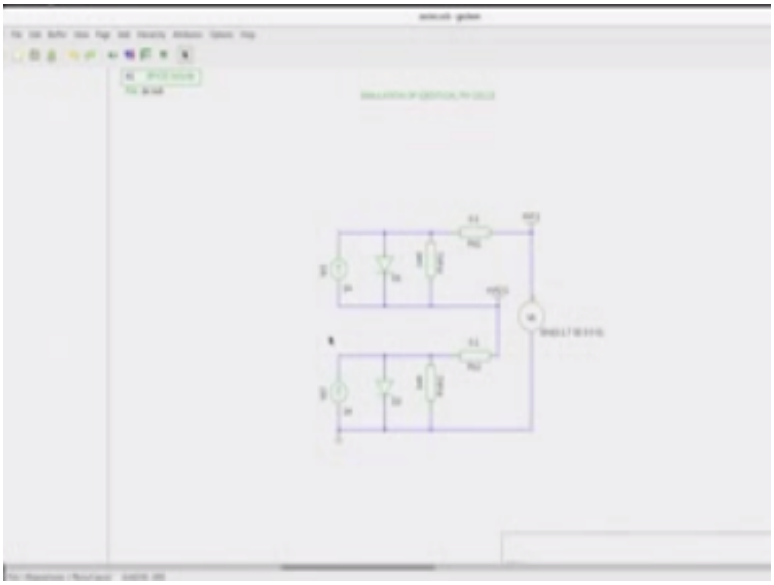

Let us simulate to PV cells in series let us take the case of two identical PV cells in series, I have captured the circuit in a ageism schematic and this is the schematic this part here is one PV cell and this is another PV cell. So I have name this one as PV cell one it is having the insulation source it is current source 1 amp there is a diode d1 and shunt resistance and the series resistance. Likewise for PV cell 2 there is an insulation current source ip 2 one amp same value D2 and R shunt and R series connect the picture.

So this cell is connected in series to this and the terminals of where the load is connected is across this point where we have connected voltage source which is sign varying source which is suppose to provide the x access C. I have name the node as NVT for the output terminal NVT 2 for the terminal which measures the terminal voltage for cell two the bottom cell, if you have to find the terminal voltage for the top cell which is the PV cell1 it is NVT – NVT 2 I have included here the specie include directive the file is PV. Sub in that one inside that one is diode model d

fault diode model which is suppose to handle these diodes D1 and D2. So we are redub the schematic let us generate the net list and simulate using a NG specie.

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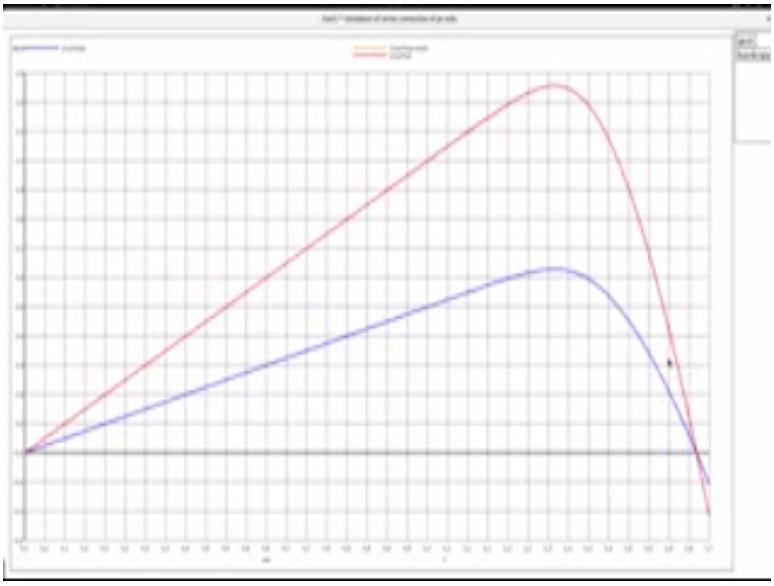

Let me go to the simulation project folder which is PV cell there are three file that you will see here series. SCH this is the schematic file that we just now saw series. CIR this is the circuit file which contain the analysis PV. Some which was referred in series. SCH through this ice directive this contains nothing but the diode model d fault diode model series.CIR actually has the transient analysis statement and an include statement for including the net list series. NET which we have not at generated we will just that now.

Where the series of controls statements one is to set the background as white and to set the photo ground as black then the uncomment so that is put in to the control statement. Now let us generate the net list file and then go in to NG spice for that first open the terminal window go the project sub folder so we have all the relevant files here I have here the net list generation command g net list minus – g spice dash SDB output to series. Net from the input series. SCH, so this will generate the net list you can come back here and see that the net list is generated and may now call NG specie series. say R.

So we are in NG specie NG specie as use the run command which was there in the dot control statement you can check the display and see that these are the vectors available for you to plot. Now we can plot and see the results, what is see that you would like to plot. You could open the

schematic file so that it becomes a bit more easy for you to understand the variable that you are plotting. Now let us say we would like to plot the current through this output source where is high and the node voltage across this that is the terminal voltage.

How does it look like? So let us plot current V_0 through the V_0 source versus NVT so we get a plot how it like this so you rather than seeing a single plot we can see group of plots which will give you a kind of a relative idea of the various things. So let me quick this let us plot the I versus week at district of the PV cell 1 PV cell 2 and the overall set. Plot IV_0 versus NVT would give you the I versus v characteristic of the overall result in PV module. And then I v0 versus NVT 2 would give you the iv characteristic of eh PV cell 2 and iv0 versus NVT – NVT 2 would give you the iv characteristic of PV cell 1 now plot that will get this maximize that and you will see that you have this characteristic.

You see this line the blue line actually this is having two lines one is the orange and the other one is the blue this is high there is high versus v for the two cells they are identical cells. And the red one is for the result in cell and that is what you are saying here which matches with our theory. Now let us plot the power versus voltage curve for the three items which is power versus voltage for cell 1 power versus voltage for cell 2 and then for the combination.

So let us now plot high v0 the high current is same for all because they are currented in series same for all the three components in to what say NVT for the overall cell versus NVT and the next plot will be iv 0 x NVT 2 for the pv cell 2 versus NVT the same access iv0 x NVT – NVT 2 would be the voltage across cell one versus NVT.

So this will give you the power versus voltage for the three cells you see them here so you see that the blue one power versus voltage for cell one and also cell2 orange so bring forced and the red curve is the power versus voltage curve for the series combination.

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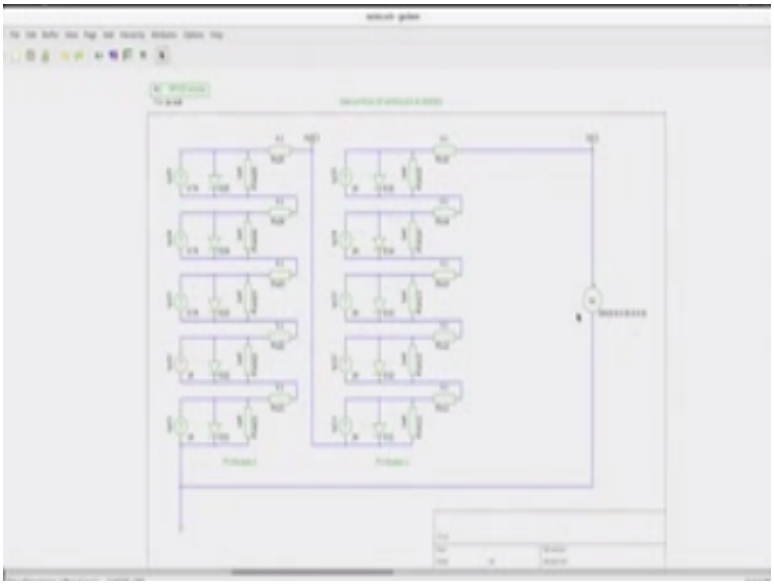

I have here the circuit of two modules connected in series now this is module one this module one contains five PV cells and these five PV cells are identical all having one amp insulation current sources they are connected in series, and there is another module, module 2 and they are also connected in series not all are identical you have two of them having one amber and source and three of hen having 0.7 amp current source indicating that these PV cell shave partial shading.

Now this module 2 and this module one are connected in series to the external load in this case external load is the voltage source which is acting as a sweep.

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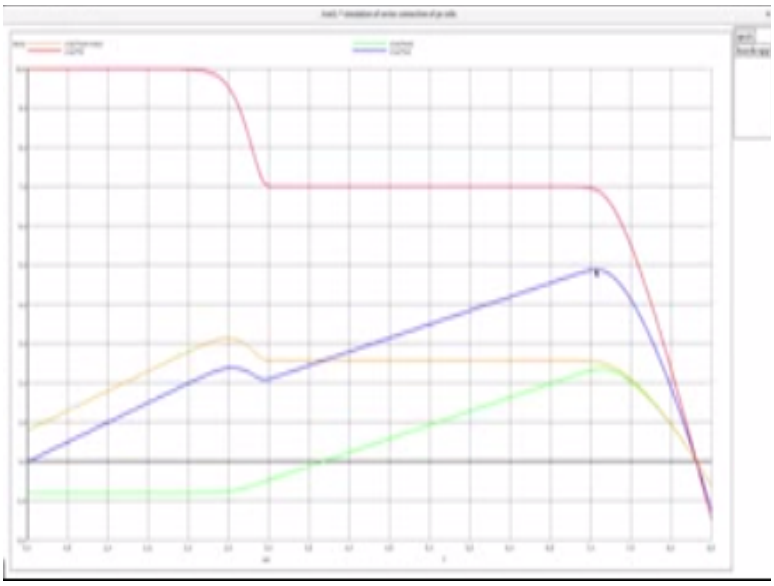

If you look at the simulation project folder you have three familiar files ewries.SCH is the schematic file which we just now saw series. CIR is the circuit file with contain the analysis statements and PV> sub contains that I would model de fault diode model in this case which is refer in series. CSH through the specie in to directive. Now if you want to have a look at the series.CIR I have here the transient analysis statement and there is an include statement which includes the series.net list file this is the net list file which we will generate shortly and there are the control statements where the first two are to set the back ground as white and black and then run you will run the simulation automatically then plot.

So plot I versus v I x v so this is a power v v power of the combined system v V power of module one v V power of module 2 v V I have scaled I v V so that you have a much more nice looking graph. So I am going to the terminal window let us generate the net list first we execute this we see now that there is a net list which has come in and now we all in this piece series. CIR and execute that you see that it was executed and then you maximize the graph you will see all the graphs that we have plot we have included in the control statement.

Now look at these I that is the current flowing through the external load so that is this red line v V and this orange line is I x NVT – NVT2 which is the voltage across module one so this would be the power of the module one which is the orange line this is the orange line. And the green line is the power of module 2 that is this the one which is weaker and has partial shading and the green one is the net power of the combined cells.

So we will see that it agrees very much with the discussion that we have had previously absorb that module 1 is always in quadrant one which is sourcing throughout absorb that the green line crosses from sourcing to shirking at this point so here all this places the power is positive module 2 is acting a source here the power is 0 and it crosses over power becomes negative and here it is sinking it is acting like a dissipater.

Now let us see what happens if we put the productive diode and try to remove this portion this negative portion of the power, this is the same circuit of two modules connected in series there is one modification that I have made and that is this diode I have included this by pass diode here to protect module 2 whenever module 2 tries to go negative that is operating in a sink mode. Now let us go the terminal let us now generate the net list and let us go to NG specie and going to its environment say R you will see that the simulation is executed and you see now this set of graphs along with the production diode.

Absorb that the green line which is the power curve of module 2 and as it tries to negative it gets clamp of course the diode is not ideal so it gets clamped to the forward voltage, absorb also the shape of this curve it is last for our discussion. Absorb that the power curve for the entire system series system is having two bumps and it is not single it is not a single hella single bumped power curve.