Computational Hydraulics
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Lecture 41
Steady Channel Flow: Channel Network without Reverse Flow (Contd.)

Now if I open that scilab code for this one.

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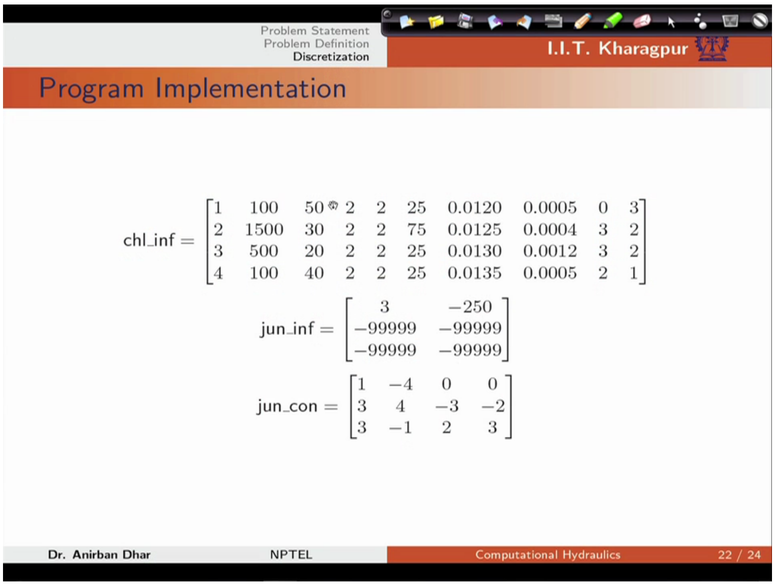

So code is steady 1D channel network without reverse flow situation. So initial program it is starting with clc clear, so clear console clear all variables in this case. Next is defining Av or area value. Next is d area, this is the dA by dy. Next is HR value that means this is hydraulic radius RH. Next is dR by dy. So these information are required for our problem.

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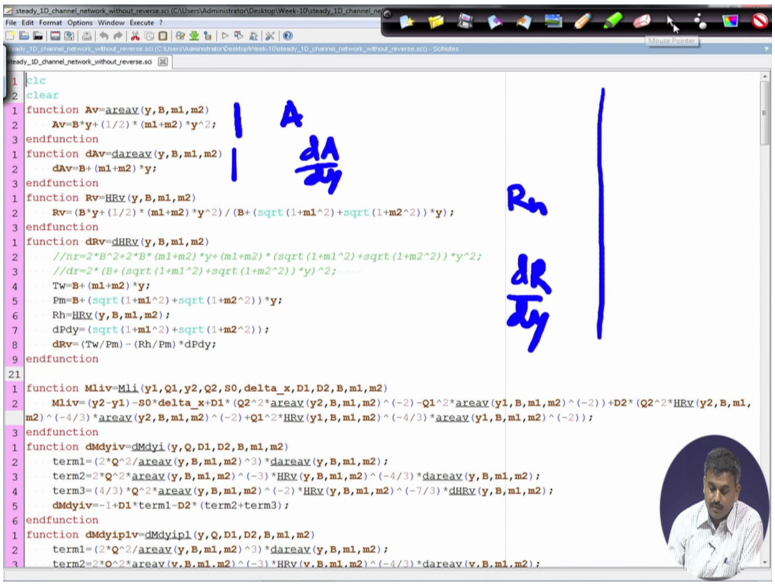

Now next part is our dM L i by this is MLV only so this is M L i only. On the second one this dM L i by dy L i. Next one this is the one. Next one is dM L i divided by dy L i plus 1. This is dM L i by dQ L i plus 1 and this is dM L i by dQ L i, this value.

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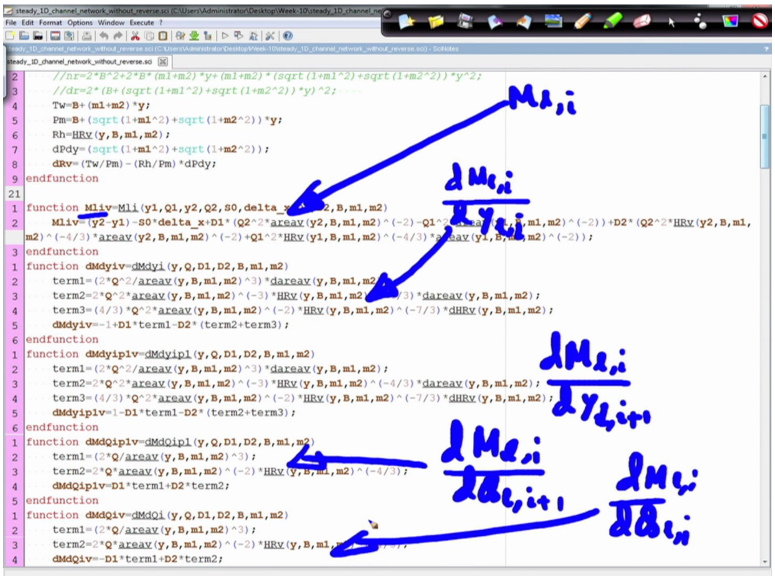

So we have defined all values there but for continuity the coefficients are constants, either plus 1 minus 1. So we will define it directly during the construction of the matrix. Now let us start with this channel reach thing. So channel reach starting is plus, ending is minus, flow depth is 1, flow discharge is 2, g is 9 point 81, g is global, yd is 3, Qd is 250, epsilon max this is required for iteration, 1 into 10 to the power minus 6. Now junction number this is 3 and channel number this is 4.

So this is channel information matrix, junction information matrix, this is yd minus Qd. Minus Qd is minus 250. This is junction connectivity and for each junction we need information for alpha. So for each channel we need (in) information about alpha. So in this case (fo) four alpha values are there.

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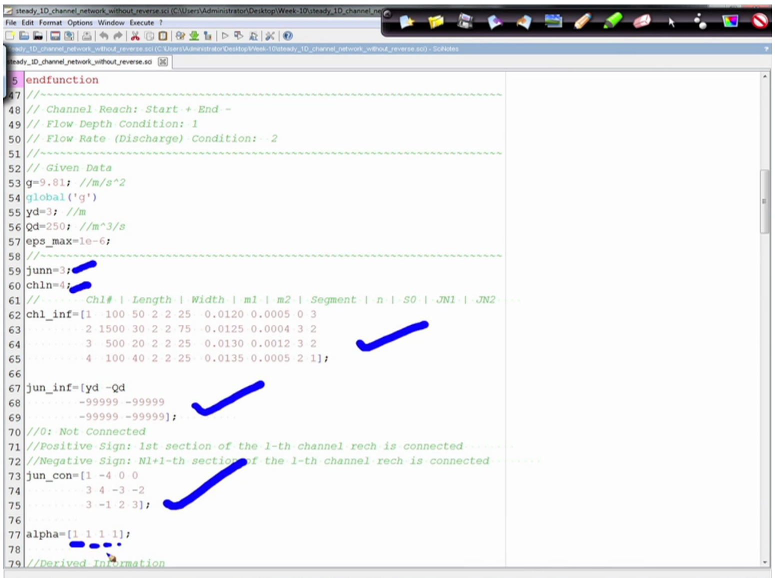

Now I can extract information from this channel information matrix. What is this second column? Second column is Lx, third column is B, fourth column is m1, fifth column is m2, sixth column is delta x, seventh column is n and S not is the eight column.

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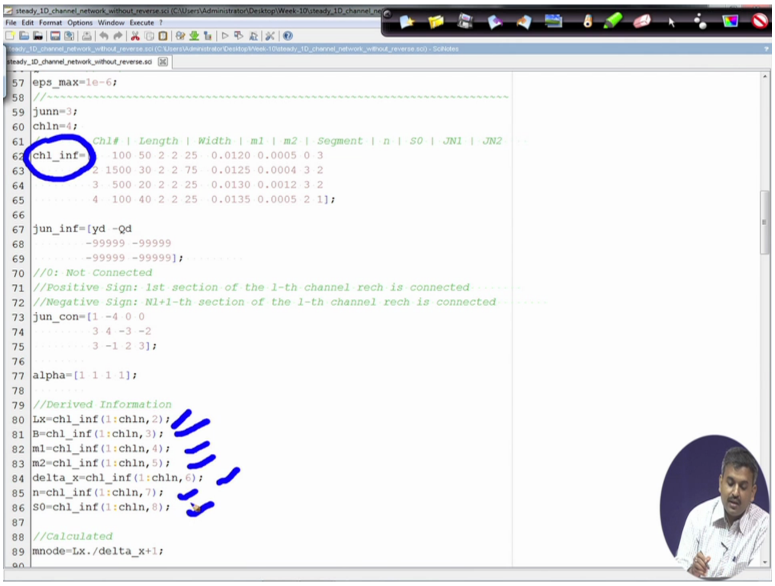

After extracting this thing we can calculate this mnode values. Mnode is Lx divided by delta x by point plus 1. We can add because it should be number of segments plus 1. Now we can define arbitrary values. This is yv, yv we means that y value. Qv means Q value. Yd into one sum mnode. Sum mnode considers all nodes for all channel lengths or channel reaches. Qv, this is for all channel reaches.

Gv, this is general variable. So in this one we will have both y and Q. So structure of gv is y1 Q1, y2 Q2, like that. So this is the general structure.

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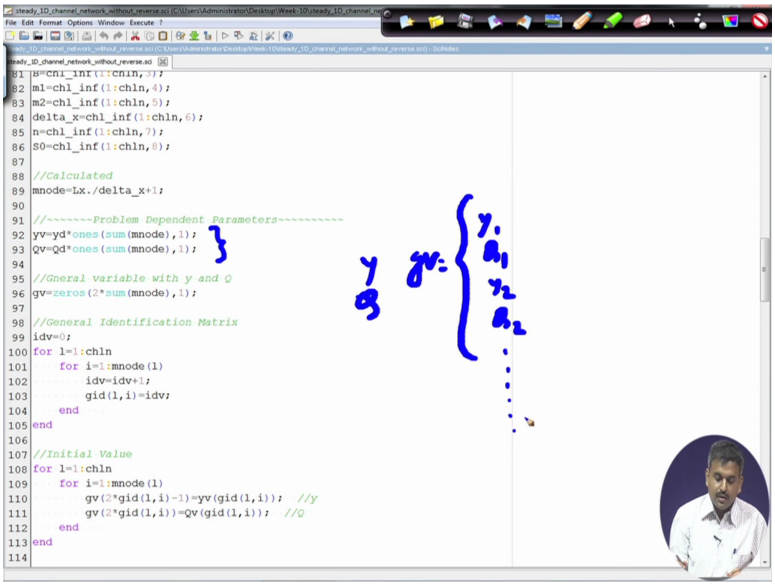

Now we need to have general identification information. What is this gid or general ID? General ID is the ID which is required for construction of our Jacobian matrix. For any channel let us say this is channel number 1. We are starting with 1, N1 plus 1. So this is 1 comma, this is 1 comma N1 plus 1. For channel reach 1 we are starting from 1 to N1 plus 1. But what will be the global ID of this one? So what I have done, I have defined it starting from 1 to N.

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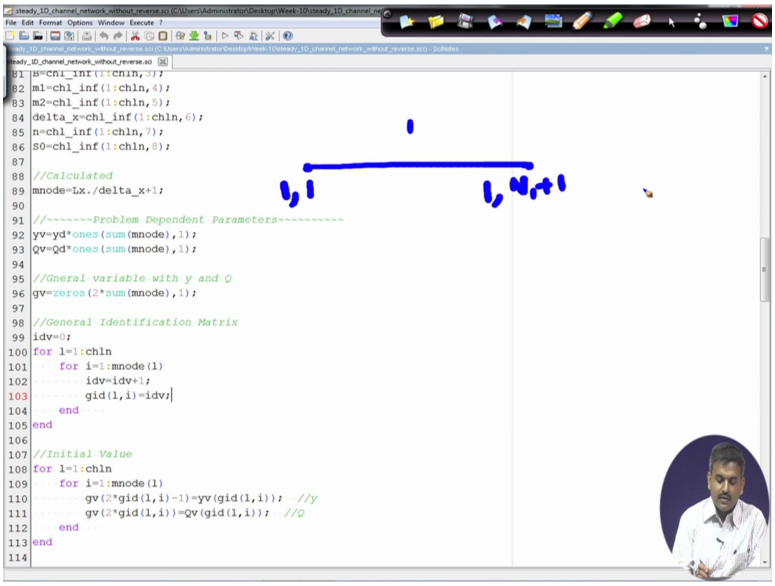

So next one is 2 1, this is 2 N2 plus 1. This is 3 1, 3 N3 plus 1. This is 4 1 or 4 N4 plus 1. So in this case I have defined this gid starting from this point. So my starting section is 1, then 2, and up to N1 plus 1 this will be my N1 plus 1. So for first one this is okay. Next one onwards this section which is the first section of the next channel reach this is N1 plus 2. That means we are adding from our previous thing. So this will be N1 plus 1 plus N2 plus 1, last one.

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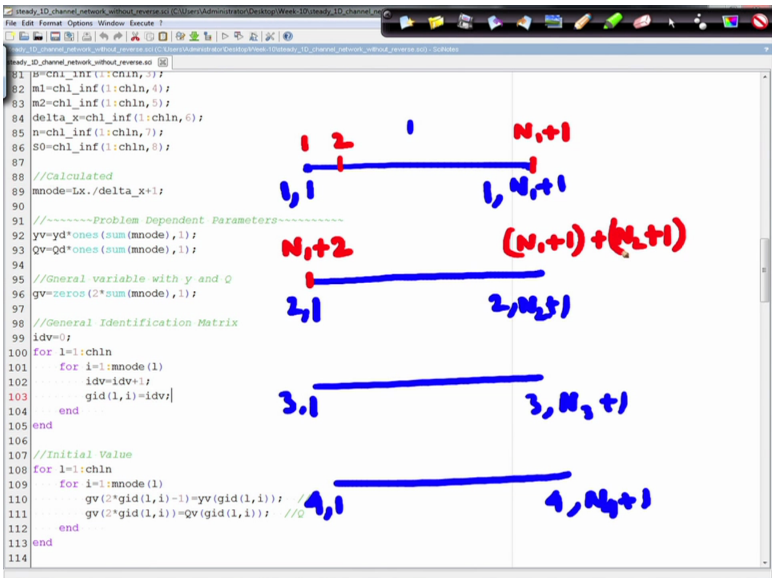

So same thing here this will be this one plus 1 plus this one plus N3 plus 1. Like that we can define a general number. So 1 to N1 plus 1 this is a local number. So we will have a general number starting from 1 up to N1 plus N2 plus N3 plus N4 plus 4.

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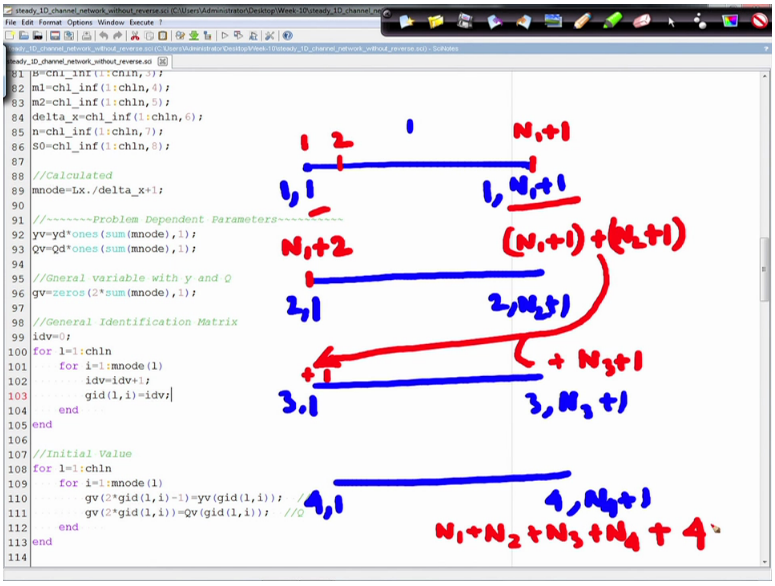

So for this one we need this many y and Q values. So yv and Qv these two values are defined for these many variables.

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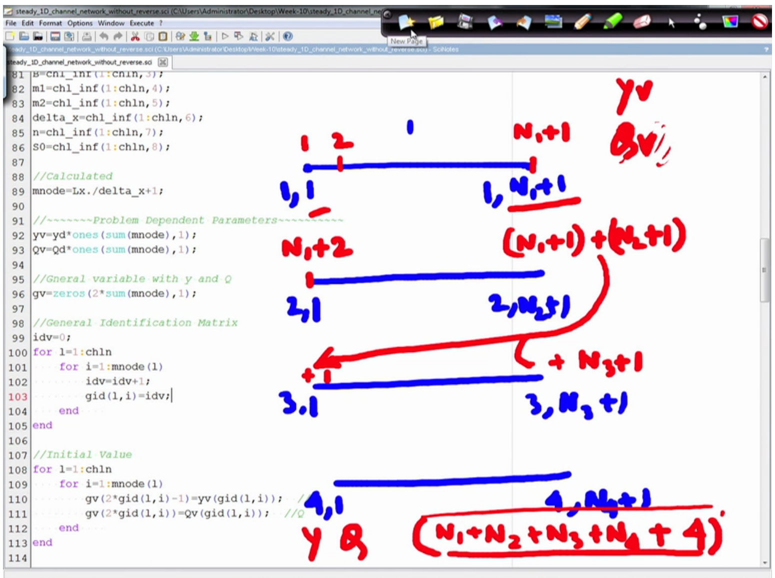

Now for this one we can transfer the initial values. So global ID is gid. Gid if I multiply 2 into any gid L i. Gid L i means this is the global ID for Lth channel and ith section. So if I multiply 2 and subtract 1 this will give me the location for y. This is with gid L i. And (glob) this is general variable 2 into gid L i, this will give me this Q value for gid L i. So like that I can transfer the initial values here.

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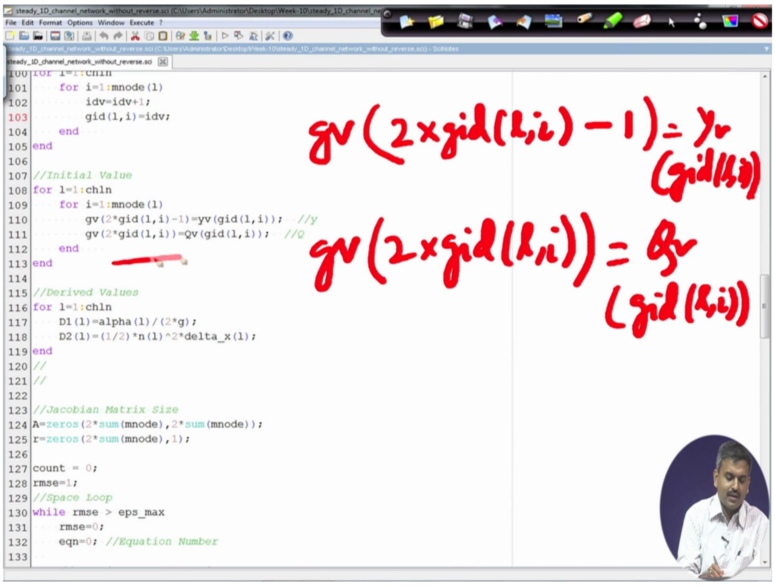

Now after transferring these initial values I can calculate this D1 and D2. These values are required for calculation of the elements of Jacobian matrix. Next is construction of Jacobian matrix. So this is A and r these two are Jacobian matrix at right hand side and we are starting our calculation with counting, this count is zero. Rmse is 1. So rmse greater than epsilon max which is 1 into 10 to the power minus 6, rmse is equal to zero.

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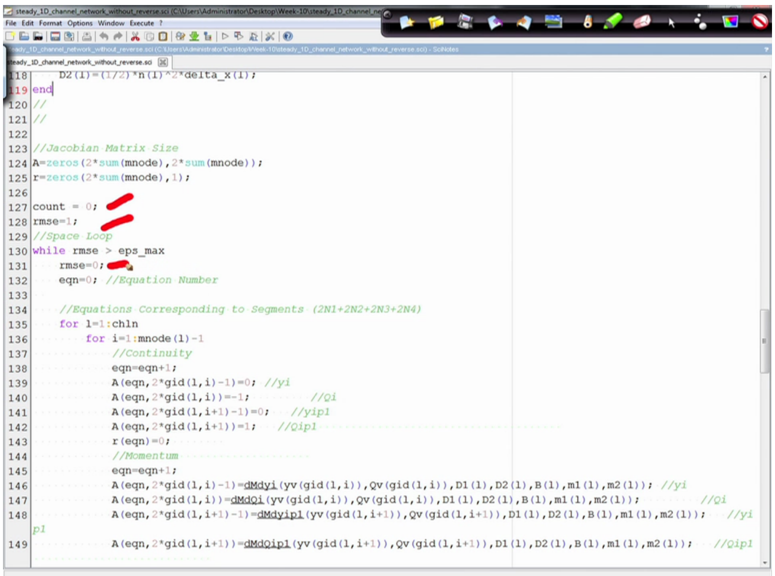

After entering into this loop I am considering rmse is equal to zero and I am starting with equation number 0. Now when I am starting the calculation here so I am considering that for each channel segment, so channel segment will be one number less because it is for NL and mnode is equivalent to NL plus 1.

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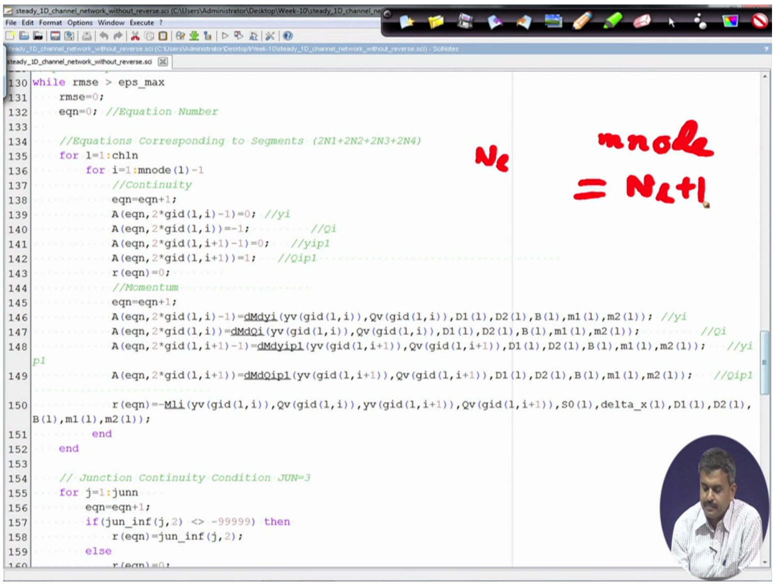

So we are considering mnode minus 1. So channel 1 to chnl channel number and 1 to mnode minus 1 for first continuity equation I am adding eqn equals to eqn plus 1. That means equation number, I am increasing the equation number. This is for momentum. So first continuity next momentum like that for all segments I can write these equations.

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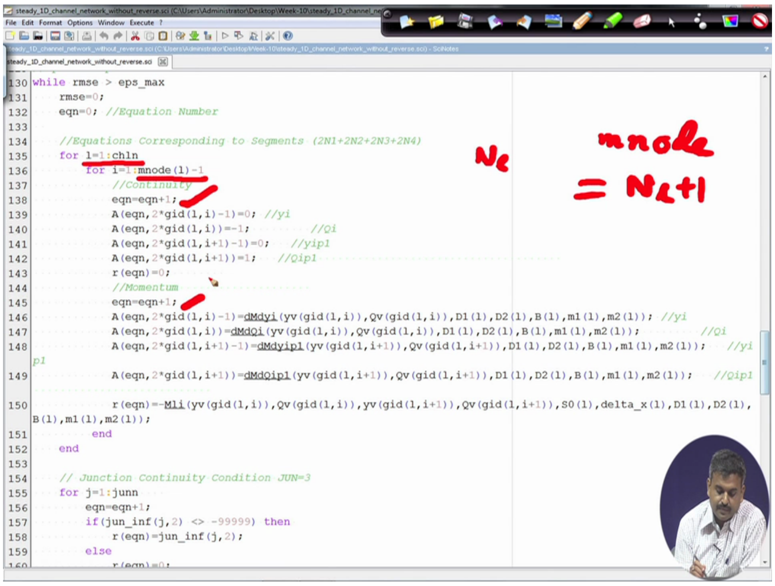

Next part is junction continuity. What is this junction continuity? J equals to junction number, 1 to junction number. Eqn equals to equation 1 because we will have one continuity equation each for this junctions. This is junction information j2. What is this J2? 1 is related to y and 2 that is related to Q. So if this is not equal to minus 999 five 9s then we should start with r eqn equals to junction information j2. That means we can directly specify that Q value there.

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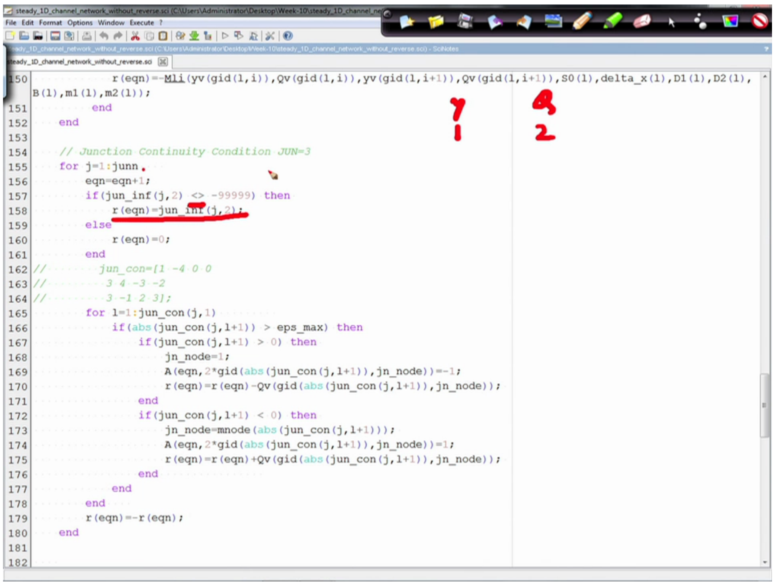

Whatever amount is added or extracted there or else we can start from r eqn equals to zero because we are not adding any quantity there. So next part is starting from L 1 to junction continuity j1. So first column provides us information about the number of channel sections connected to a particular junction.

So starting from 1 to junction condition or junction conditions j1 we have to check weather this junction condition jL plus 1 that means the next one if it is absolute value is greater than epsilon max because if it is zero that means we do not have any connectivity there. If it is greater than zero or small number then only we should proceed. If this junction continuity is greater than zero that means we are starting from j node is starting node from 1.

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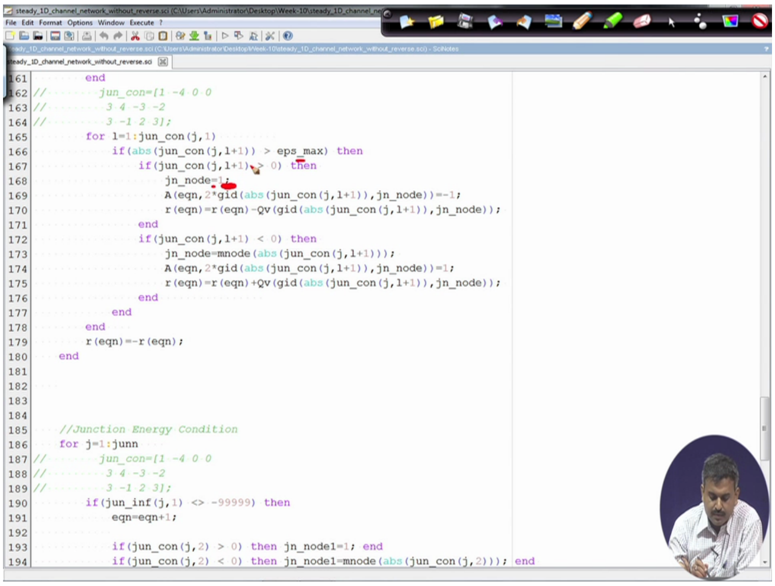

So we can write this equation for this L. L is again absolute value of junction continuity jL plus 1 and jnode. This is minus 1 because at the starting node it should be minus. And this r eqn equals to r eqn minus this Q value because we are considering that Q value is positive here. Now no reversal of flow.

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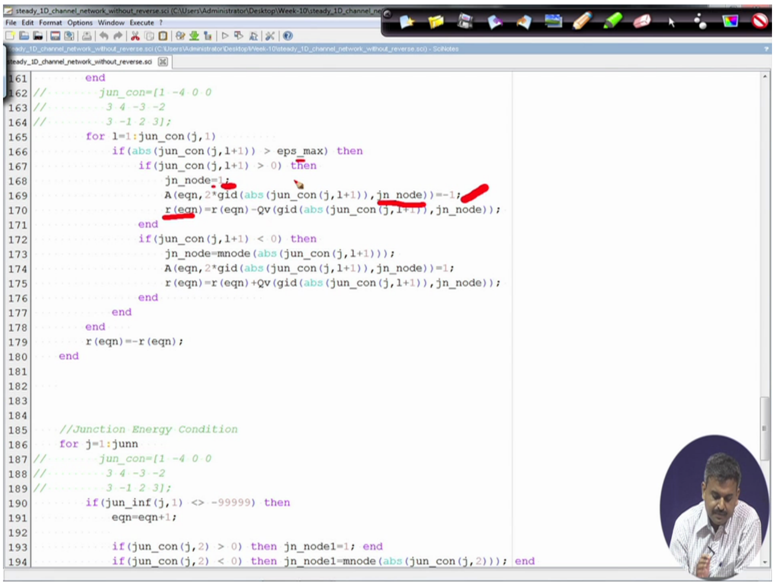

So this is directly subtracted from r eqn or junction continuity less than zero. That means this is terminating section. Then jn node equal to (mo) mnode equal to or absolute value of junction continuity jL plus 1. This will provide us information about the channel reach.

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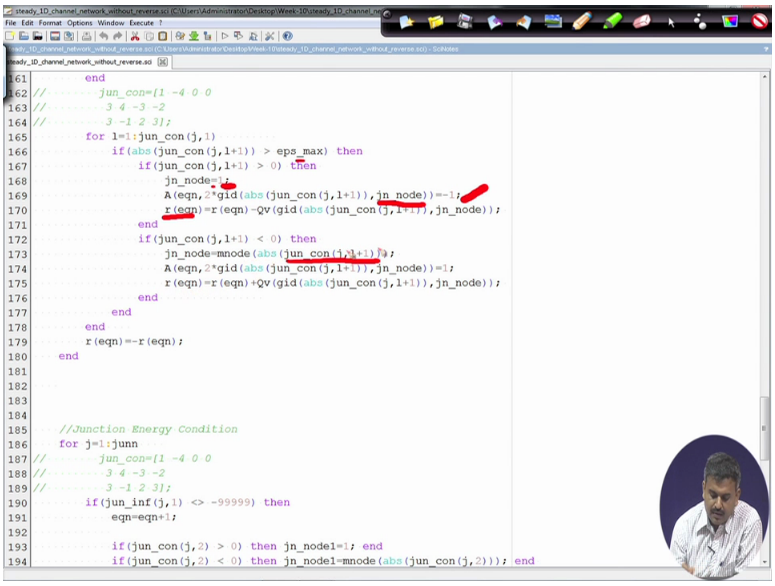

Then I can write this code there and finally r eqn should be minus r eqn because minus of the function value should be there. So with this our next part is junction condition or energy condition. What should be there? For junction 1 to junction number and if junction information j1 which is not equal to minus 999 so we should start or increasing our equation number and first node is the value which is there in the second column.

And we can directly provide the information there that value in the second column minus the value which is directly provided at the downstream junction point or upstream junction point depending on the junction condition. This is r eqn equals to minus r eqn.

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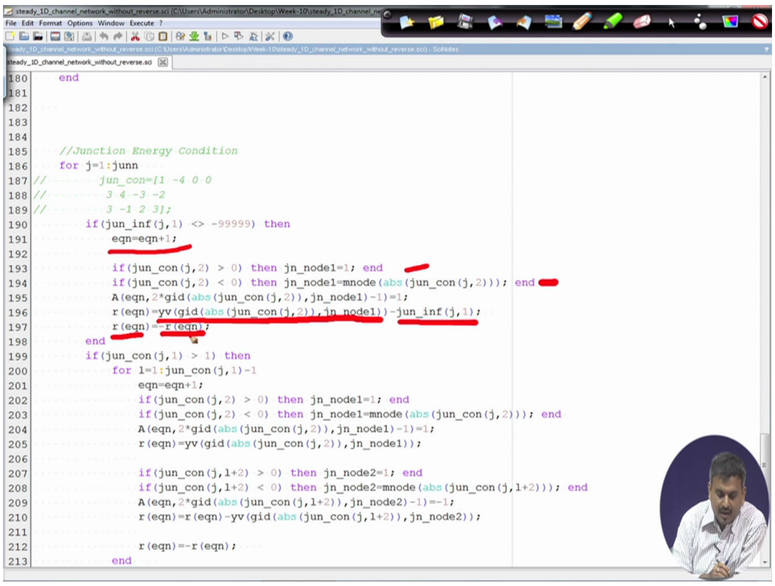

Now if this is the condition which will be there with 1 section or 1 channel. Now if you have multiple channels then we can utilise this junction connectivity 1. This is j1 which is greater than 1. If it is 1 then obviously this will be calculated with the first condition.

If connectivity is greater than 1, this connectivity number then L is equal to 1 to junction connectivity 1 minus 1 we can identify the starting and terminating nodes and for that one we can specify the derivatives or elements of the Jacobian matrix. And finally r eqn equals to minus r eqn there.

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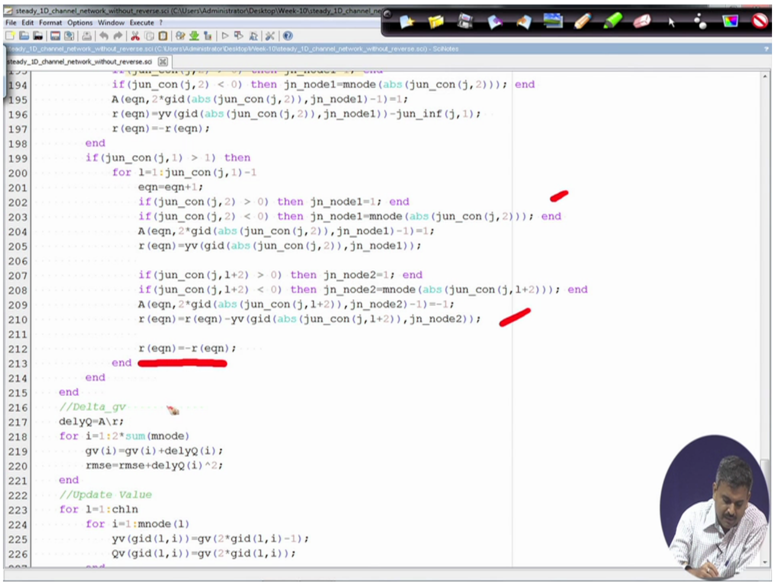

And finally we can calculate this delta yQ. After calculation of this delta yQ we can update gv value and simultaneously we can also calculate this rmse value. And after calculation of gv again we need to transfer these values directly for yv and Qv because during calculation we are directly utilising this yv and Q. From gv to yv Qv this mapping we can directly use and we can directly transfer these values.

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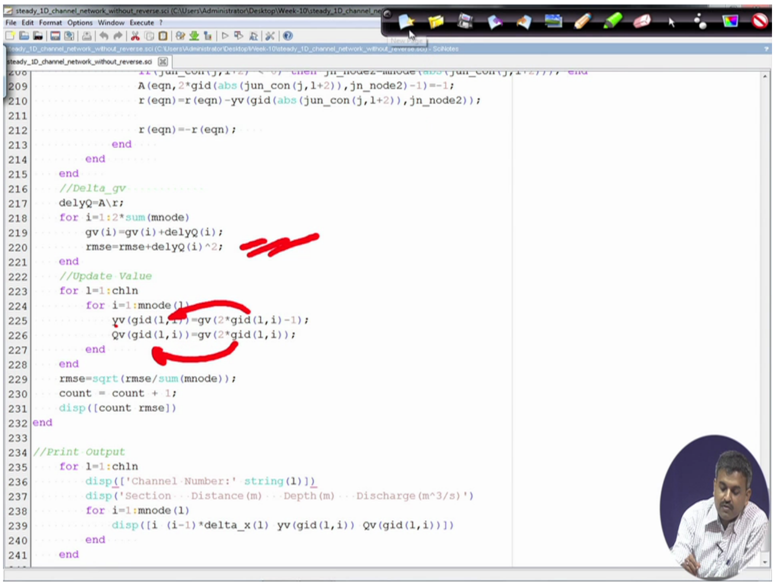

And we can stop based on the convergence criteria. And final is the output. This is for 1 to channel number, display the channel number and display section, distance, depth, discharge, this for i equals to 1 to mnode L. That means we are considering all sections. I i minus del x, this will provide us the distance at which the section is there. Next one is depth, this will provide us the discharge.

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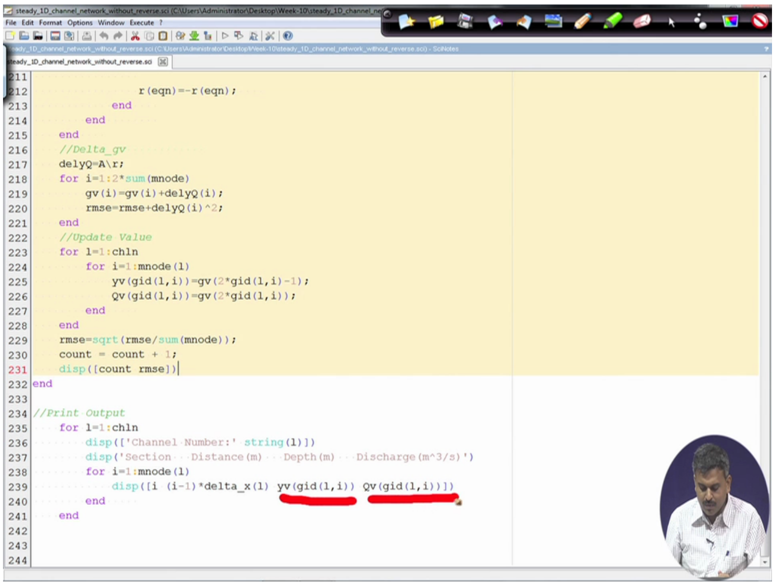

So if I run this one, now after iteration what I am getting? This is for channel number 1, this is section 1, 2, 3, 4, 5. This is distance zero, 25, 50, 75, 100. These are depth values and this is discharge. Obviously this discharge we have not directly provided at distance zero which is our entry point or inlet point.

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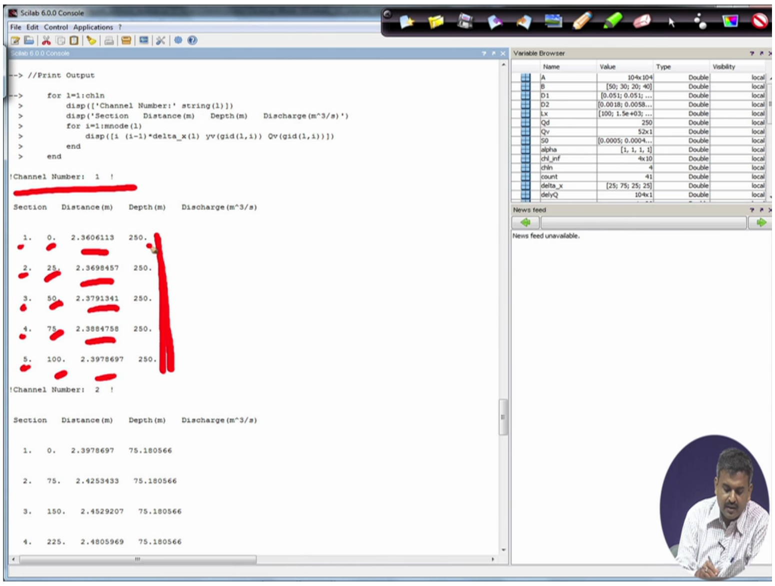

So indirectly we are getting this 250 metre cube per second value. Similarly for other sections, channel number 2 section starting from 1 to 21 and channel 3 starting from 1 to 21 and channel flow starting from 1 to 5, we are getting these values.

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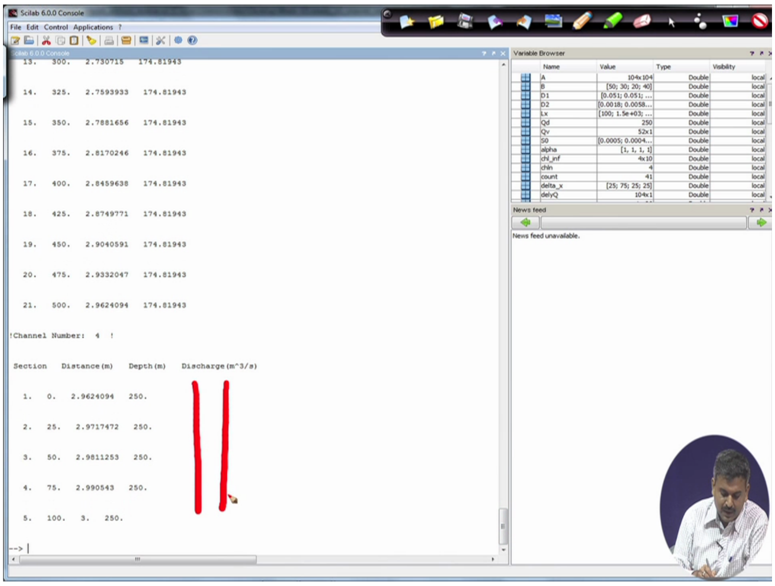

Now these values we have got without providing the initial guess by satisfying the continuity equation. Now so these values are directly coming from the iteration process with arbitrary initial values.

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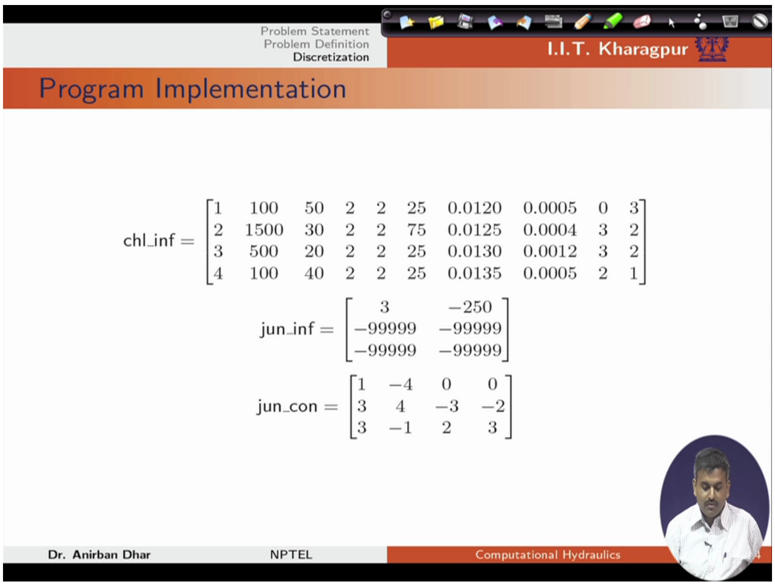

Now this code is steady 1D channel network without reverse.

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And in the next lecture we will be talking about the steady 1D channel network with reverse flow situation. Thank you.