**Computational Hydraulics**
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**Lecture 45**
**Unsteady 1D Channel Flow (Contd.)**

So in this case let us start this program with clc which is clear console, clear, clearing all variables. First one is area calculation. Area as a function of y, b, m1. B, m1, m2 these values are fixed values for any section. Only varying thing is y. This is dA by dy. Third one this is hR, hydraulic radius. And forth function this is dRh divided by dy. Fifth function this is CL i N N plus 1.

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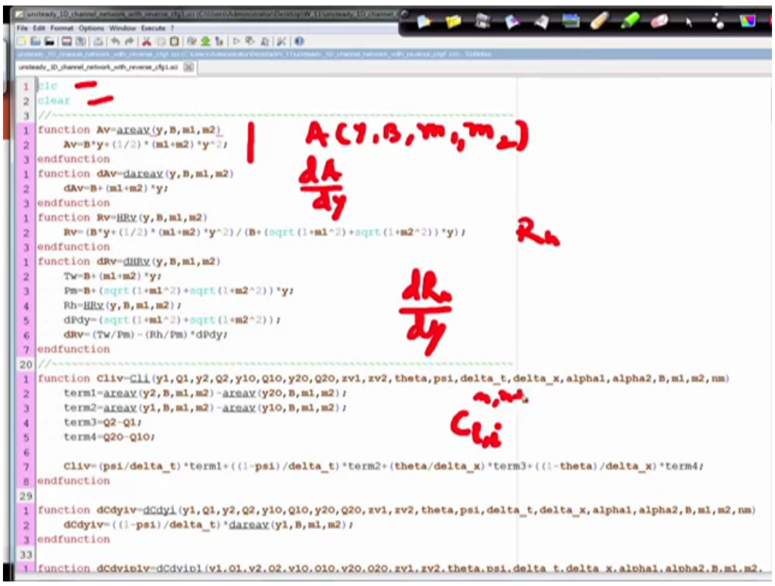


Then comes our function which is dc or dc by dy i. This is dc by dy i plus 1 and next one is dc by dQ, this is i. Next one is dc by dQ i plus 1. So we have defined CL i without specifying this L i here I have written this. This is dc L i, y i, dc y i plus 1, dc dQ i, dc dQ i plus 1.

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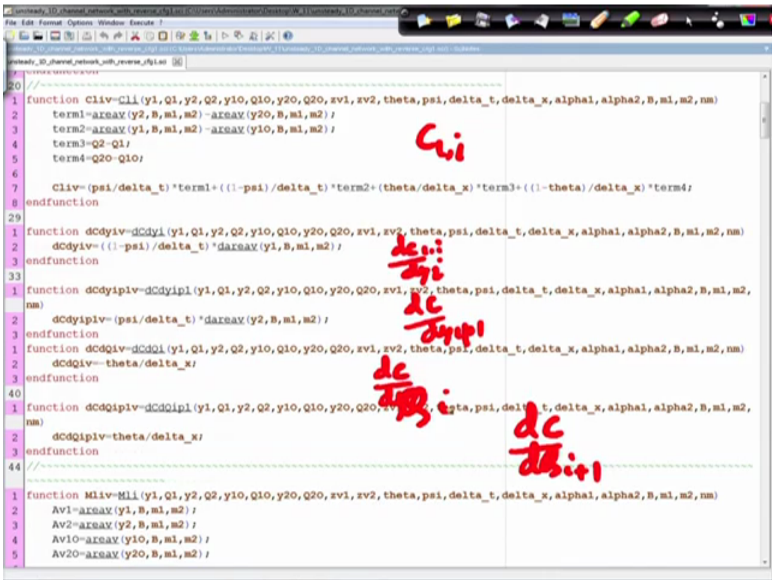


Now within this again we need to specify this ML i. This is ML i N N plus 1. Next is specification of dM by dy i. This is dm by dy i plus 1.

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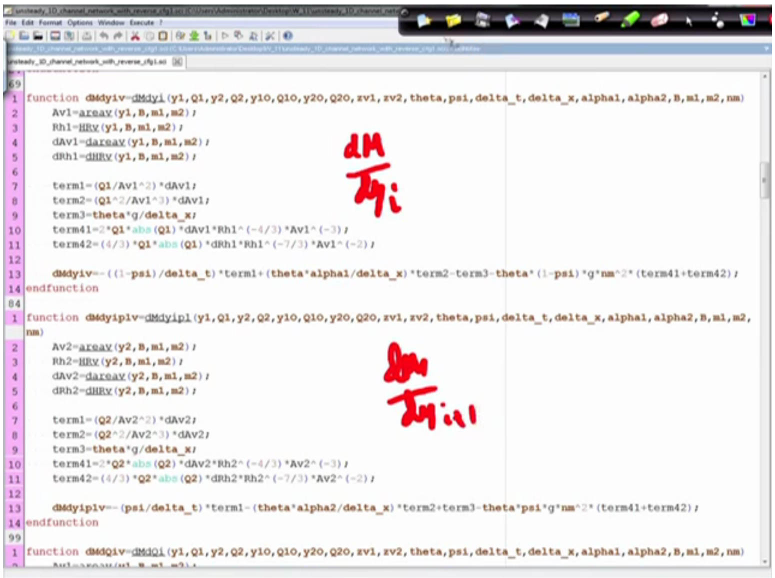


After this calculation interestingly please note here that we have used this Q abs terms here, Q abs terms here.

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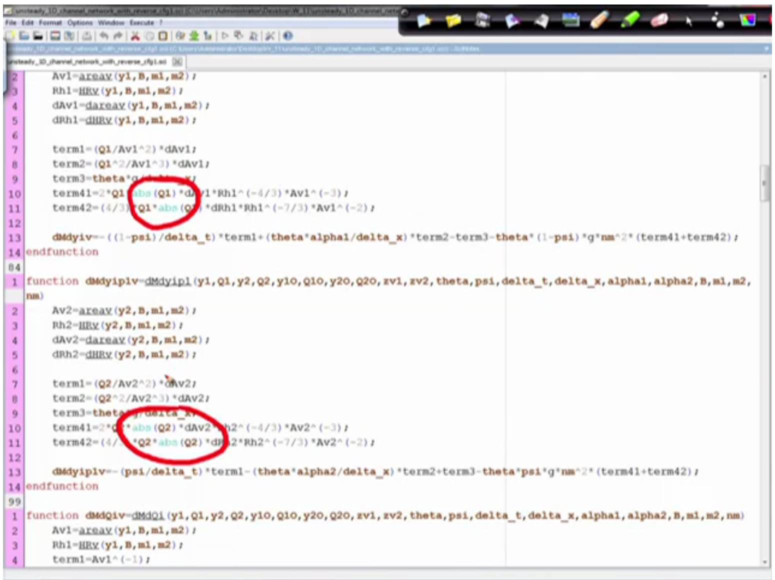

These two are Q this is dM by dQ i and this is dM by dQ i plus 1.

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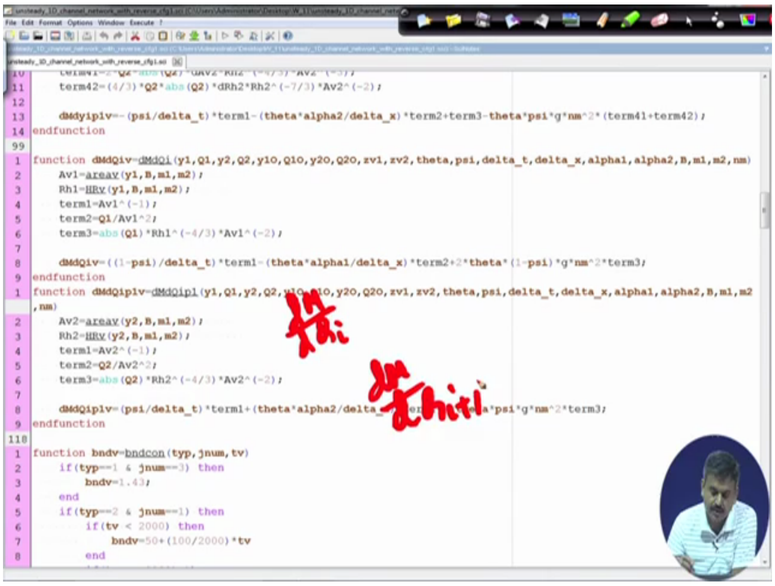

Now after specifying this we need to specify the boundary conditions. So what is this boundary condition function? This is boundary value function. This is boundary condition bndcon. This is type. If type is 1 so we will specify the depth. If type is 2 then we will specify discharge. Then junction number, depending on the junction number we can specify and tv or time value is required in this case.

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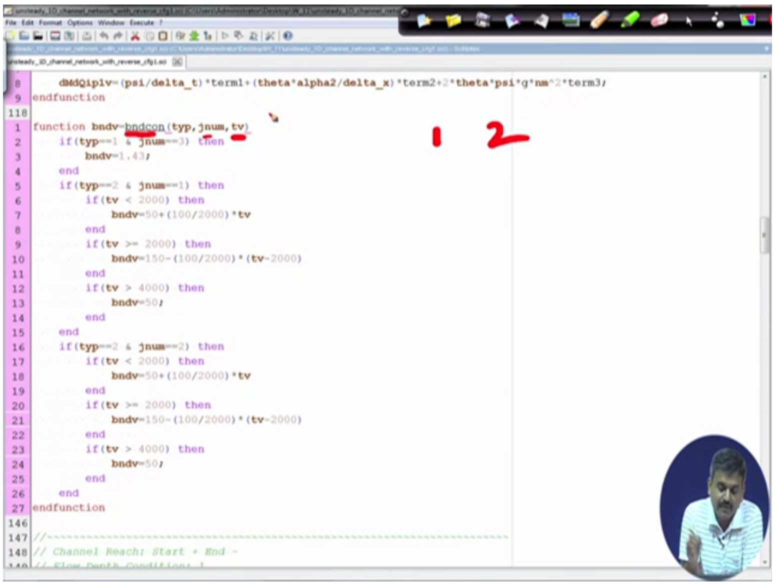


So type 1 junction number 3 we have 1 point 43 which is specified flow depth at the end point. Then it is type 2 and junction number 1. This tv is less than 2000 then starting from 50, 50 plus 100 divided by 100 because it is ranging from 50 to 150. So 100 divided by 2000 into tv. This tv is greater than equal to 2000 then 150 minus which is the maximum value, minus 100 divided by 2000 into tv minus 2000. And tv is greater than 4000 then this is fixed value 50 metres cube per second.

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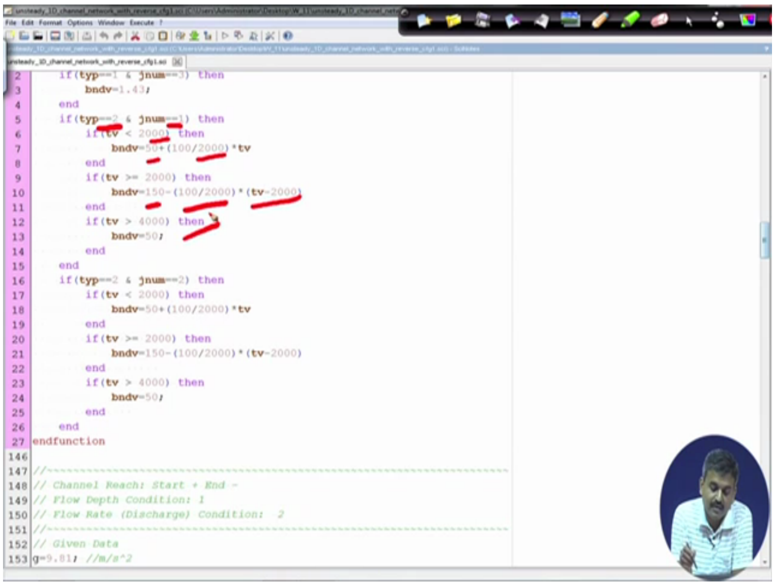


The same thing is specified for junction number 2 which is again boundary junction. So with our initial information let us say this is our g value, eps max, t max, delta t. Delta t is 250 seconds and theta is point 5, psi is point 5. So theta equals to point 5 and psi equals to point 5 and junction number is 4. Boundary junction, we have three boundary junctions. Channel number is 3.

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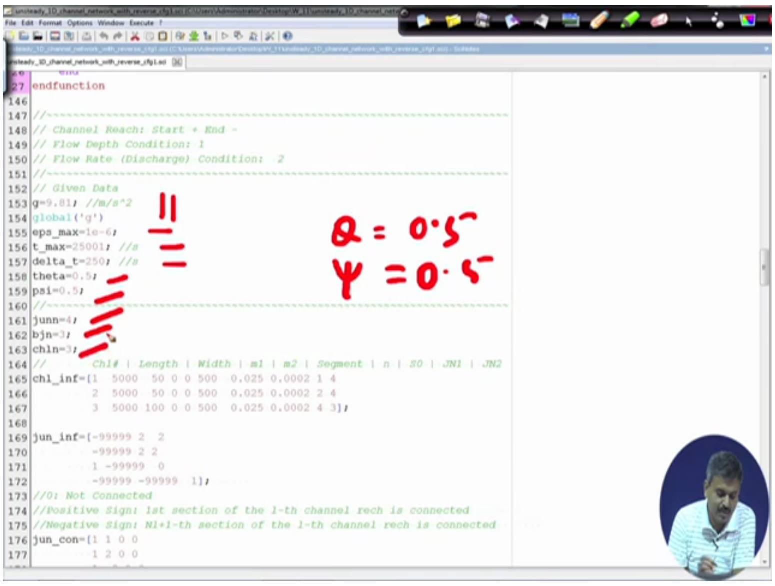


Now this is our channel information matrix, junction information matrix and then we have this junction connectivity matrix. Alpha for each channel we will consider that alpha is constant and equals to 1. So this value is 1.

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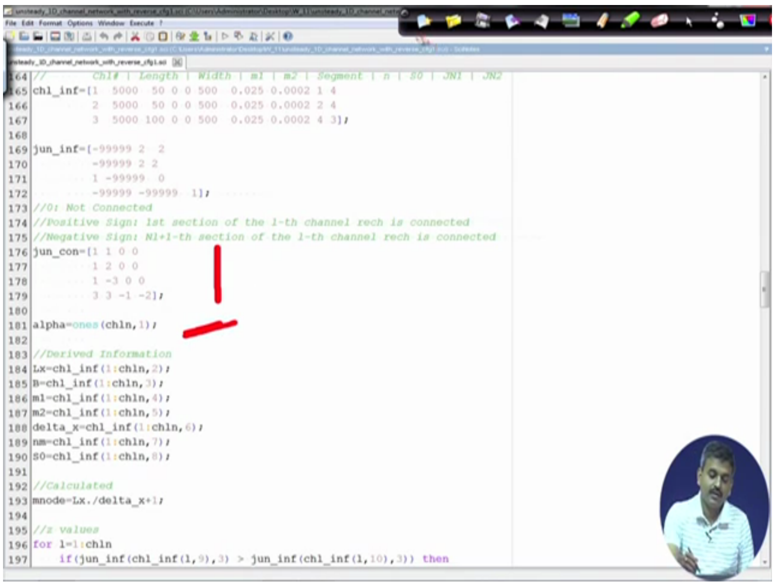

Now we can transfer these values Lx, B, m1, m2, delta x, nm and S not from this channel information matrix directly and mnode we can calculate Lx by delta x plus 1. That will give us mnode or total number of sections for a particular channel.

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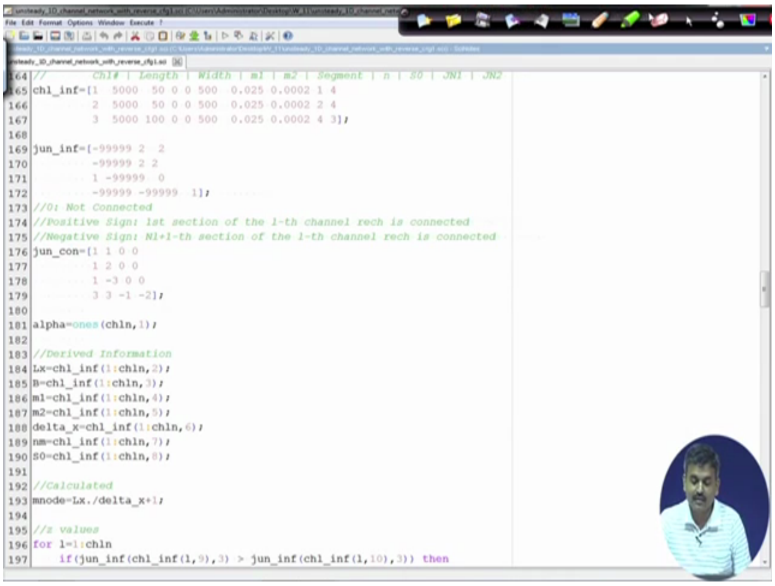


Now z values, we need to calculate these z values as per our previous calculation thing. That if connectivity this one junction information this channel information L 9. L 9 will give us the starting junction. This is 3, (cha) this junction information is giving the elevation at third column. So starting elevation is more than the ending elevation then this factor is negative because we are starting from that section. Or this factor is positive if this one is less than the ending or elevation of the end section.

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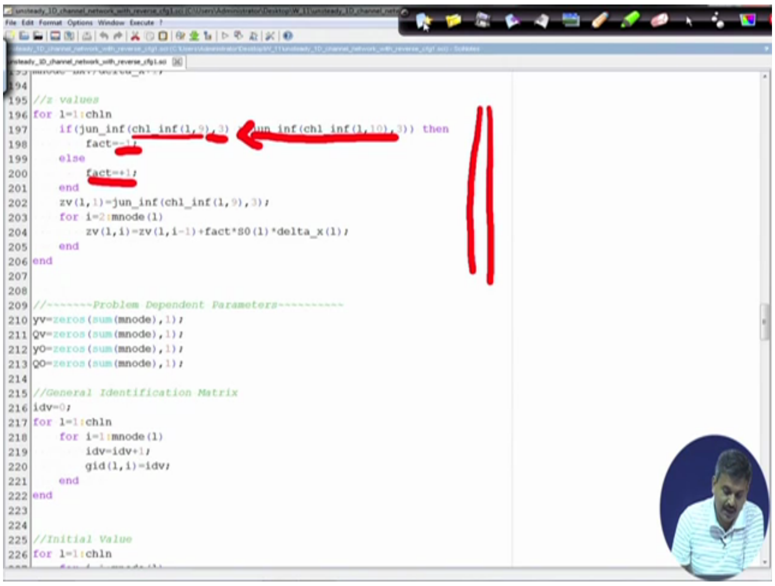


So we need to specify Qv which is Q value at future time level. Yv, Qv, yO or yOld, QOld and we have this general identification matrix gid which we have utilised for our steady state case also.

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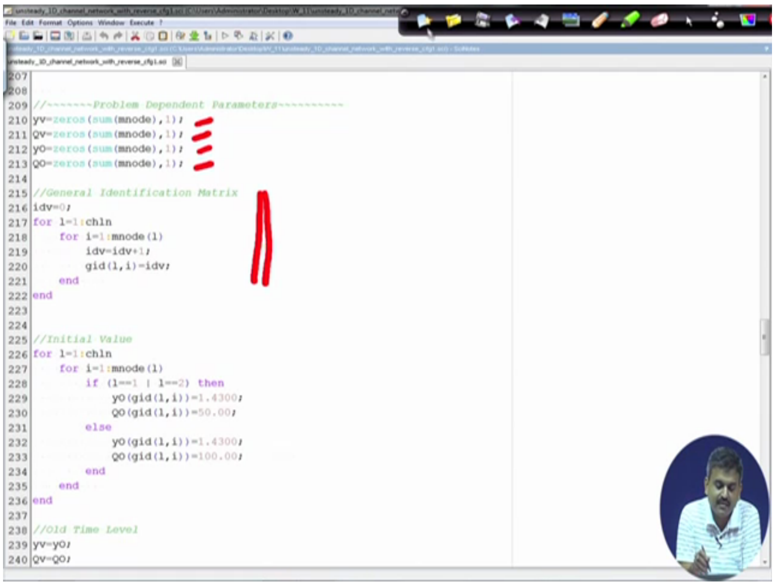


Now in this case we need to specify initial values. This is 50 and 1 point 43 for L that means channel 1 and 2. And this is 100 and 1 point 43 for this channel 3.

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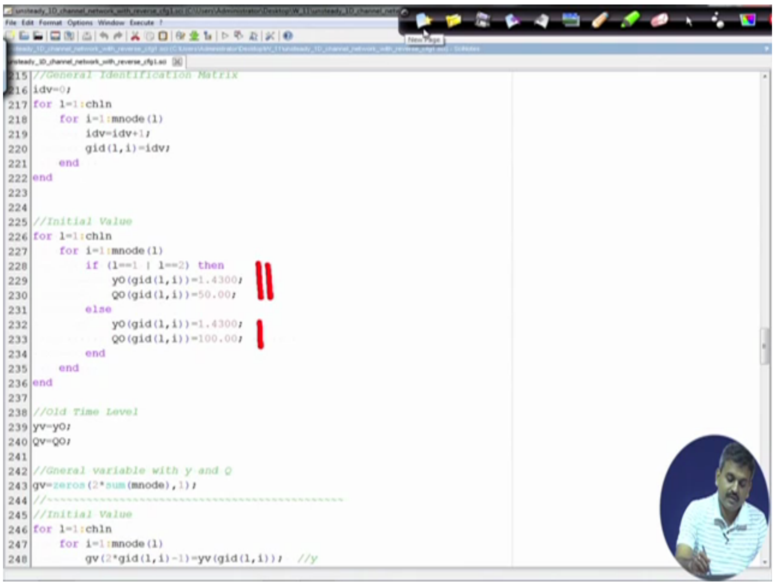


Old time level values we are taking this as guess value. We are starting this. Now we have defined this general variable and we can transfer these values to the general variable. After that we can start our time loop. This is our time loop, this is our space loop.

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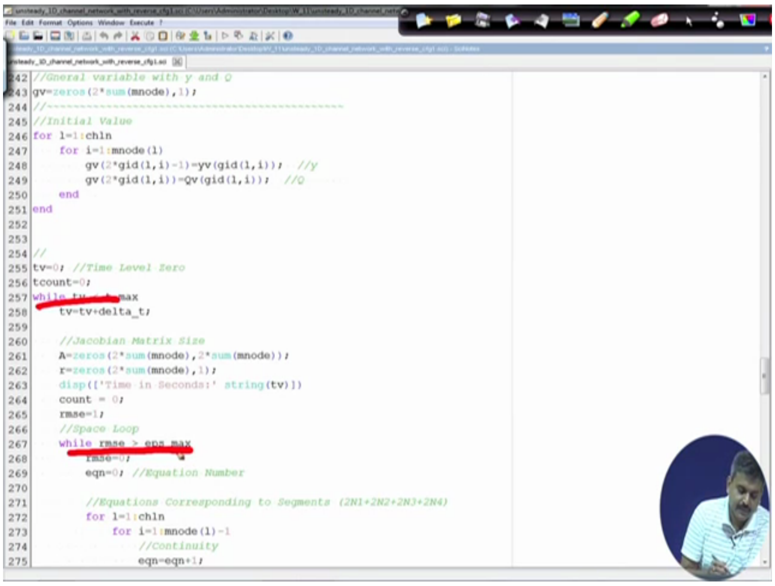


So after starting at tv equals t zero and t count this is time counter equals to zero, after entering we can increase this time value tv equals to tv plus delta t and we can specify over Jacobian matrix A and right hand vector which is r. Time display, time in seconds, count equals to zero, rmse equals to 1 to enter into this space loop.

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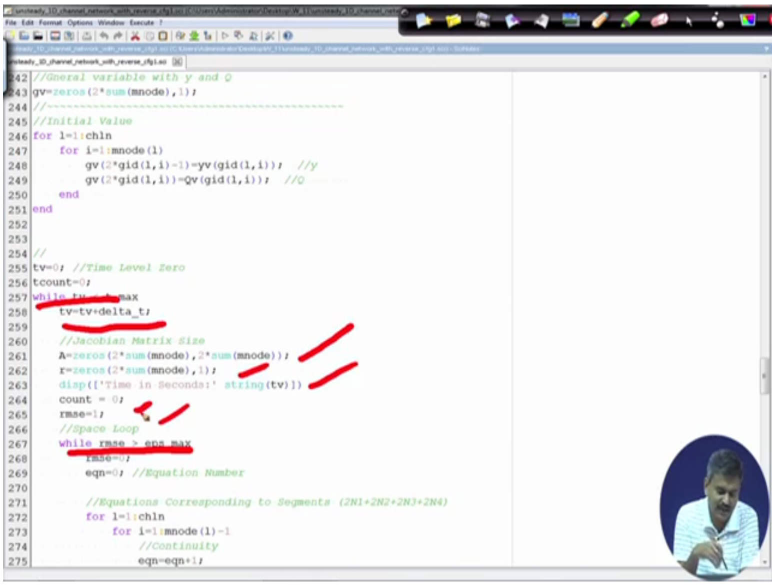


After entering into this space loop rmse greater than epsilon max, rmse is equal to zero, equation number equals to zero. Then we can start adding equation number when we will be writing the equations for continuity.

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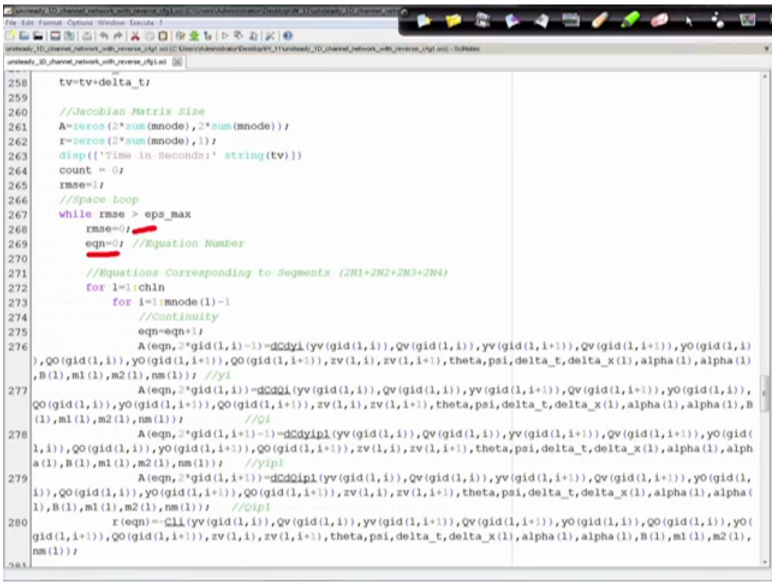


So this is for continuity. Obviously too many (thi) input variables are required for dc dy calculation. So this is first one, this is second one, this is for y i, Q i, y i plus 1, Q i plus 1 and this is minus CL i.

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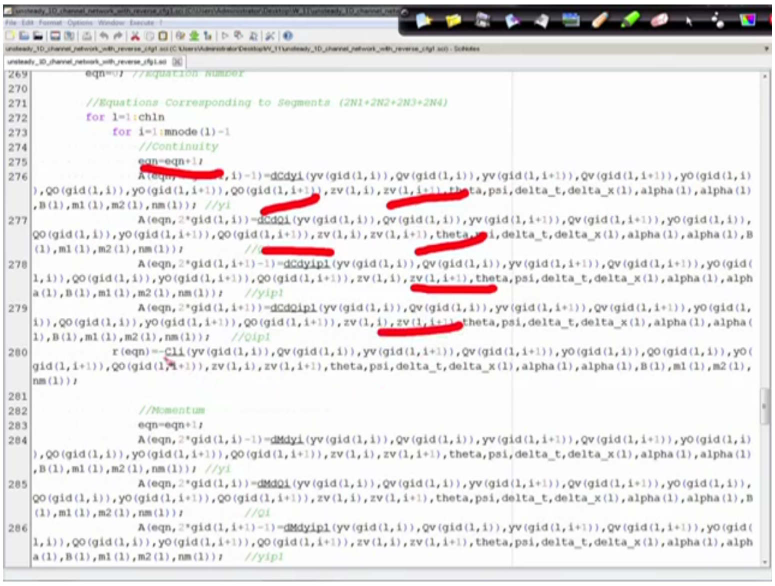


This is for momentum, for momentum we have this dM by dy which is for y i, Q i, y i plus 1, Q i plus 1, this is minus ML i.

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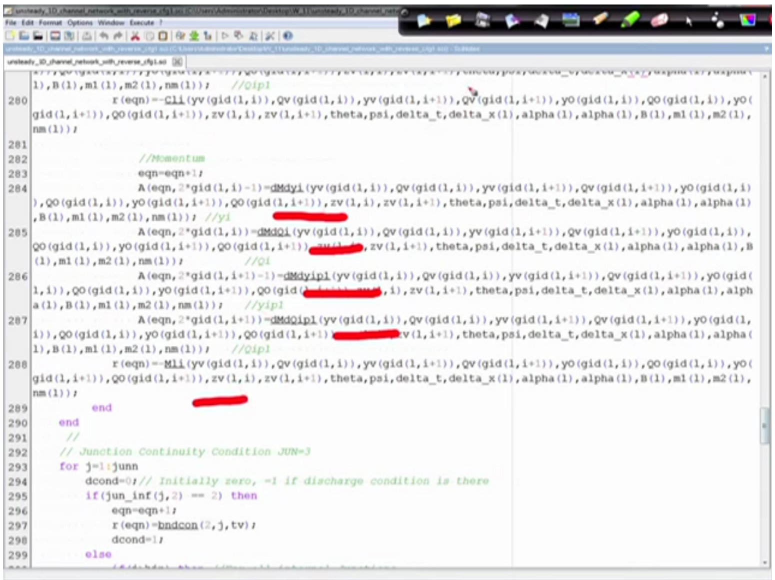


So after getting this 2 into N1 plus N2 plus N3 number of equations we should try to get the junction conditions. So first one is for d condition which is our condition in this case. Initial is zero if discharge condition zero equals to 1 if discharge condition is there. That means if discharge condition is there for boundary nodes then only we should utilise this otherwise we should omit it. If in junction information j2 that means column 2 if it is equals to 2 that means our discharge is specified.

We should calculate the discharge from boundary condition bndcon function and I will just change this d condition or dcon value to 1.

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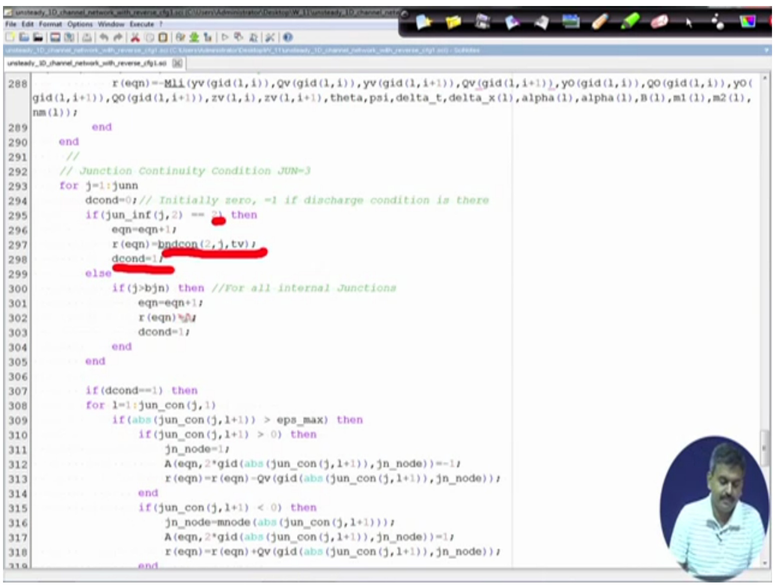

If junction number is greater than bjn that means boundary junction then this r eqn that is equation number that should be zero because we do not have inflow condition from somewhere. So we will have only the variables. So we should start with the zero value.

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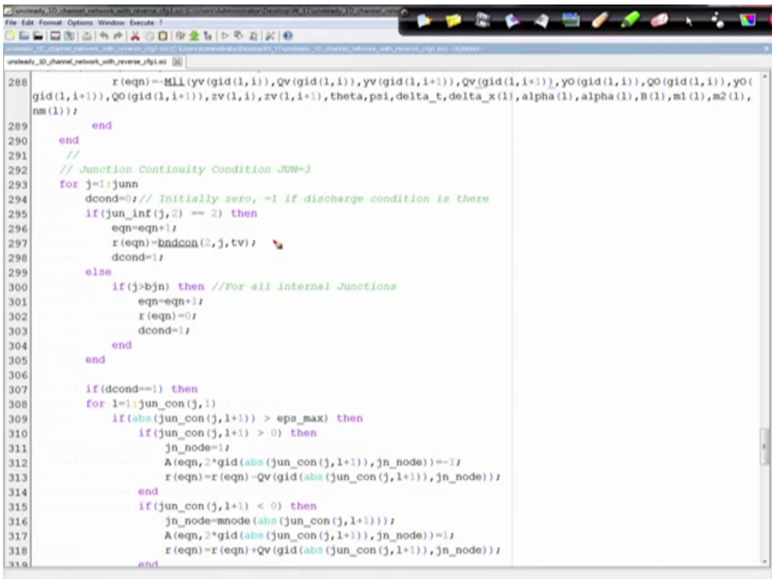


Now if this dcon or discharge condition equals to 1 then only we should iterate here. Now if junction condition or (connec) junction connectivity depending on whether it is positive or negative we can identify this starting and end nodes and we can add with r eqn equals to r eqn plus Q values or subtract this one Qv.

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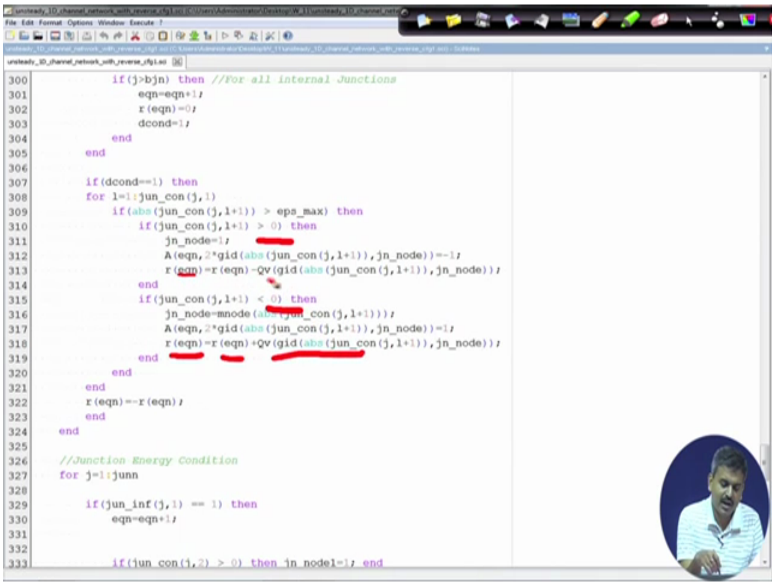

For each junction node or internal junction node or boundary junction node we will have one discharge equation or discharge continuity equation. But if we have flow depth condition specified at the end section of 3 then we do not need any discharge condition there. Then we should omit that point. For junction energy condition if junction information 1 that is first column equals to 1 somewhere so then we should specify this boundary condition value directly and we should directly specify that value into this yv.

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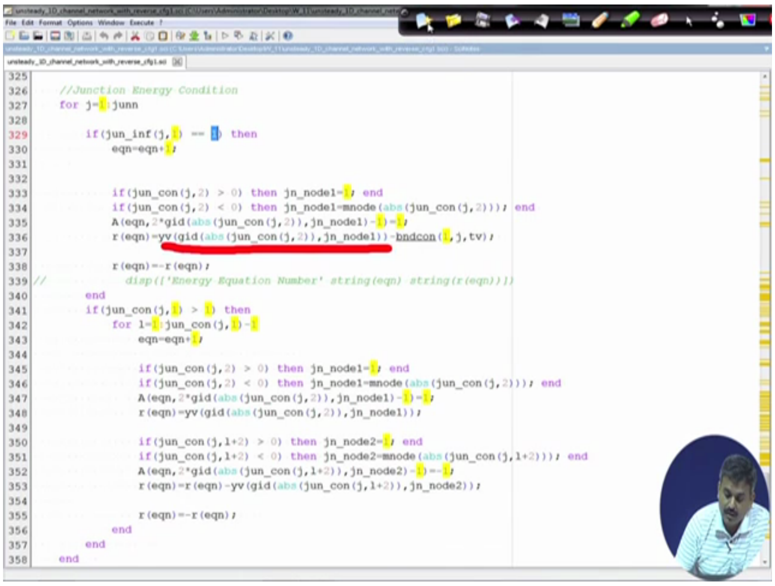


Now in this case if this condition is not satisfied and junction connectivity this one first column we have more than one entry that means let us say for internal junction we have three nodes available or three channels available. Then we should write at least two energy conditions for that one. So that is why I have written L equals junction connectivity minus 1. That means 1 to 2. That means at least two conditions we should add. We have three connected channels so we will have two conditions.

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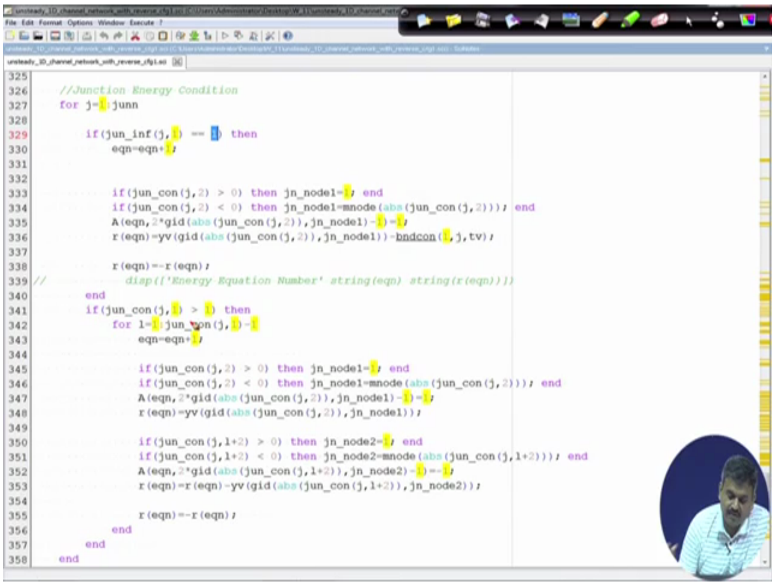


Now after writing this finally what we have to do? We have to calculate this del yQ and we have to add this del yQ with gv. Gv is general variable in our case.

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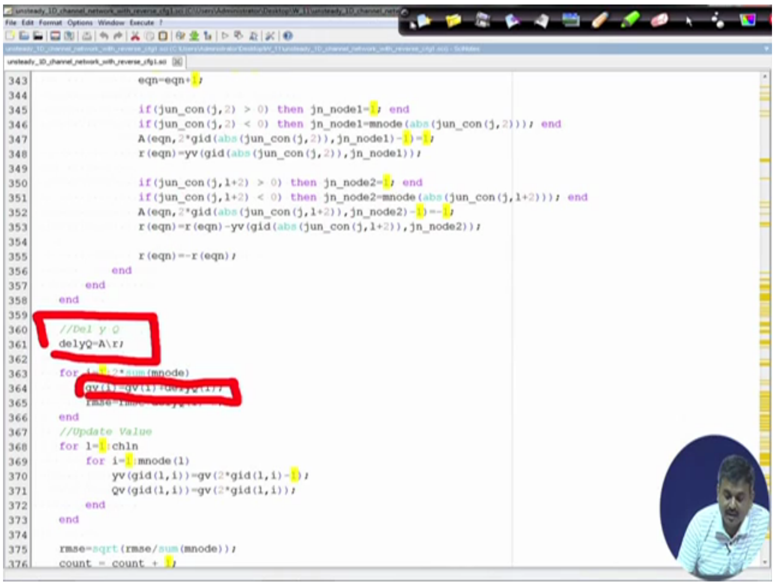


Now after adding this we need to update these values because updated values should be transferred to yv and Qv so that we can utilise these values for next iteration. And we should also calculate this rmse because if rmse is less than epsilon max we should terminate this one.

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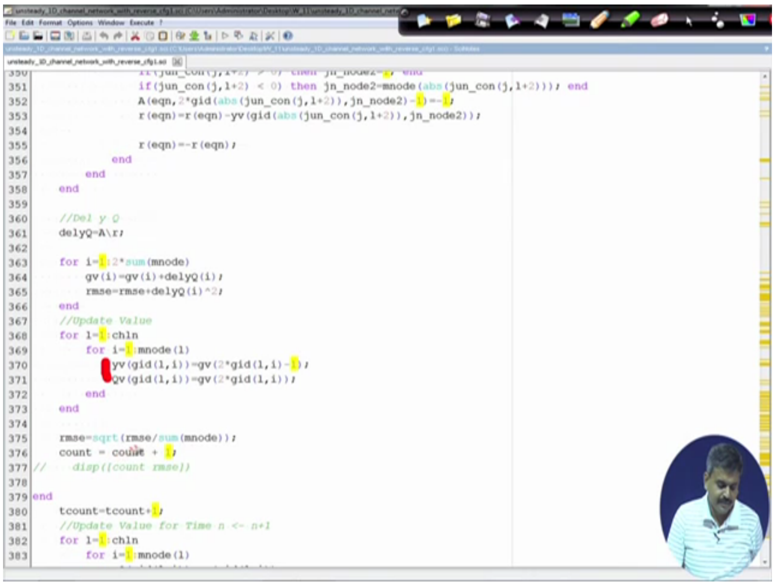


So after termination of this space loop we should update our time loop value because this new time value will be old time value for our case for the next time loop iteration. So update value for time n which is again specifying the value n plus 1 to nth level. And I have stored these values which is yv at 31 which is equivalent to x is equal to 4000 and I can utilise this value for plotting so that I can get the desired plot for this one.

If you have 100 as del x then yv and Qv should be calculated at 143. If it is del x is 43 then yv and Qv should be collected at 283 to get the information about x is equal to 4000.

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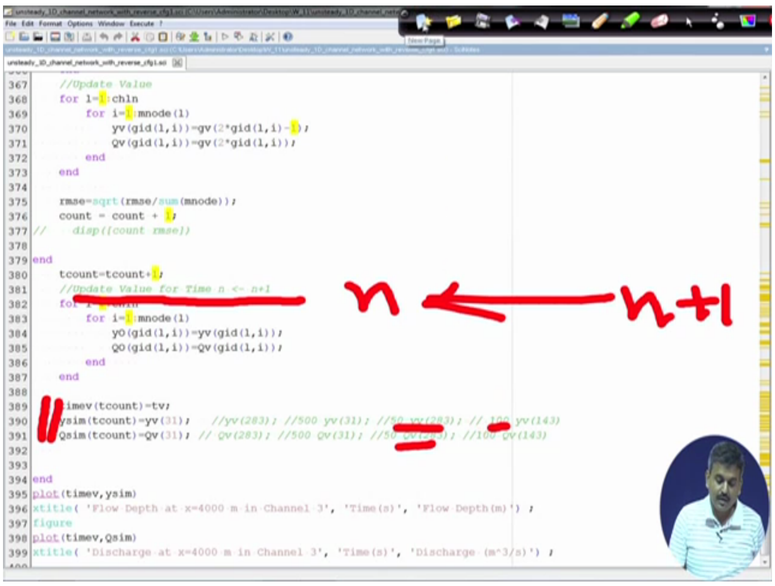

Now at that point if I run this one so time in seconds, so time is increasing so after each convergence in the space loop the time is increasing here. Now in this case we can see that two plots are there. One is for flow depth.

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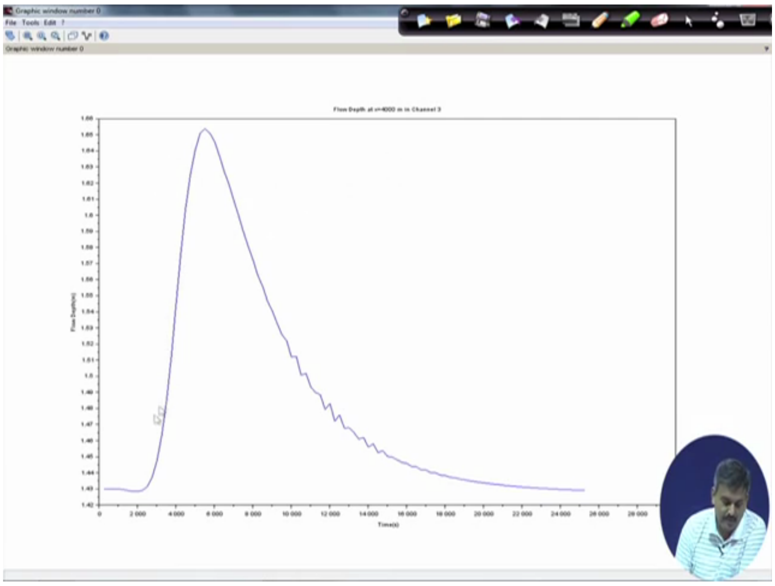


So what flow depth we are getting? Starting from 1 point 43 here this flow depth is reaching up to 1 point 65 and above. But it is below 1 point 66. And again there is decrease because we have considered one inflow discharge at upstream. So obviously there will be increase in the depth initially with a lag, this much is the lag.

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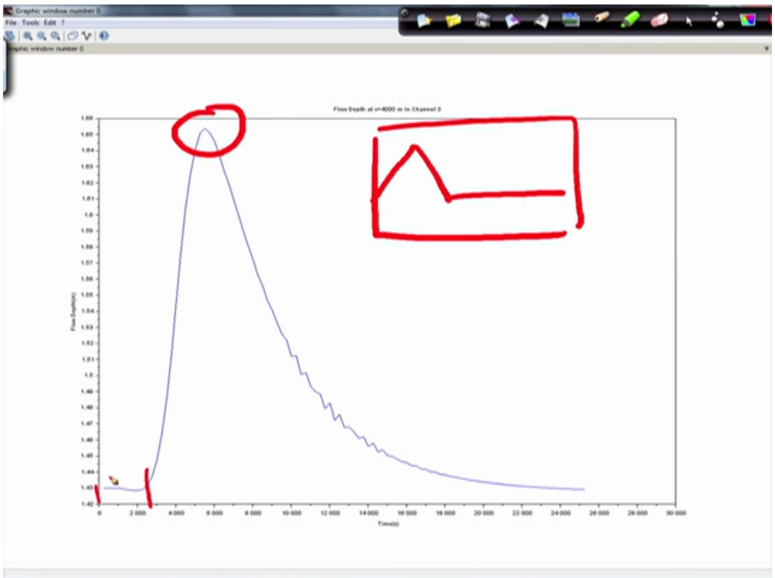

And finally there will be decrease in the depth level. But in this case we can see that some variations are there in depth.

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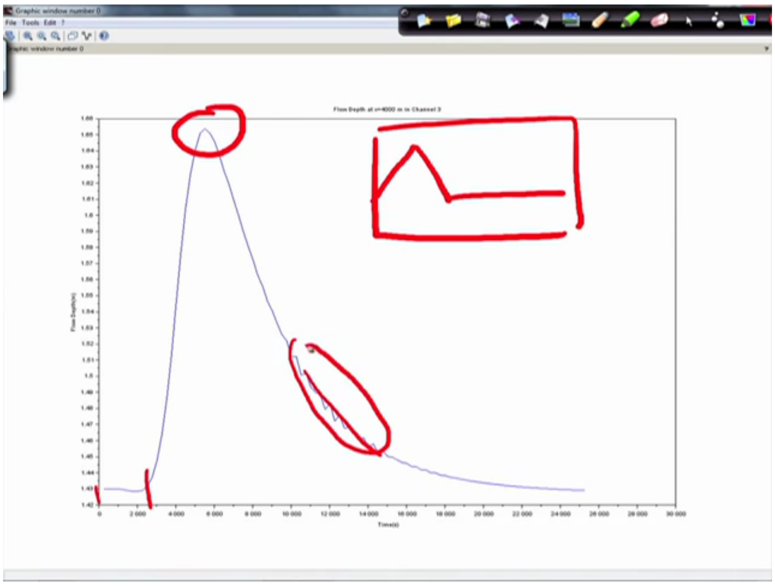

We can change theta and psi values to get different values here for depth. In this case this is a discharge plot. It is starting from 100 because we have specified 100 metre cube in this case. So this is our plot that we have got.

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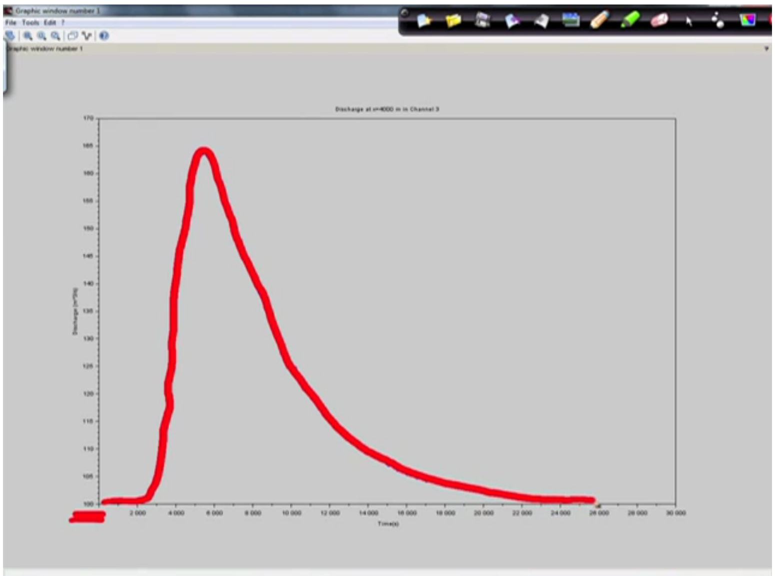

So interestingly it is reaching up to 165 metre cube per second. And again this discharge values are decreasing here. Initially there is rise in the discharge obviously because of the inflow condition, the upstream junction nodes at 1 and 2. But finally discharge values are decreasing again reaching to that 100 metre cube per second value.

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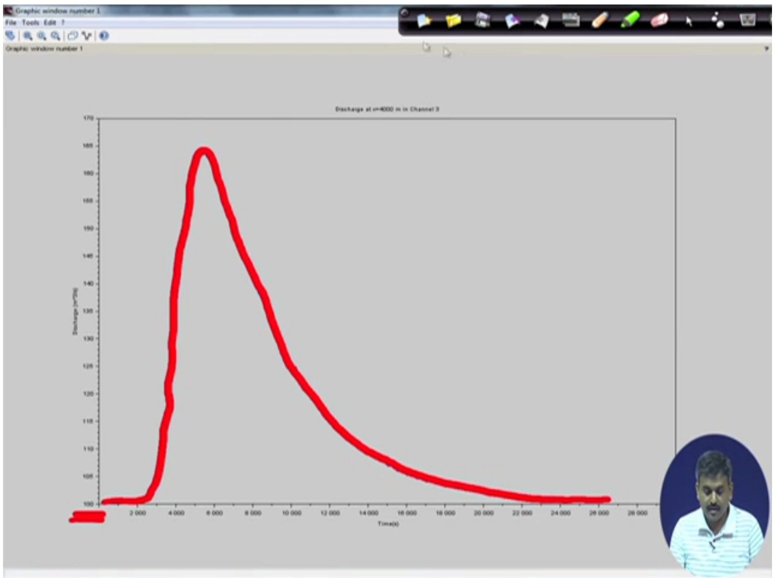

So this is all about our unsteady channel flow problem. Now you can utilise this source code unsteady 1D channel network with reverse cfg1 because we have used only configuration 1 in this case. And try to simulate the same problem with different theta and psi values. In this case I have utilised theta equals to point 5 and psi equals to point 5 but you can change the values of theta and psi and check the stability of the problem.

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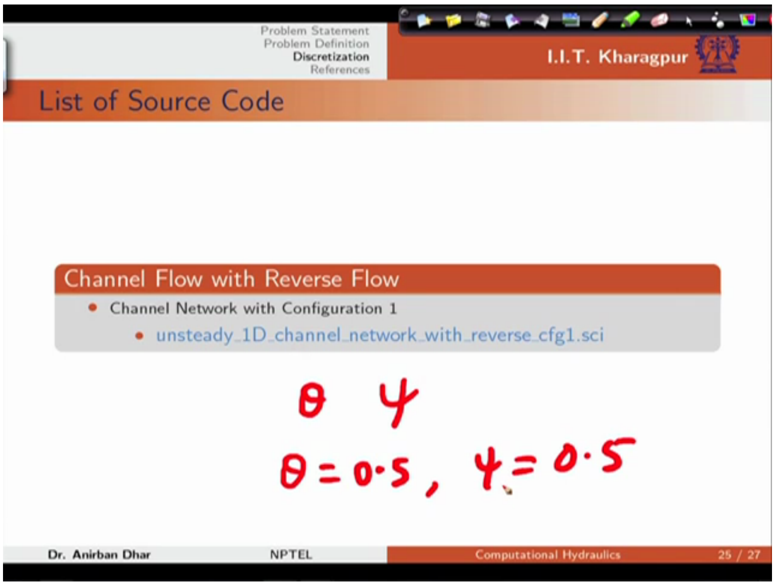

So obviously as per literature this problem this theta and psi if I start from zero to 1 in this case, if this is my psi and this is theta so obviously this part is unconditionally stable part.

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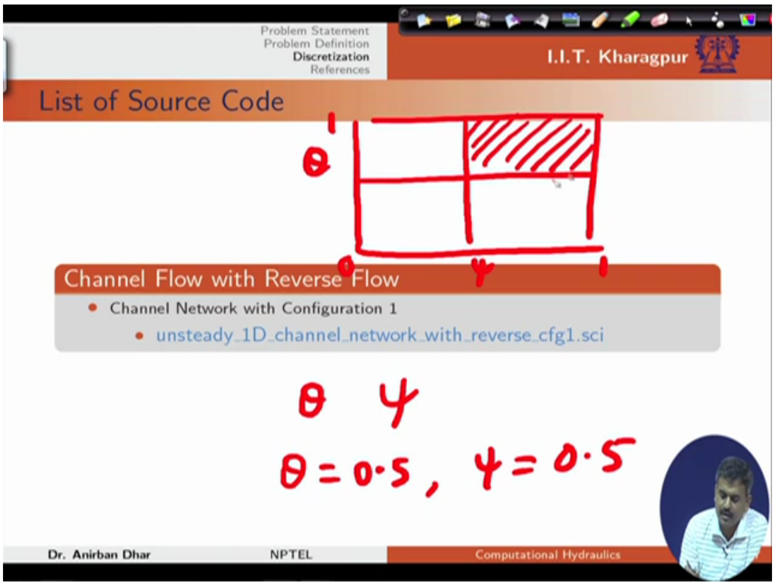


That means if both the values are more than point 5 then I have unconditionally stable situation. But check what is the solution if I change the values or I decrease one value with respect to another? Thank you.