DC Operating Point, I-V Curve Trace

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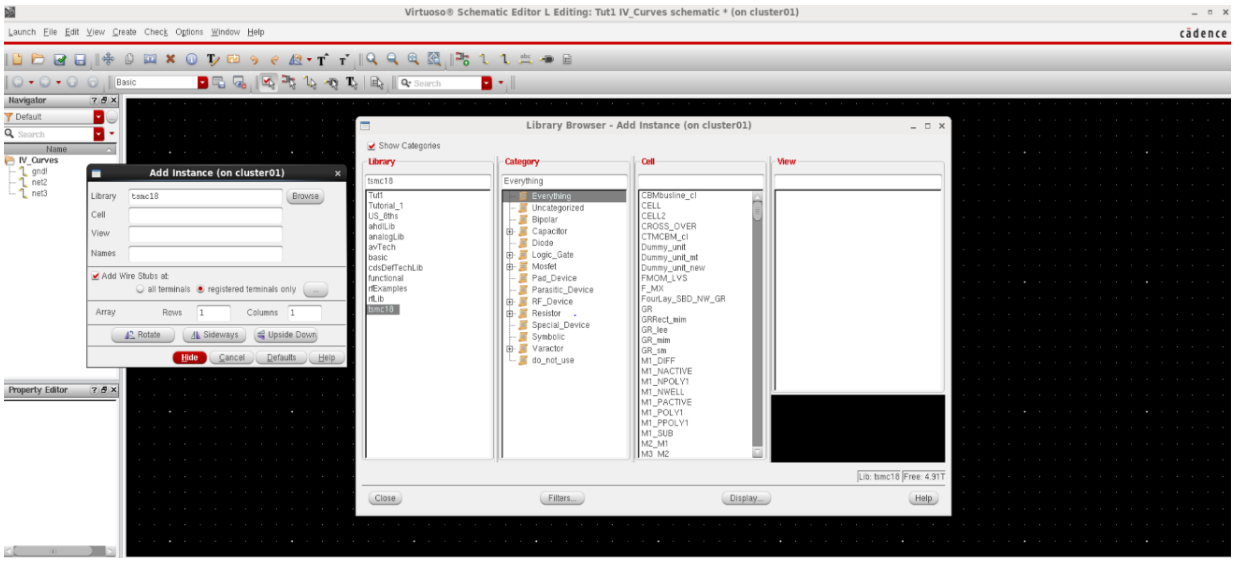
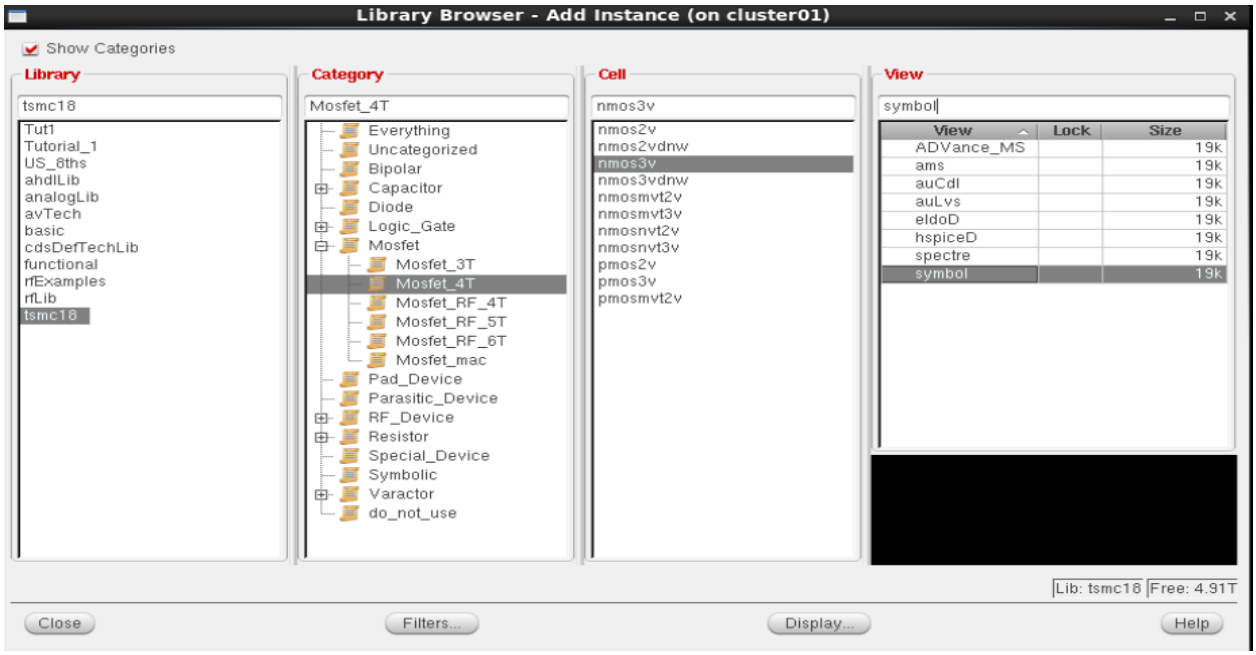
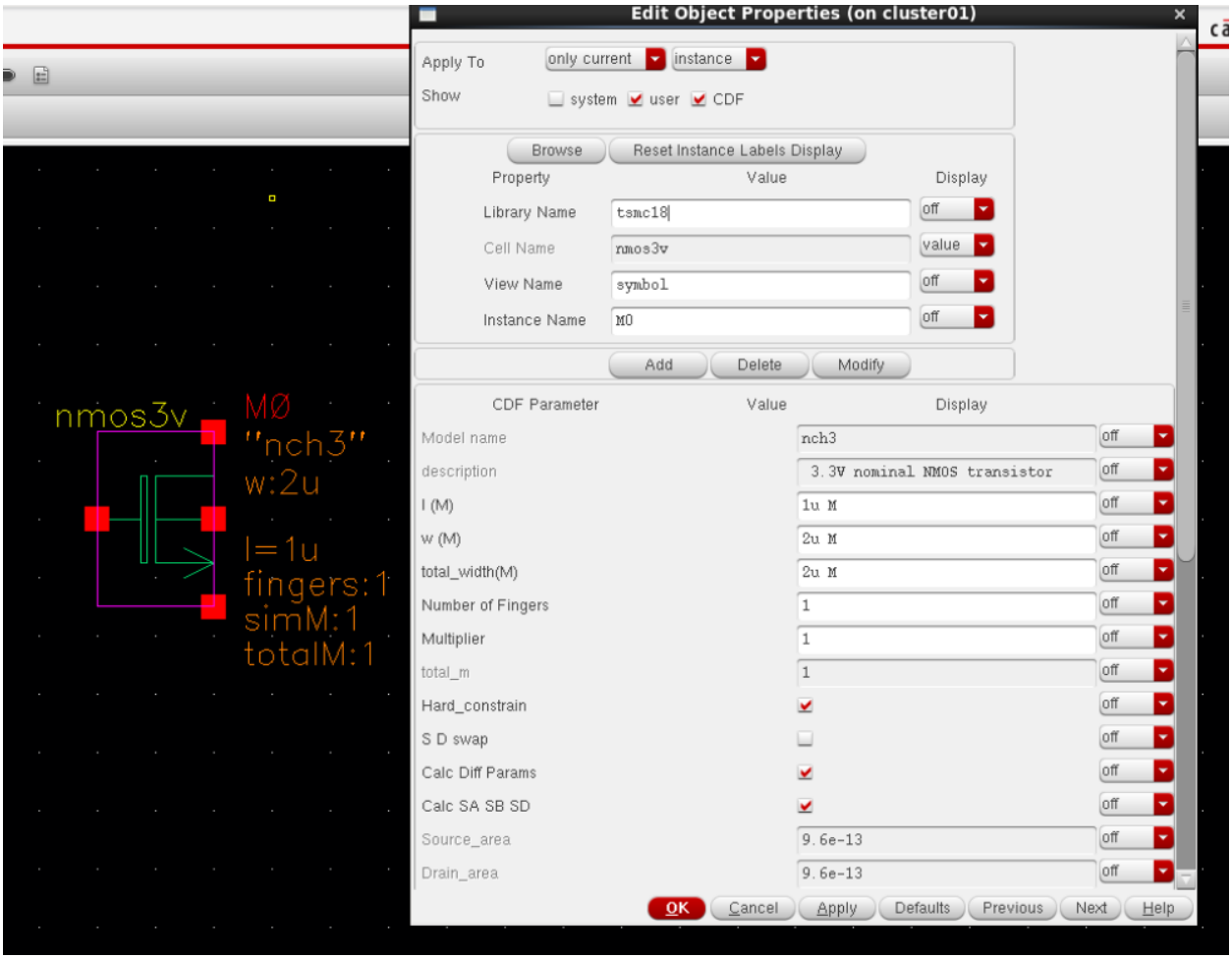
Description: This tutorial demonstrates how to print the DC-Operating Point as well as trace the I-V curves for a transistor in the tsmc 180nm process. Also, it demonstrates how to save a state for the ADE.



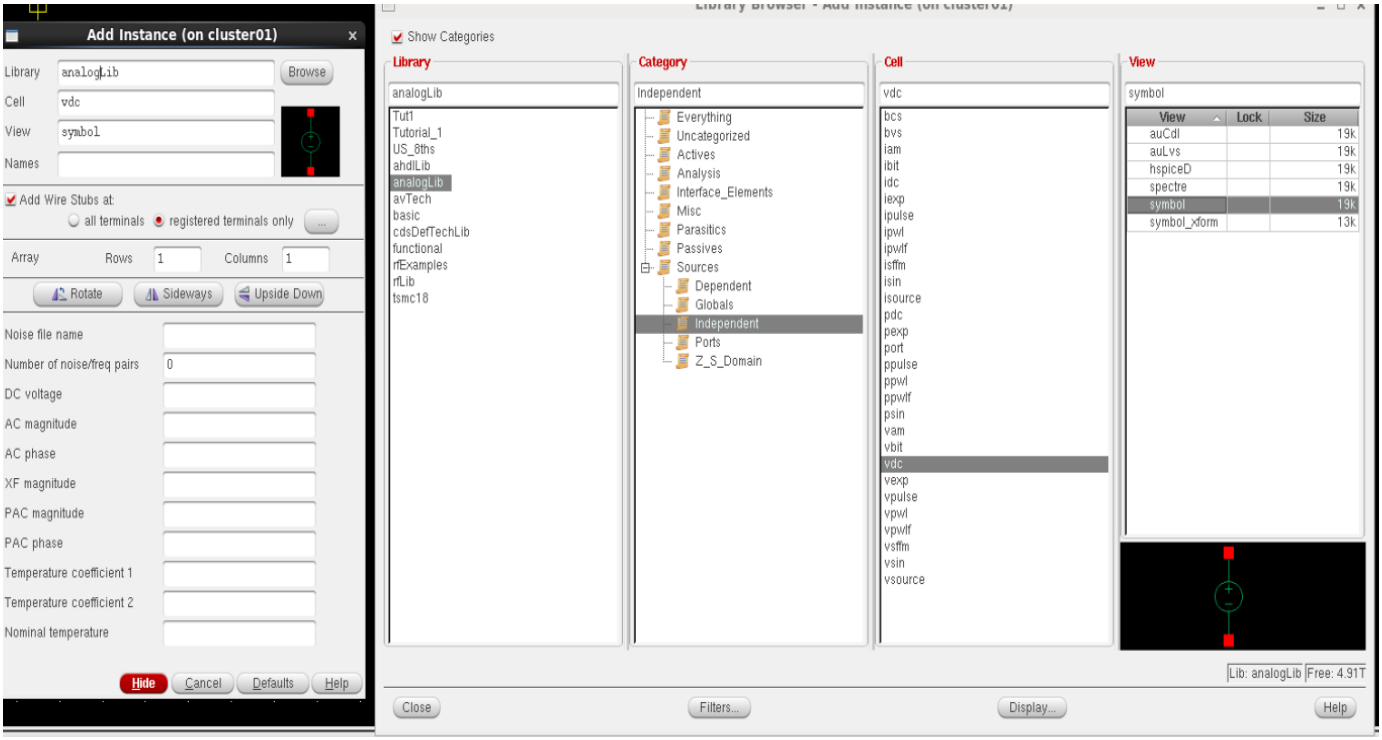
1. Press **i** to Add Instance → **Browse** → **tsmc18** under Library column



2. Under Category select **Mosfet → Mosfet_4T → nmos3v → Symbol**, after selecting symbol an outline of the device will appear on the schematic. Left click to place in the schematic

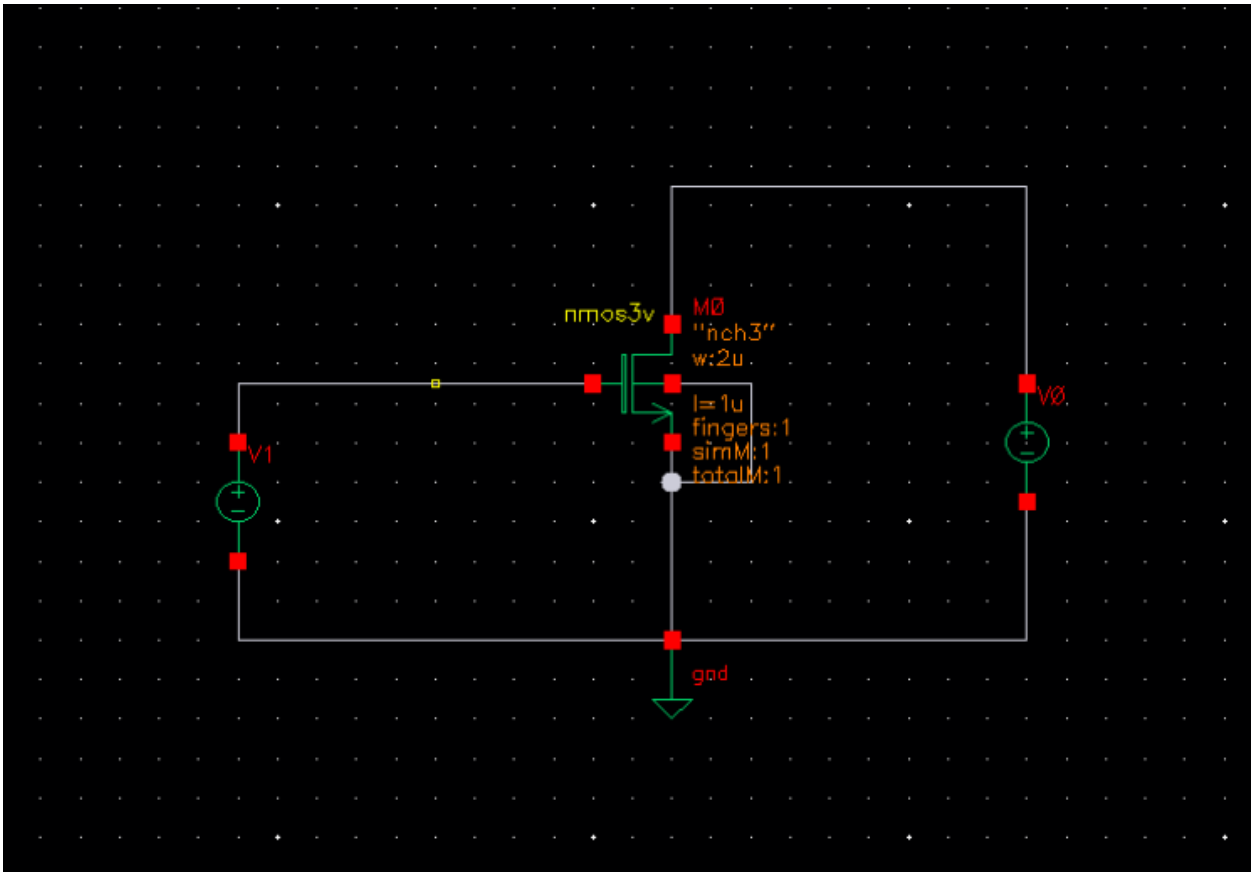


3. M0 will appear on the schematic, hit ESC to prevent placing copies. Select the transistor and press **q**, change the length to **1u**, and the width to **2u**, as seen in the picture above and hit **OK**

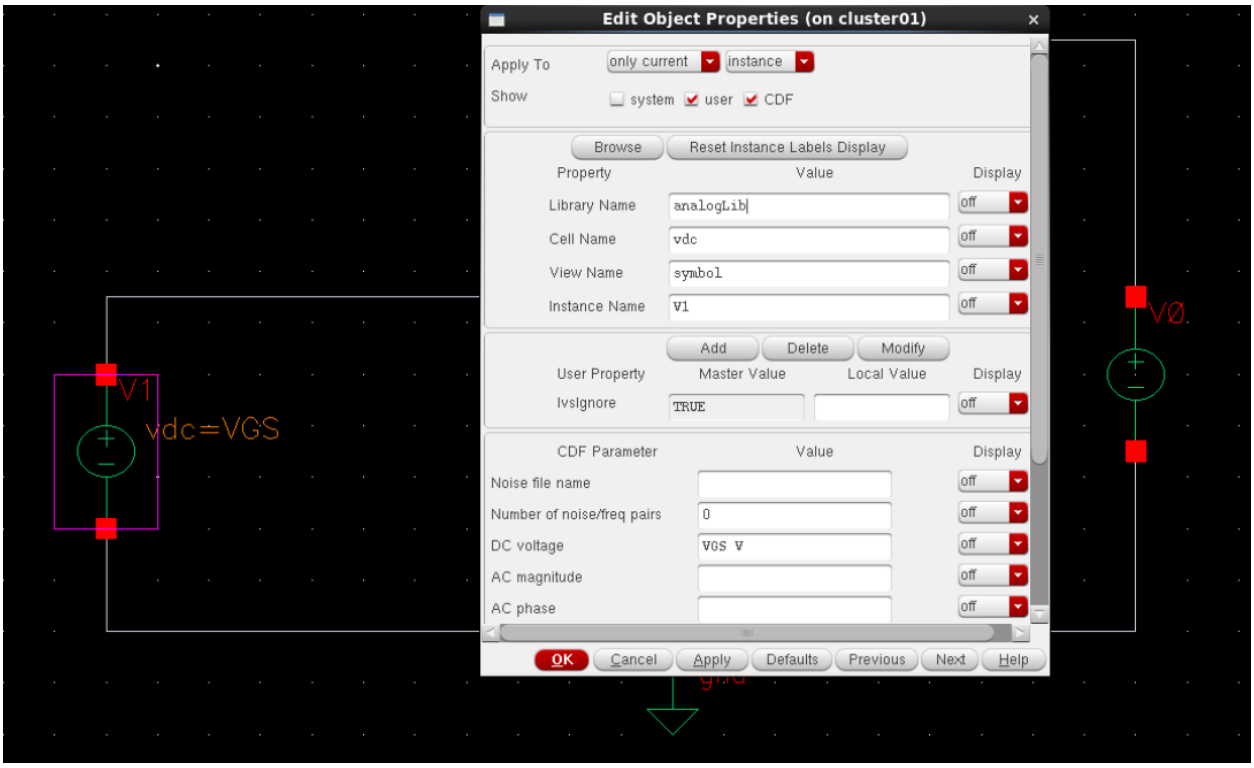


4. Now press **i → Browse → analogLib → Sources → Independent → vdc → symbol →** place two of these on the schematic.
5. Repeat step (4) but go to **analogLib → Sources → Globals → gnd → symbol →** place on schematic.

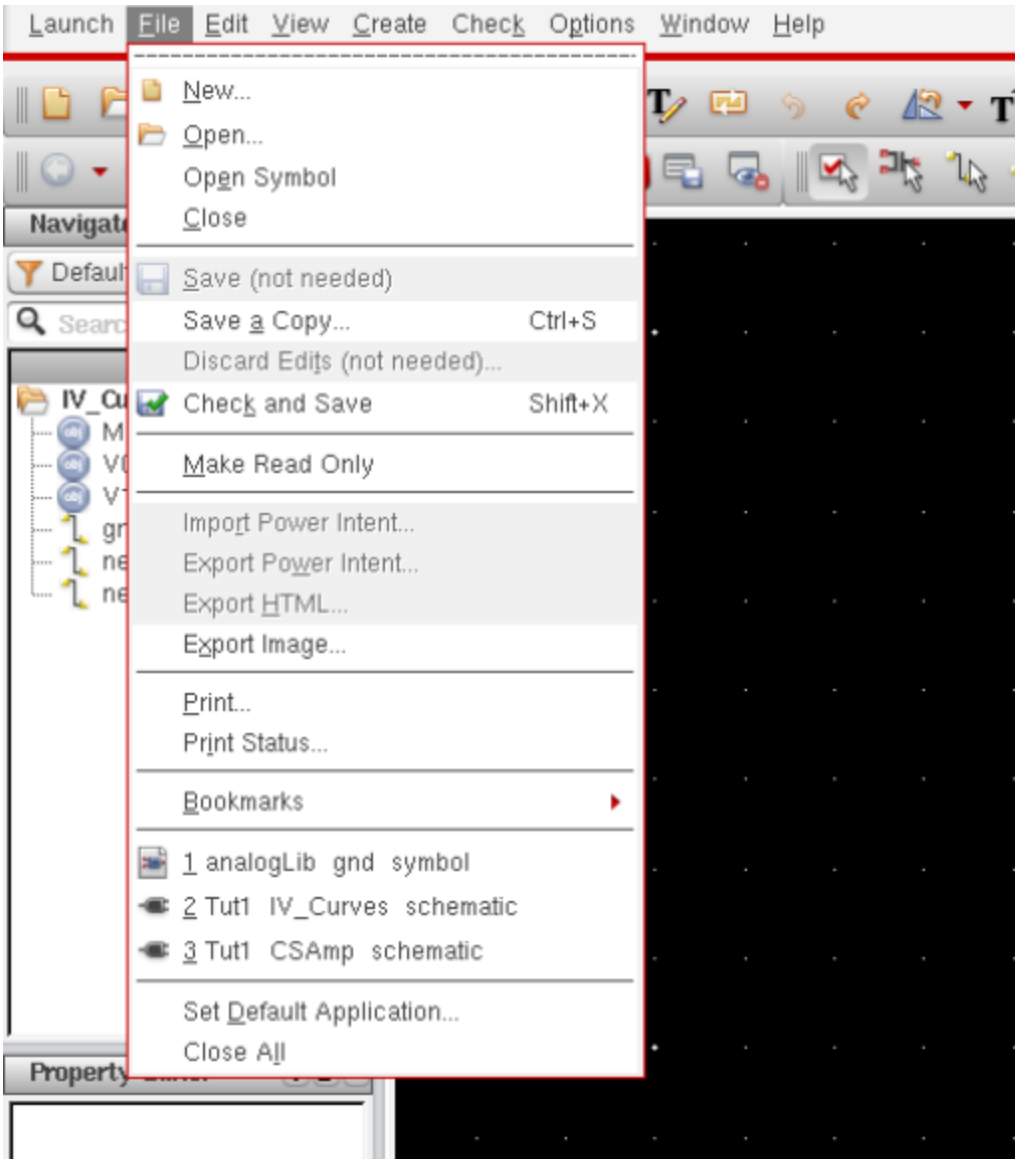
**Tip: If you accidently hit a bindkey, and you're not sure what is happening try hitting ESC a few times to reset.



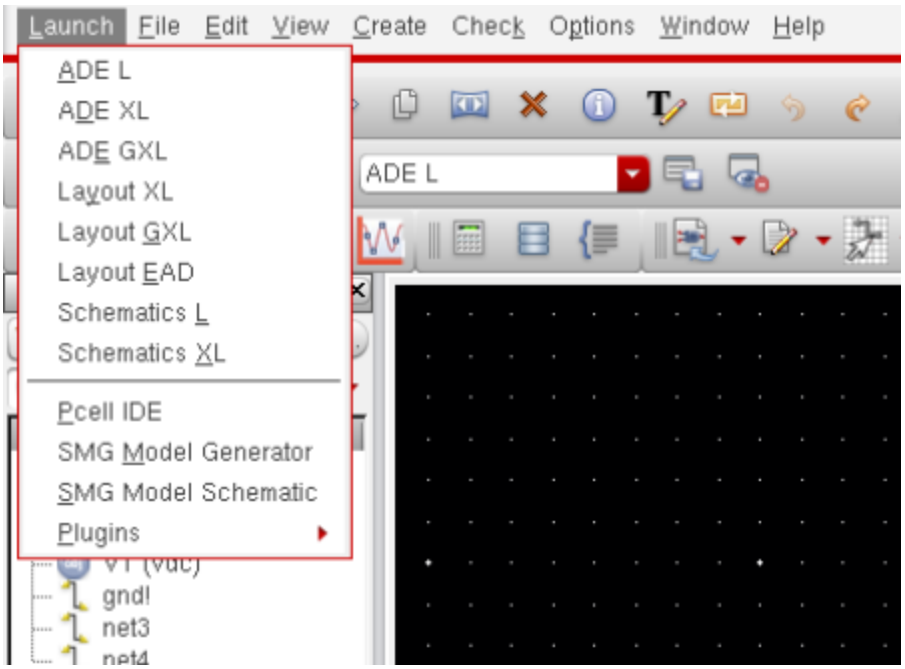
6. Press **w** (wire) to draw the connections between the two voltage sources and the transistor as shown in the picture above.



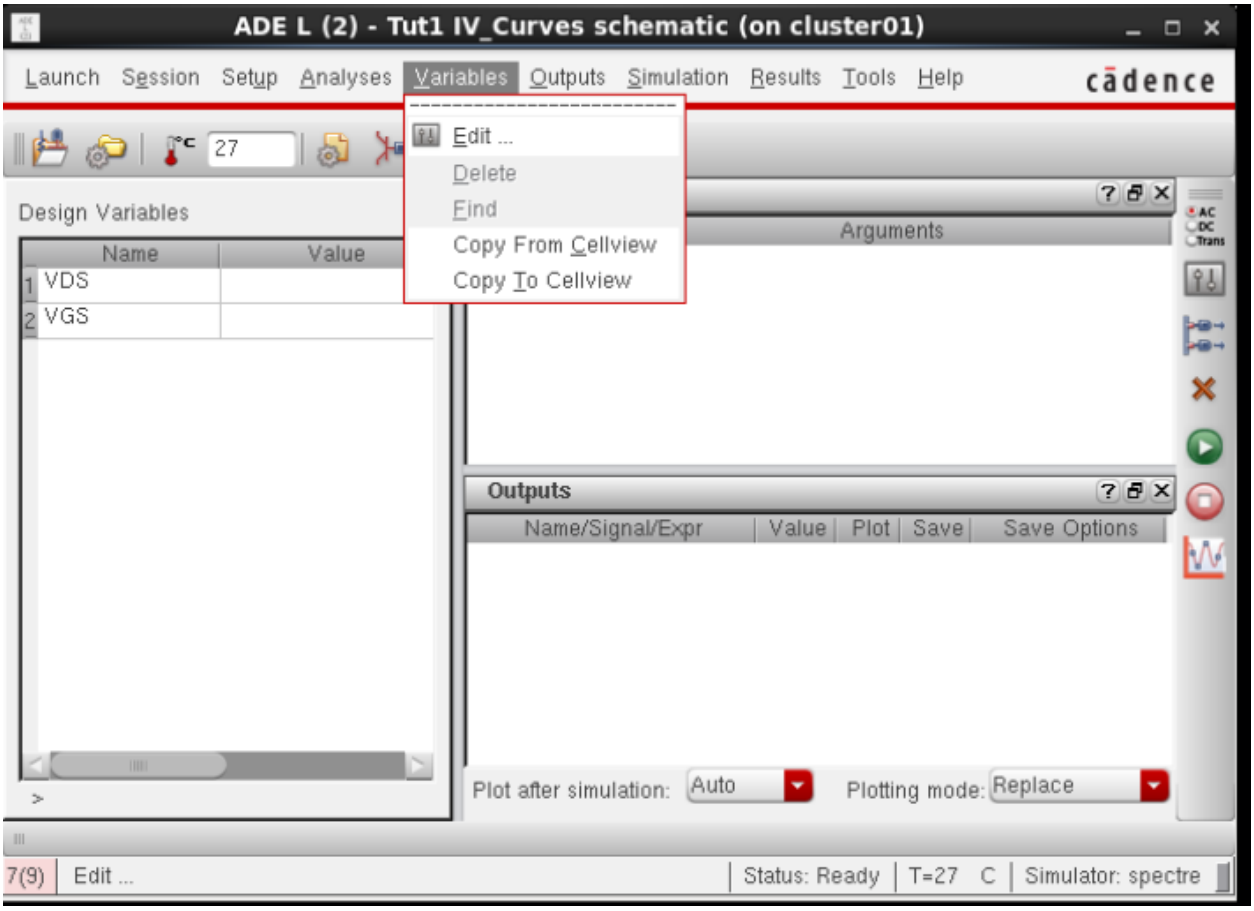
7. Select voltage source V1 and press **q** and change the DC Voltage to **VGS**
8. Repeat step (7) for source V0, but label the DC Voltage as **VDS**



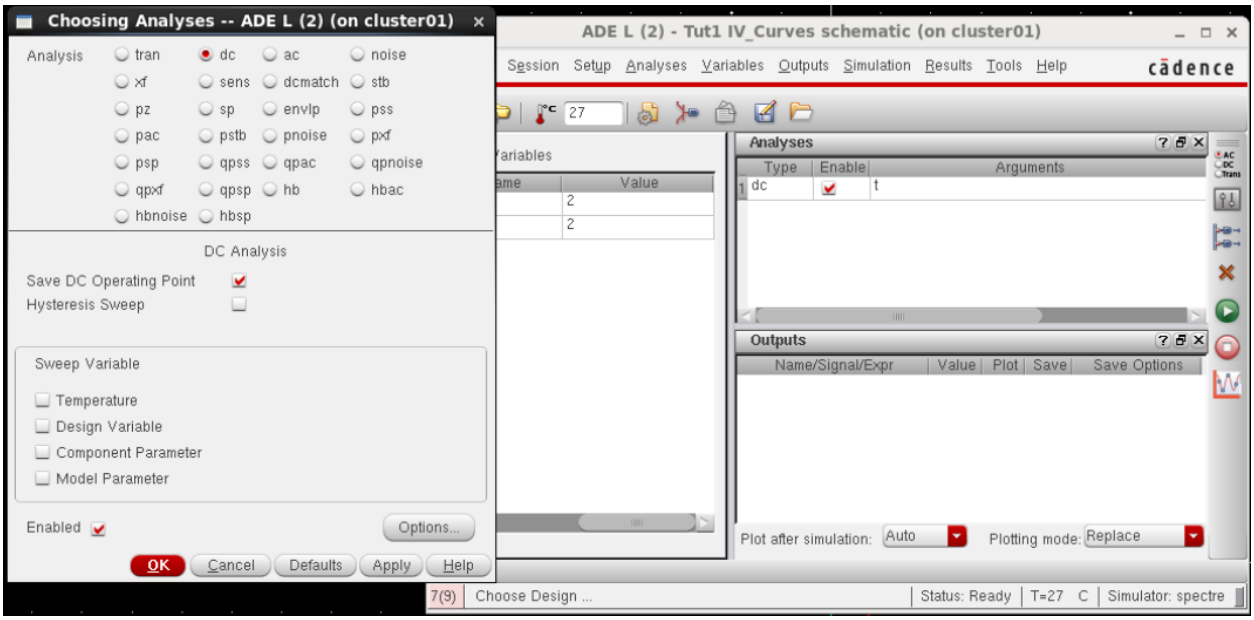
9. Go to **File → Check and Save**, or hold shift and hit x (**Shift+X**)



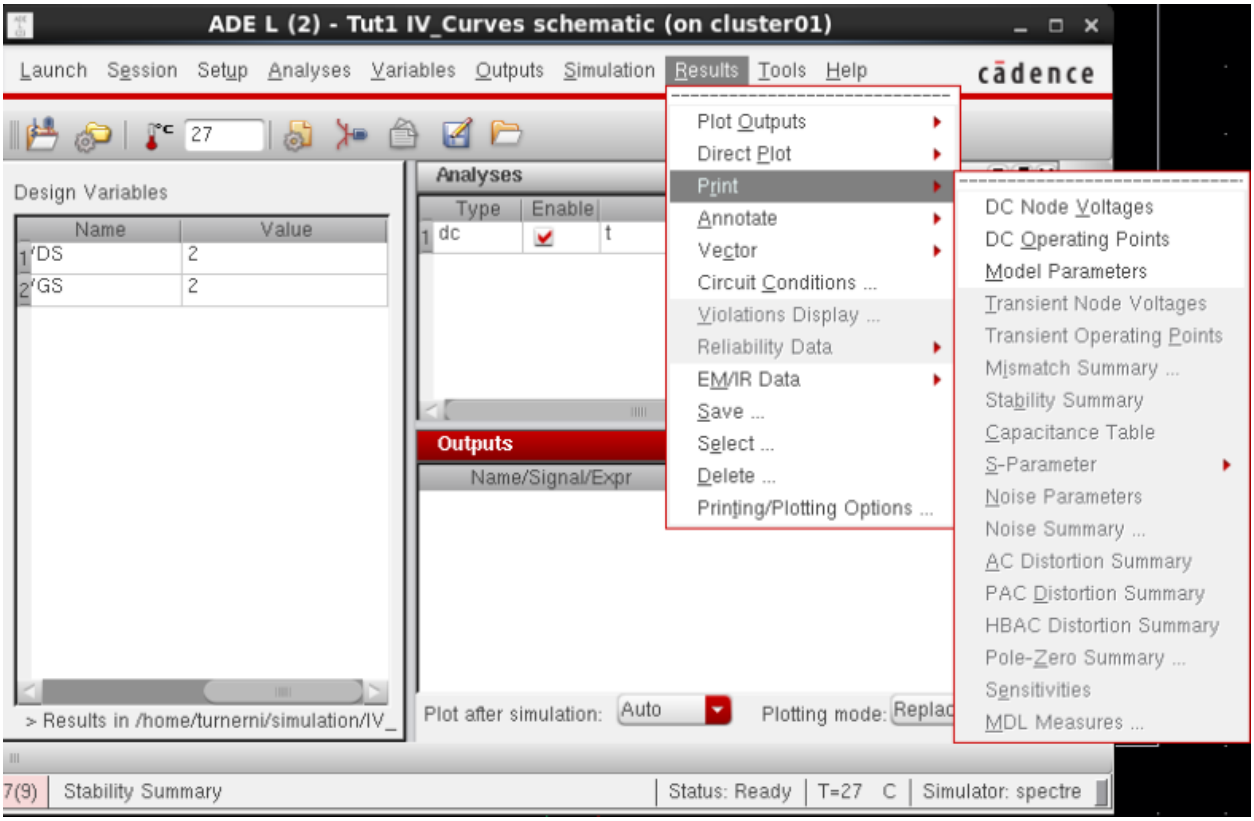
10. Go to **Launch → ADE L.** If a prompt appears asking whether you want to check out a license for ADE XL, select **Always**.

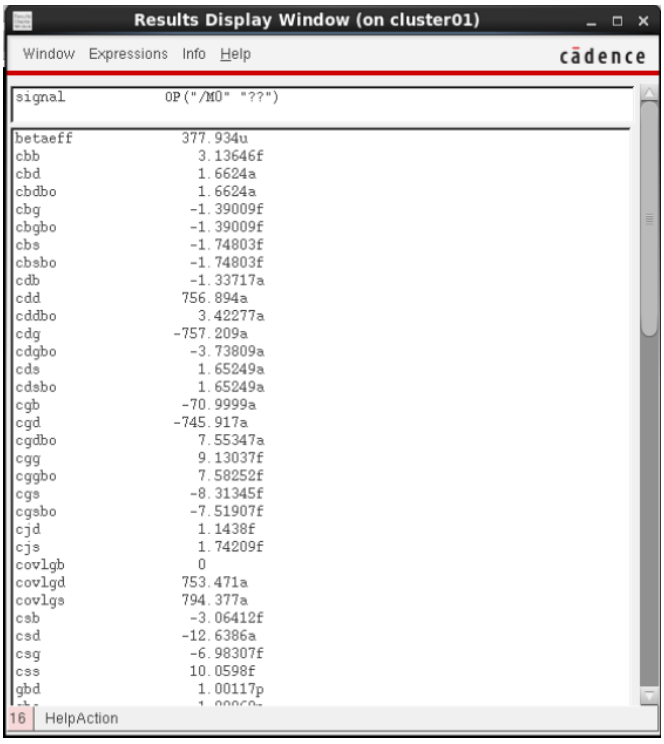


11. Once the Analog Design Environment (ADE) has been launched, select **Variables → Copy from Cellview**, notice that in the Design Variables, VDS and VGS have now appeared. Click on the **Value** column for each of the variables and set them both to 2 V.

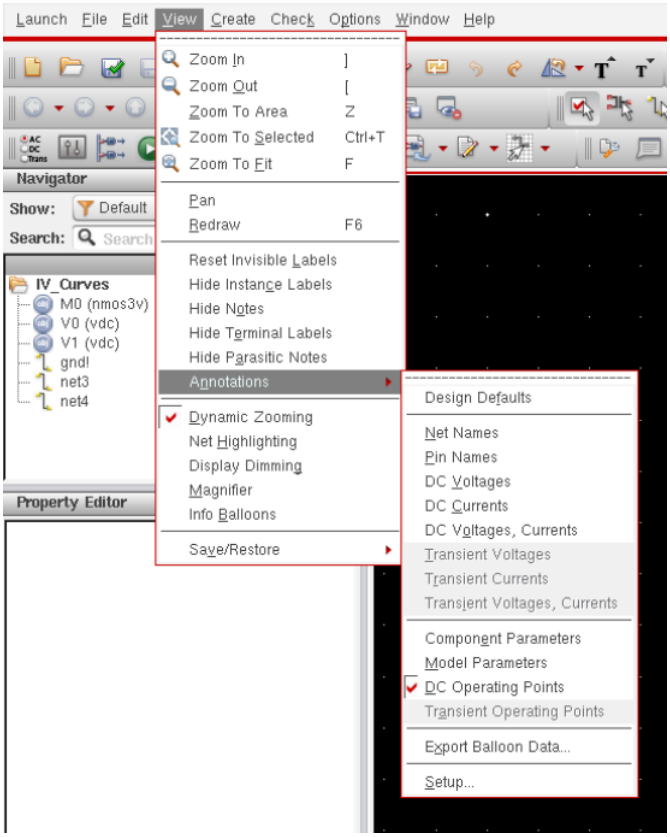


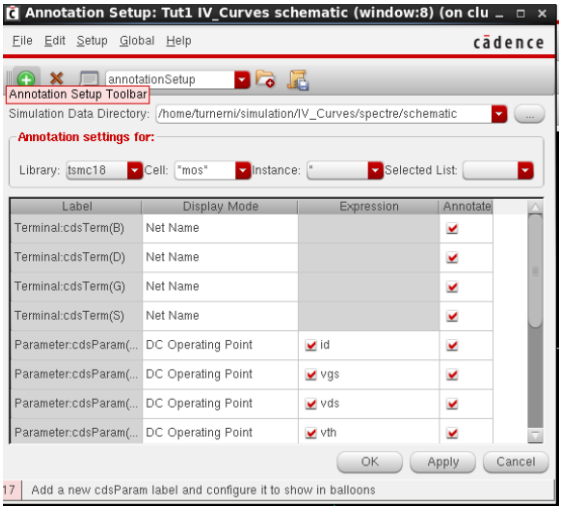
12. Go to **Analyses → Choose → dc → Save DC Operating Point → OK**
13. Click the Green Arrow (Netlist and Run)



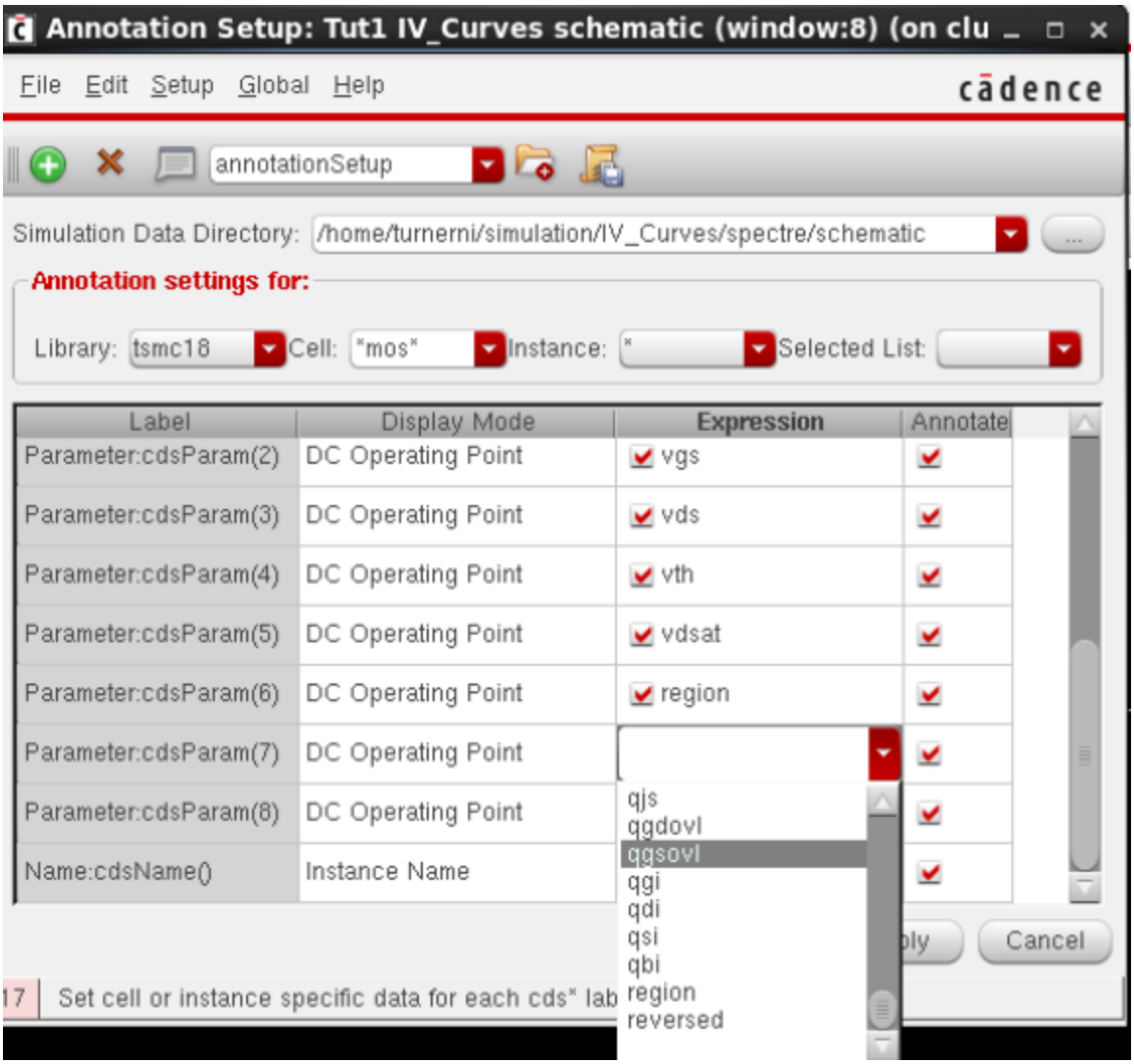


14. After the simulation finishes go to **Results → Print → DC Operating Points**, and then on the schematic select M0. The Results Display Window should now display all the of the operating parameters for the transistor. This is very useful in determining region of operation, current, threshold voltage, parasitic capacitances, etc.

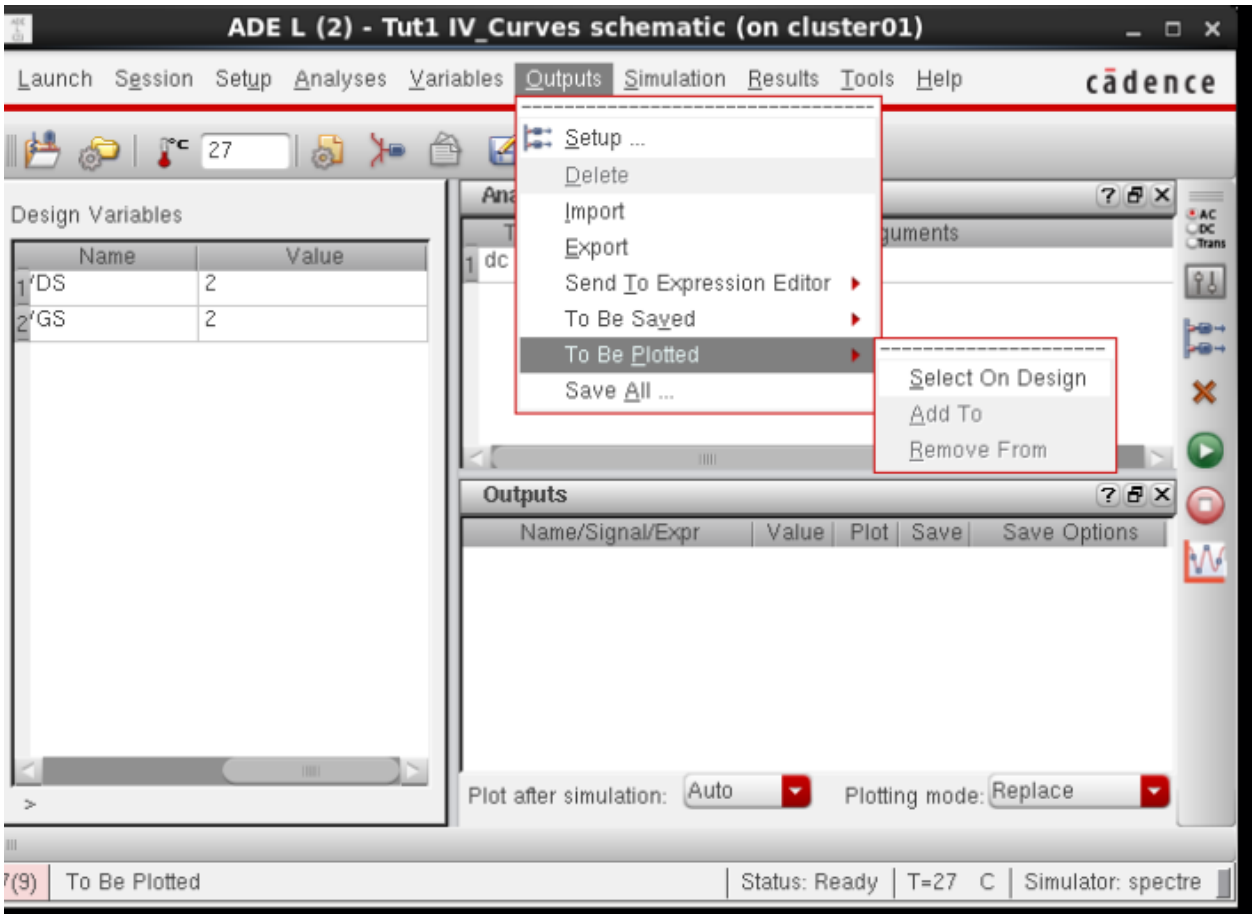


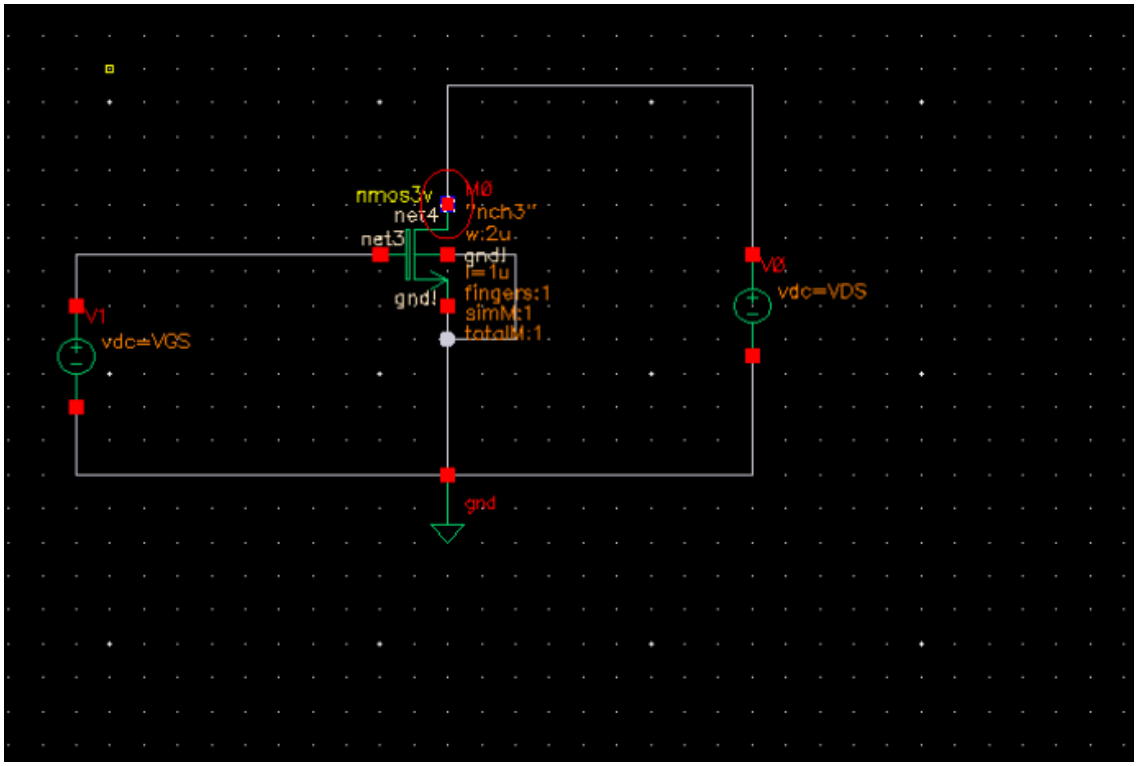


15. Additionally, you can then annotate these parameters on the schematic by going to **Results → Annotate → DC Operating Points**. The default annotations will show up next to the transistor. To change these defaults you can go to **View → Annotations → Setup**, selecting in the Annotation Settings for the following Library: tsmc18, Cellview: type *mos* (wildcard mos wildcard)

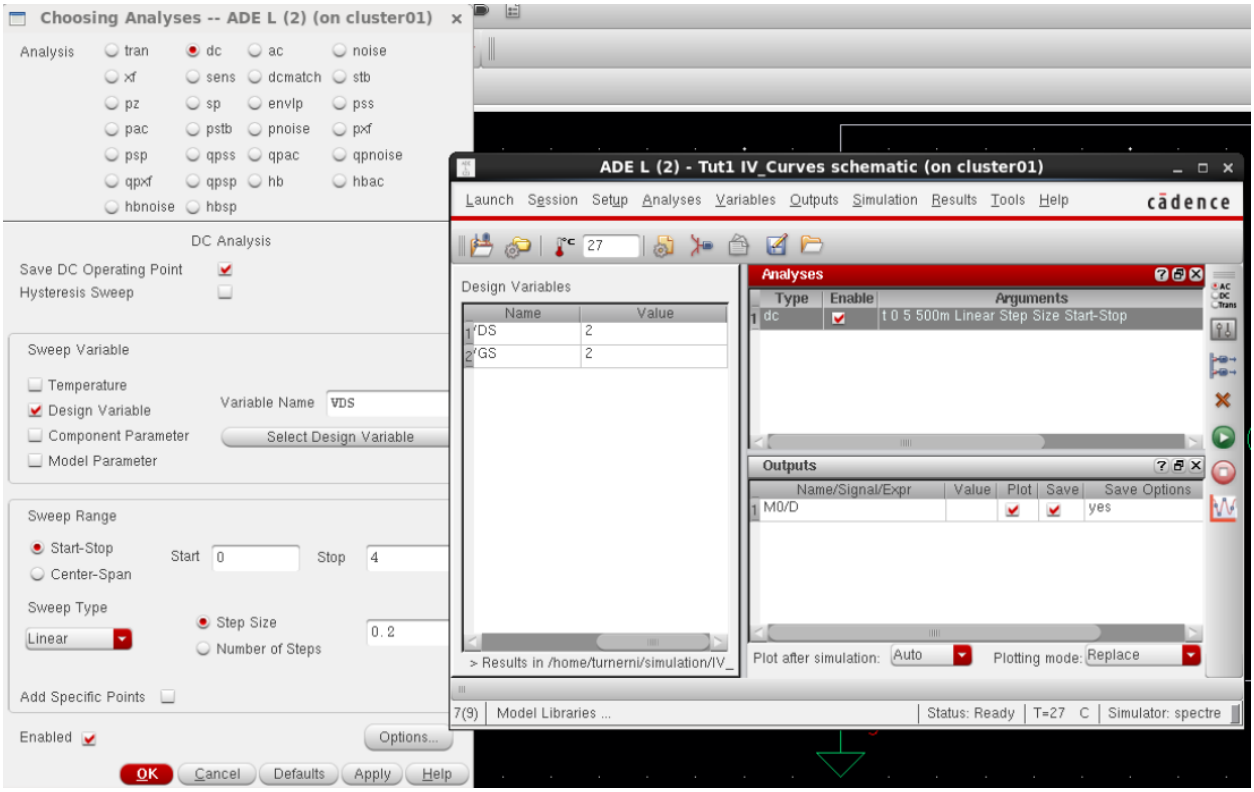


16. Then go to **Global → Parameters → DC Operating Point**. After selecting this you can change which parameters are displayed by clicking in the "Expression" column. You need to double click to get the down-arrow to appear to select which parameter to display.

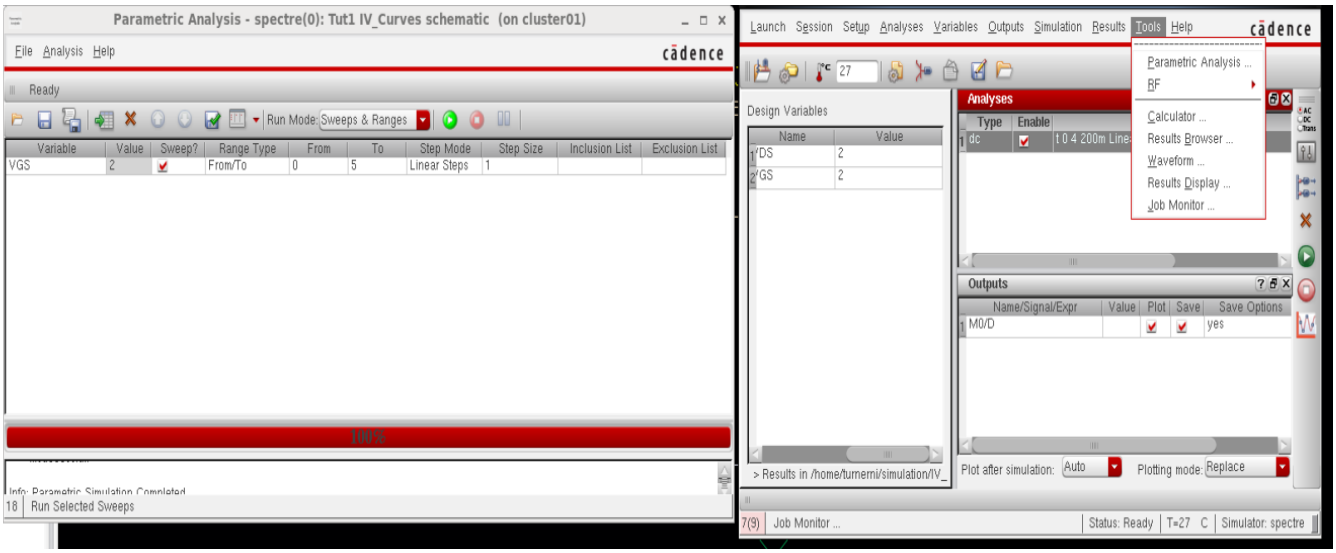

ADE L (2) - Tut1 IV_Curves schematic (on cluster01)
Launch Session Setup Analyses Variables Outputs Simulation Results Tools Help
cadence
Setup ...
Delete
Import
Export
Send To Expression Editor
To Be Saved
To Be Plotted
Save All ...
Select On Design
Add To
Remove From
Design Variables
Name Value
1 VDS 2
2 VGS 2
Outputs
Name/Signal/Expr Value Plot Save Save Options
Plot after simulation: Auto
Plotting mode: Replace
To Be Plotted
Status: Ready
T=27 C
Simulator: spectre


nmos3v
net4
net3
M0
"nch3"
w:2u
gnd!
l=1u
fingers:1
simM:1
totalM:1
V1
vdc=VGS
V0
vdc=VDS
gnd

17. Go back to the ADE and Click **Outputs → To Be Plotted → Select on Design**. And then click the drain terminal of the M0 Transistor. A red circle will appear around the terminal and in the Outputs section of the ADE you will see MO/D appear – This is the current through the drain of the MOSFET.

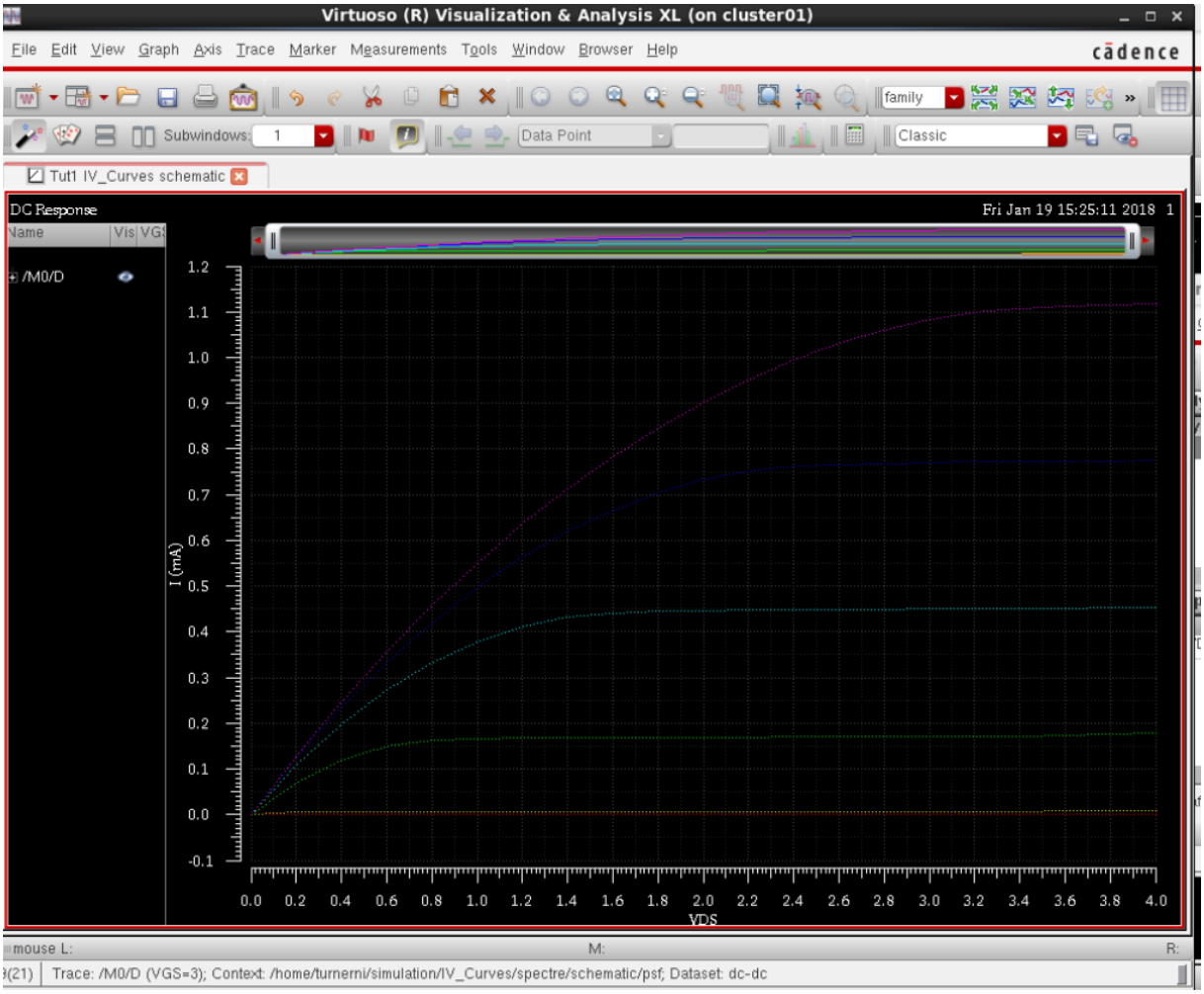


18. Now double click on the dc analysis and select **Design Variable** under sweep. Then click **Select Design Variable → Click VDS → OK**. Under Sweep Type Select **Linear → Start-Stop → Start = 0, Stop = 4 → Step Size = 0.2 → OK.**

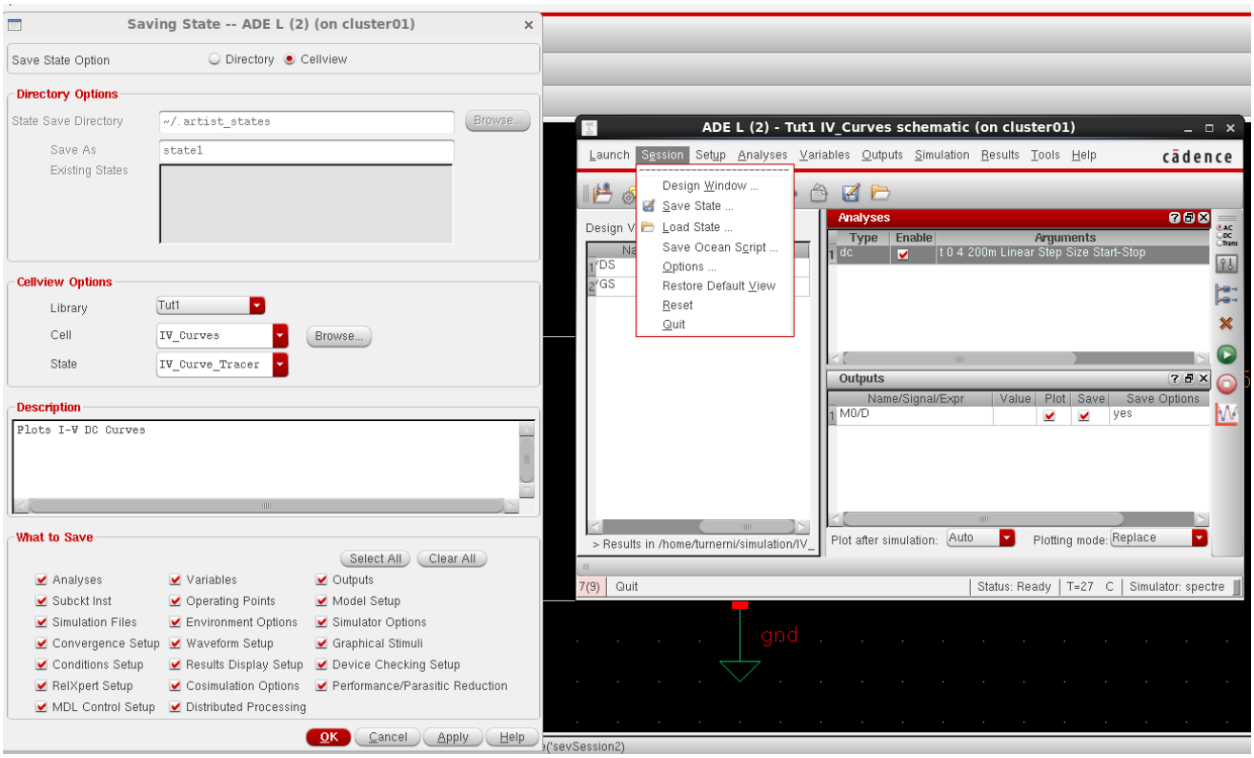


19. Go to **Tools → Parametric Analysis.** Make the settings match what is shown in the picture above – Variable: VGS, Range Type: From/To, From: 0, To: 5, Step Mode: Linear Steps, Step Size: 1.

20. Click the Green Arrow **In the Parametric Analysis Window**



21. A plot with several traces of Id vs. VDS should appear.



22. Exit the graph, and go back to the ADE and go to **Session → Save State → Cellview.** Under Cell, select the name of the cell you are in. The name of the state is whatever you want it to be, in this example it is labeled IV_Curve_Tracer. Additionally, you can add a description.

** Some useful bindkeys: f – fit, right-click and drag a box around area you want to zoom into, m – marker