EE 660 VLSI Design Laboratory

Assignment I

Submitted by: L.Sri Sai Swathi(2414202)

1. Simulate the ID – VDS characteristics of a UMC65 NMOS transistor with an aspect ratio of W/L =2 µm/60 nm. You have to vary VGS from 0.2 to 1.1 V in steps of 0.2 V and vary VDS from 0 to 1.1 V.
Plot the family of curves.

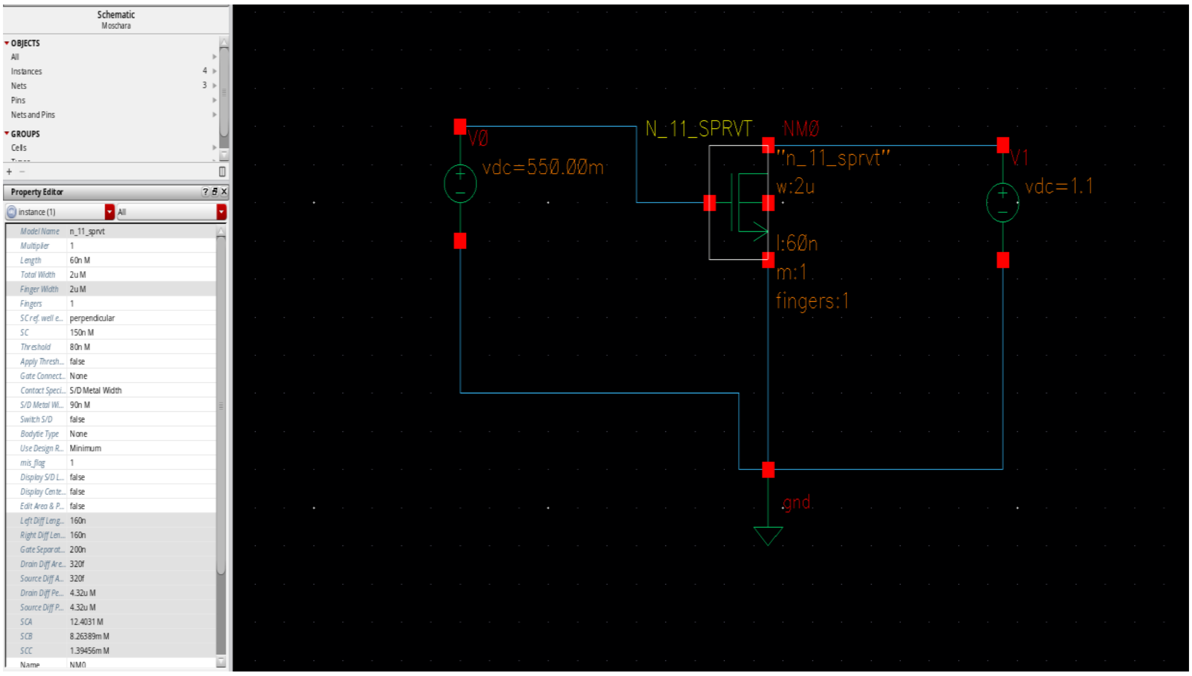


Figure 1. .Schematic of NMOS CS Amplifier with aspect ratio of W/L =2 µm/60 nm.

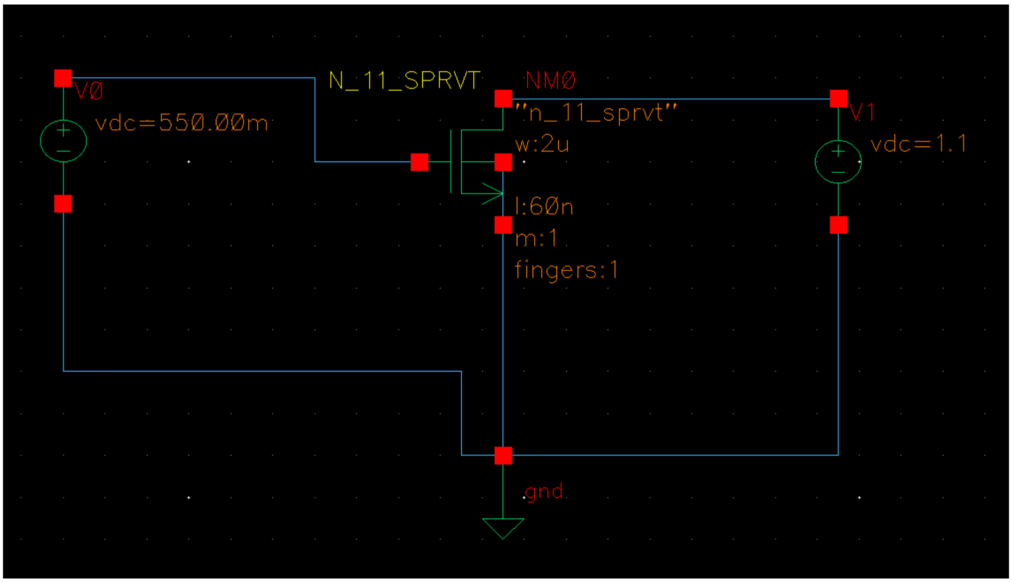


Figure 2. .Schematic of NMOS CS Amplifier with aspect ratio of W/L =2 µm/60 nm

ID – VDS characteristics of a UMC65 NMOS transistor:Simulation Results :

1. Vgs=0.2v

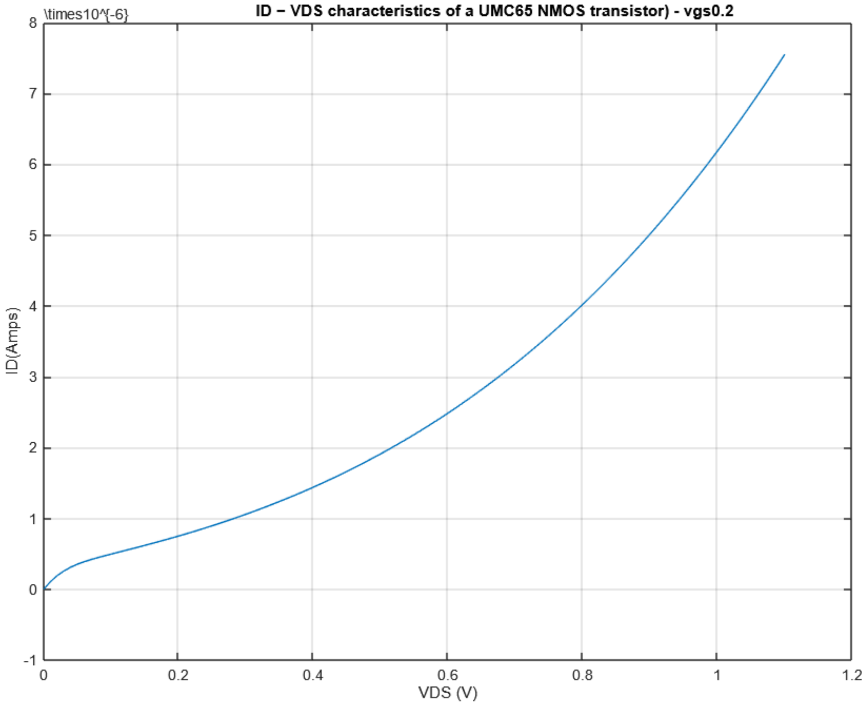
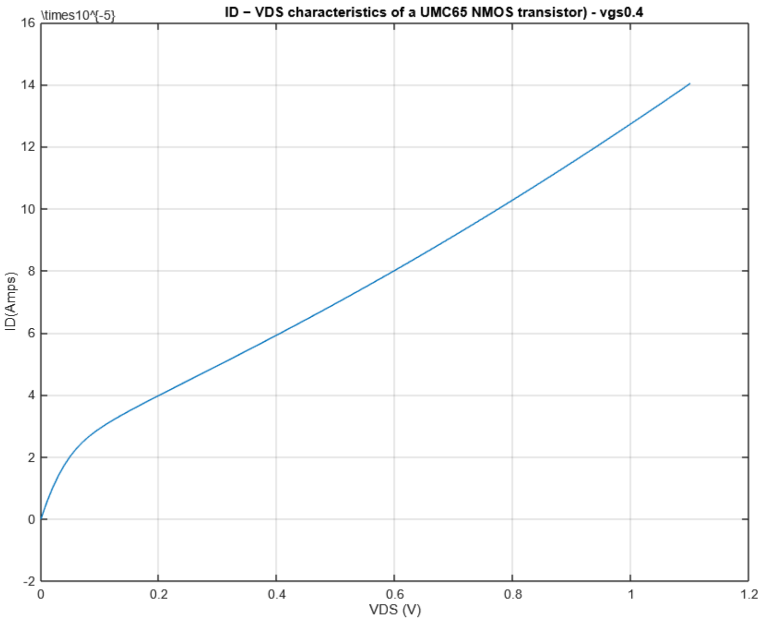


Figure 3.Plot showing Id Vs Vds when Vgs is set to 0.2V

2.Vgs=0.4V



2. Vgs=0.4v

Figure 4.Plot showing Id Vs Vds when Vgs is set to 0.4V

3. Vgs=0.6v

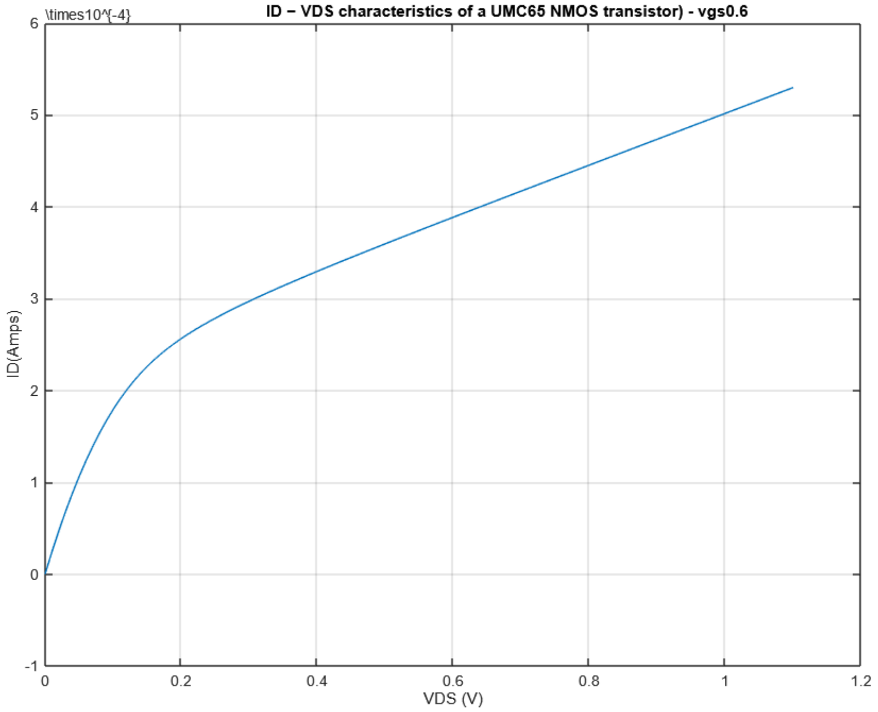


Figure 5.Plot showing Id Vs Vds when Vgs is set to 0.6V

4.Vgs=0.8v

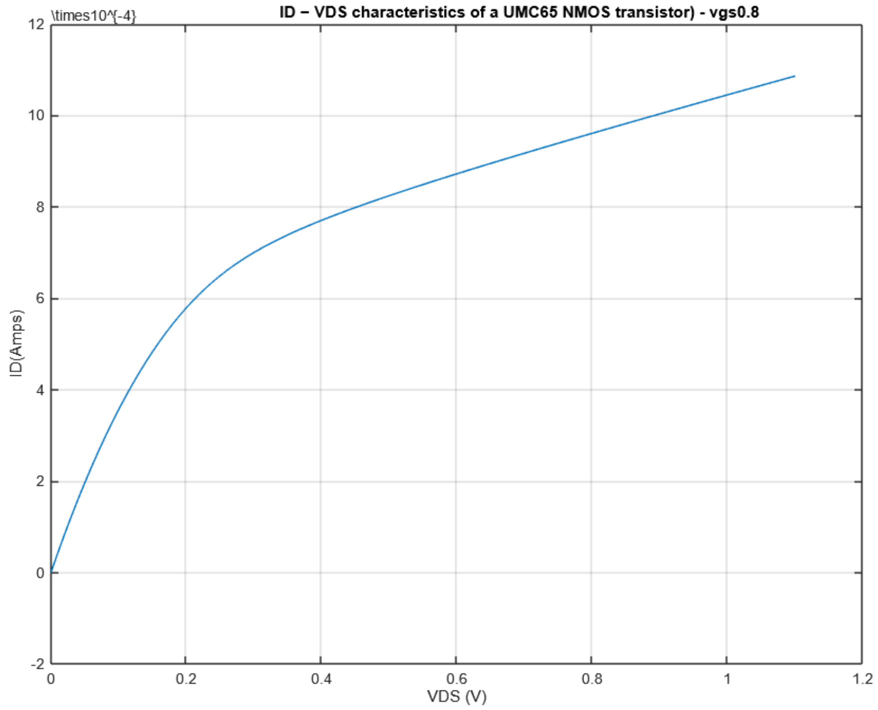


Figure 6.Plot showing Id Vs Vds when Vgs is set to 0.8V

4. Vgs=1.0v

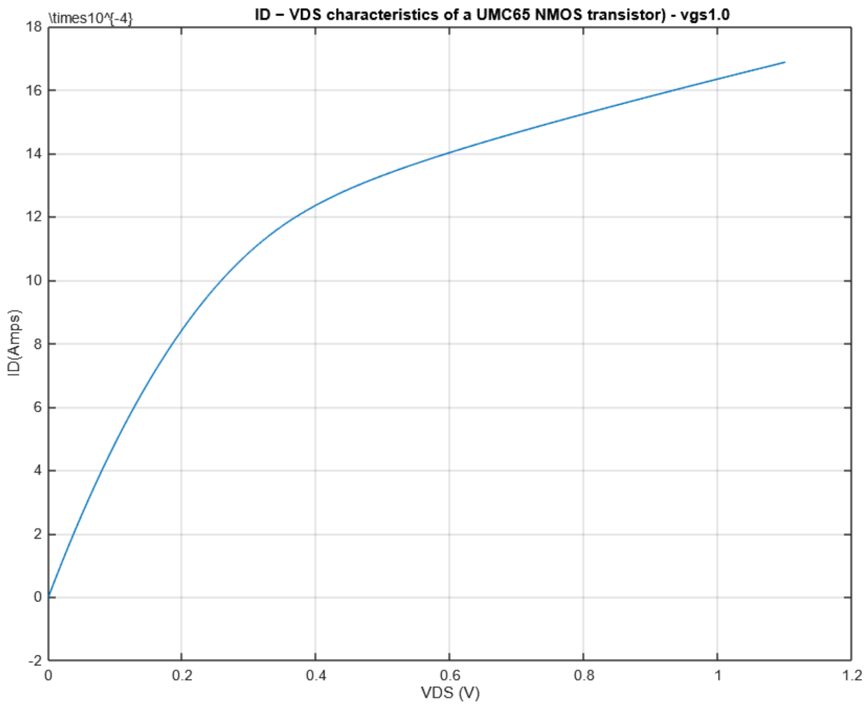


Figure 7.Plot showing Id Vs Vds when Vgs is set to 1.0V

5. Vgs=1.1v

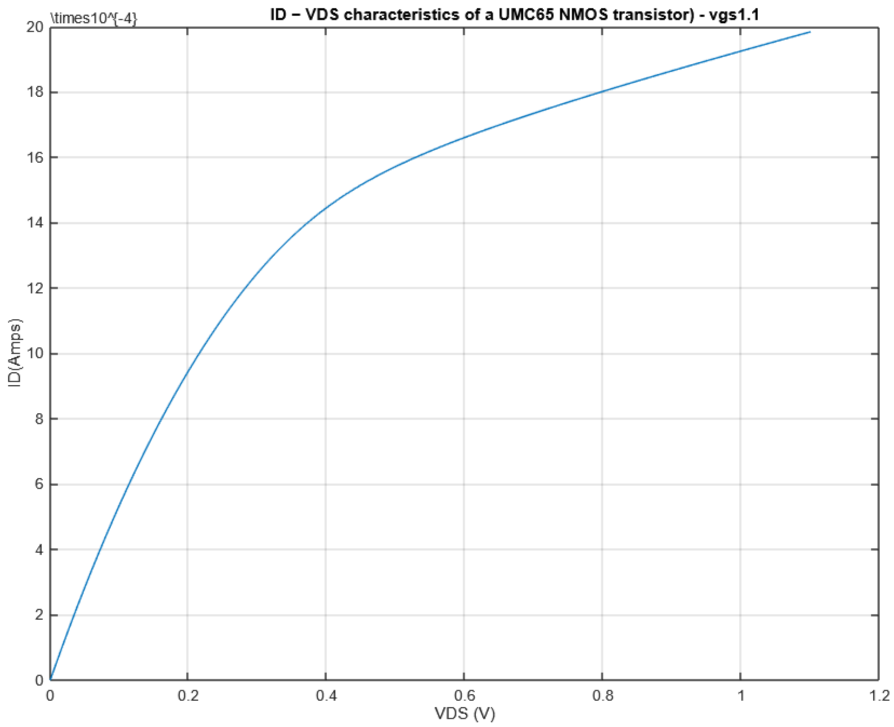


Figure 8.Plot showing Id Vs Vds when Vgs is set to 1.1V

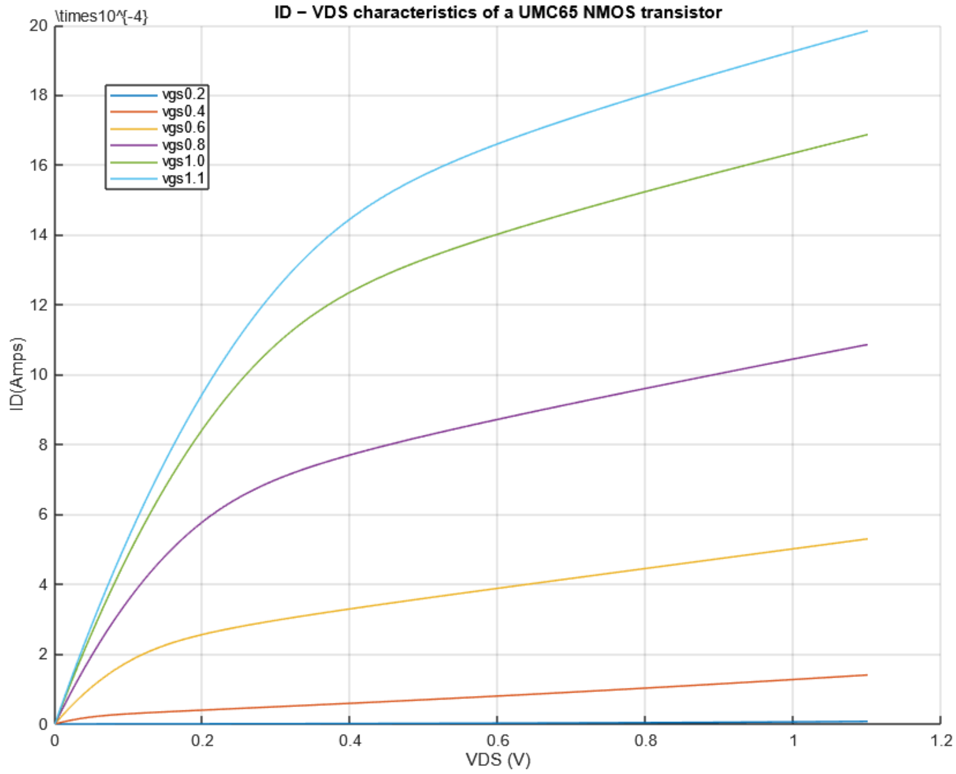


Figure 9.Plot showing Id Vs Vds when Vgs is sweeped from 0.2v to 1.1v in steps of 0.2v

2. Using the above simulation results plot an Ron – VDS curve different values of VGS . Are you able to observe the linear dependence of ID on VDS in the deep triode region?

1. Vgs=0.2v

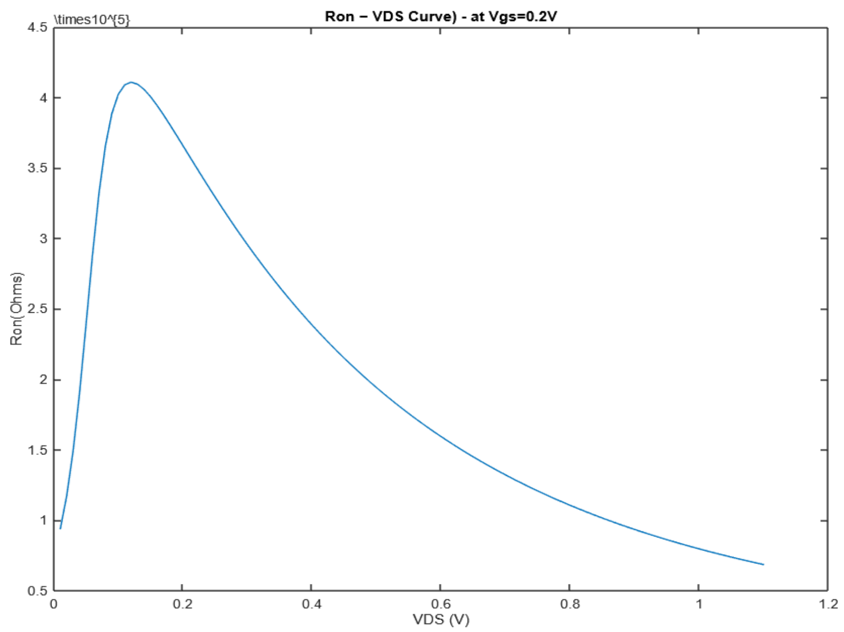


Figure 10.Plot showing Ron Vs Vds when Vgs is set to 0.2 V

2. Vgs=0.4v

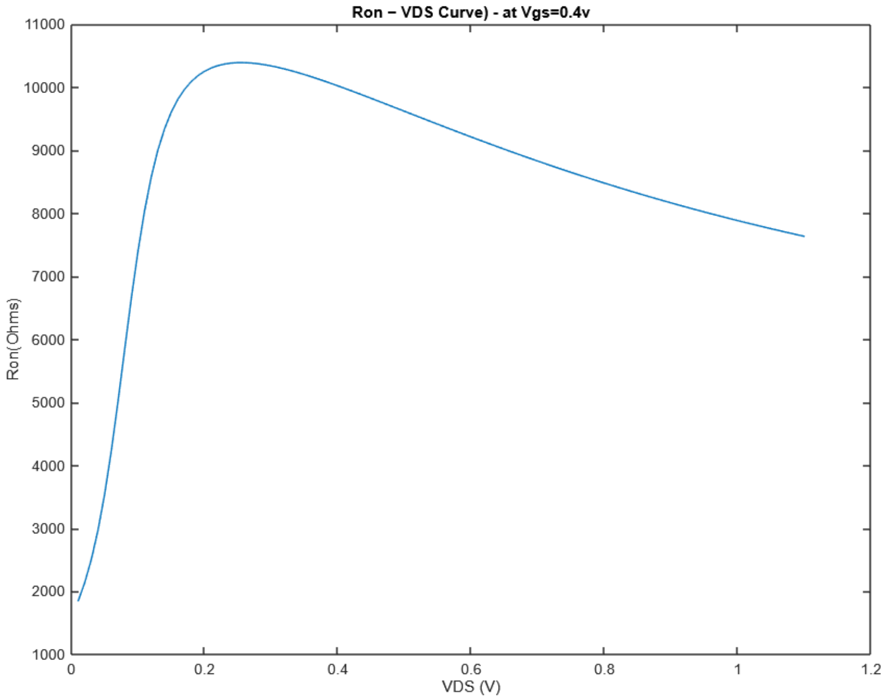


Figure 11.Plot showing Ron Vs Vds when Vgs is set to 0.4 V

3. Vgs=0.6v

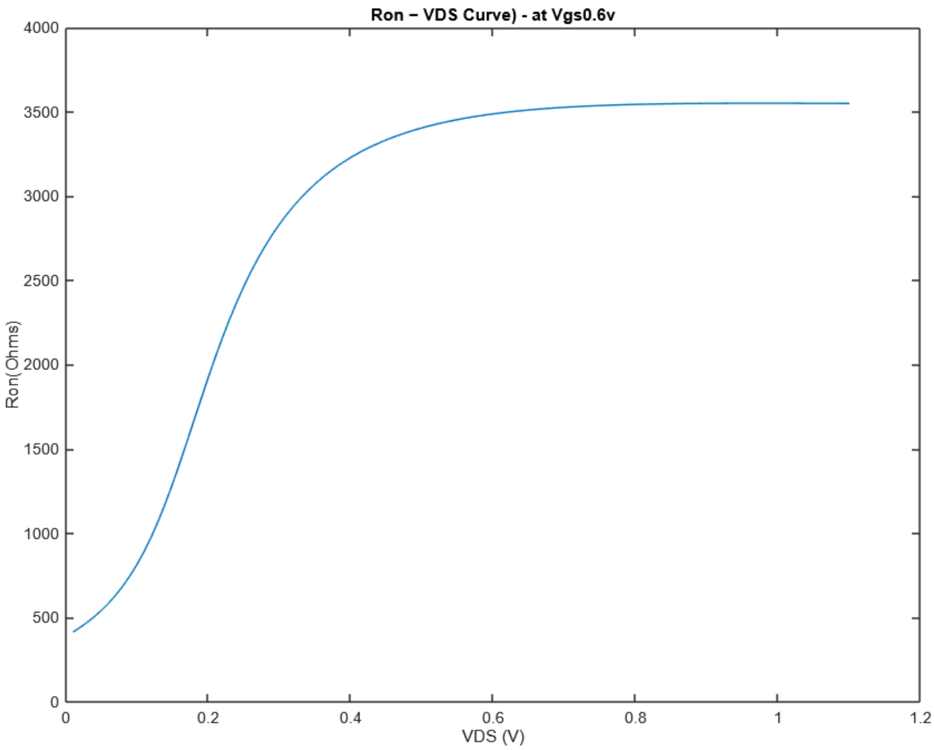


Figure 12.Plot showing Ron Vs Vds when Vgs is set to 0.6 V

4. Vgs=0.8v

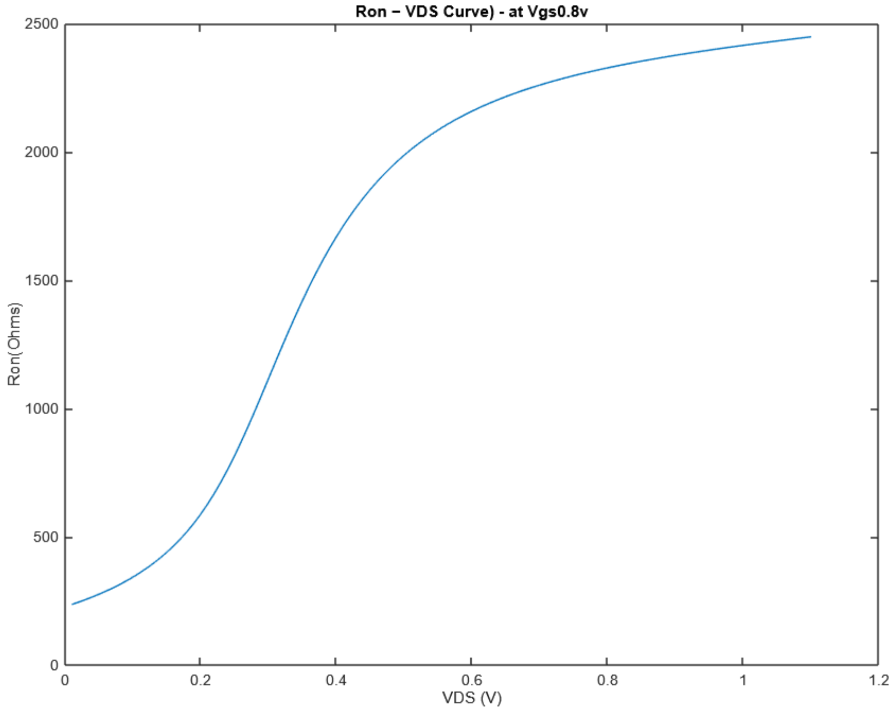


Figure 13.Plot showing Ron Vs Vds when Vgs is set to 0.8 V

5. Vgs=1.0v

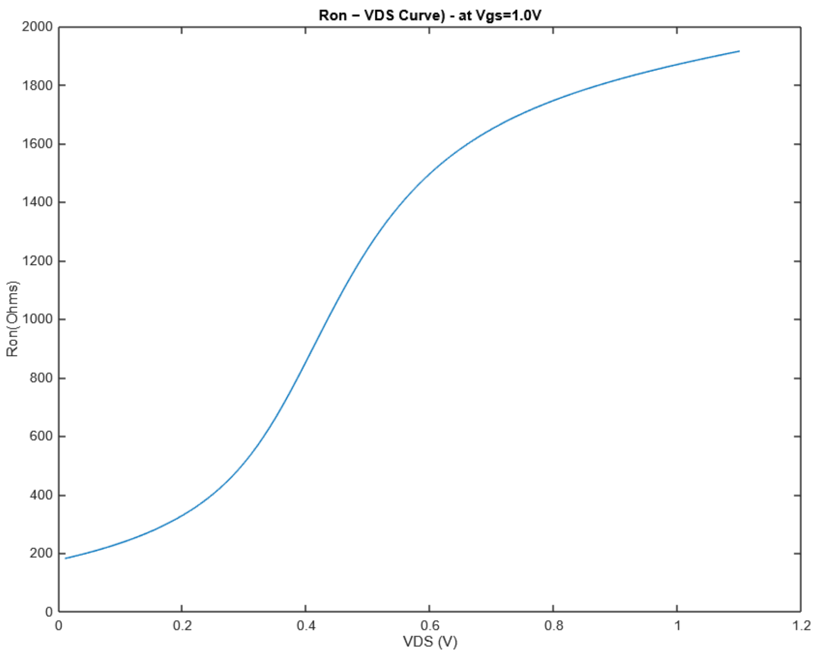


Figure 14.Plot showing Ron Vs Vds when Vgs is set to 1.0 V

6.Vgs=1.1v

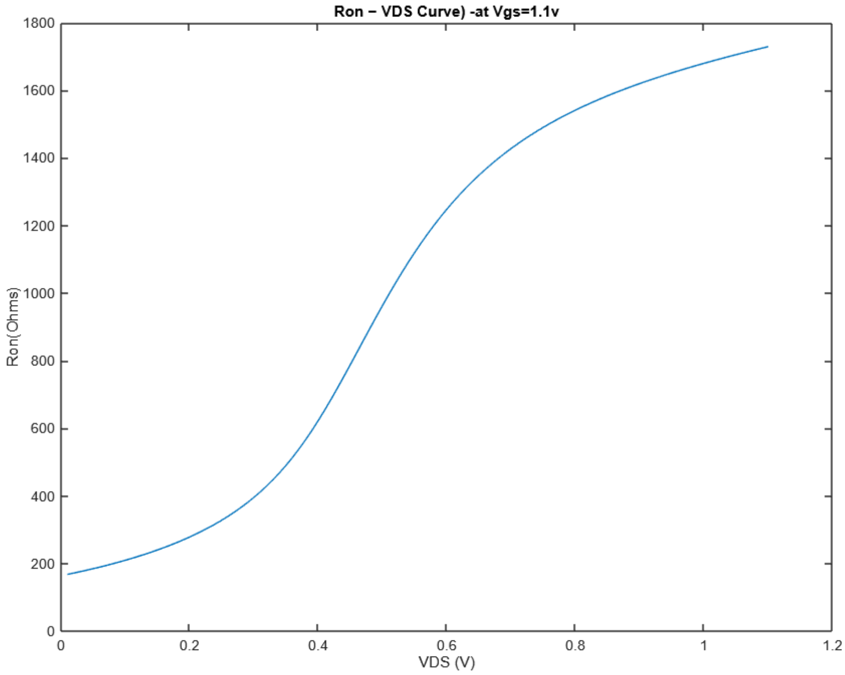


Figure 15.Plot showing Ron Vs Vds when Vgs is set to 1.1 V

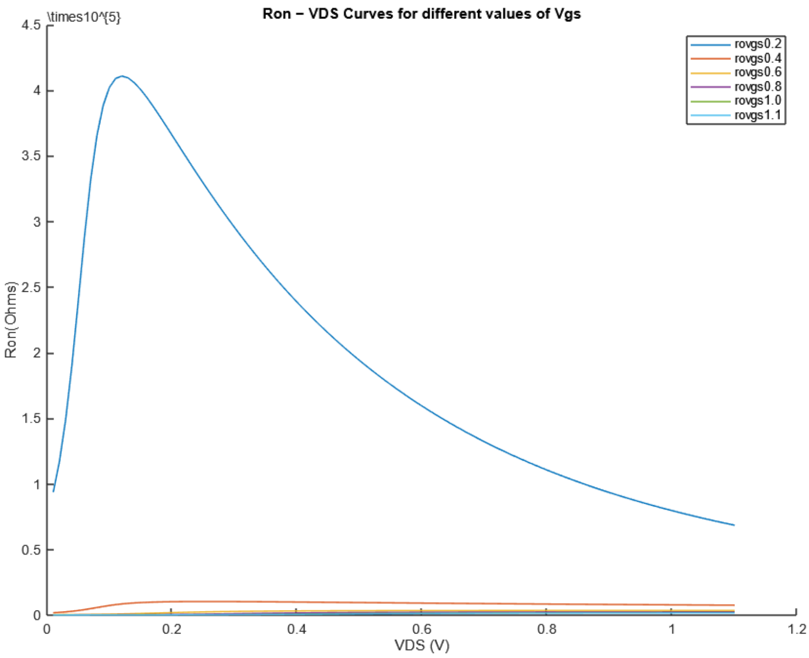


Figure 16.Plot showing Ron Vs Vds when Vgs is varied from 0.2v to 1.1 V in steps of 0.2v

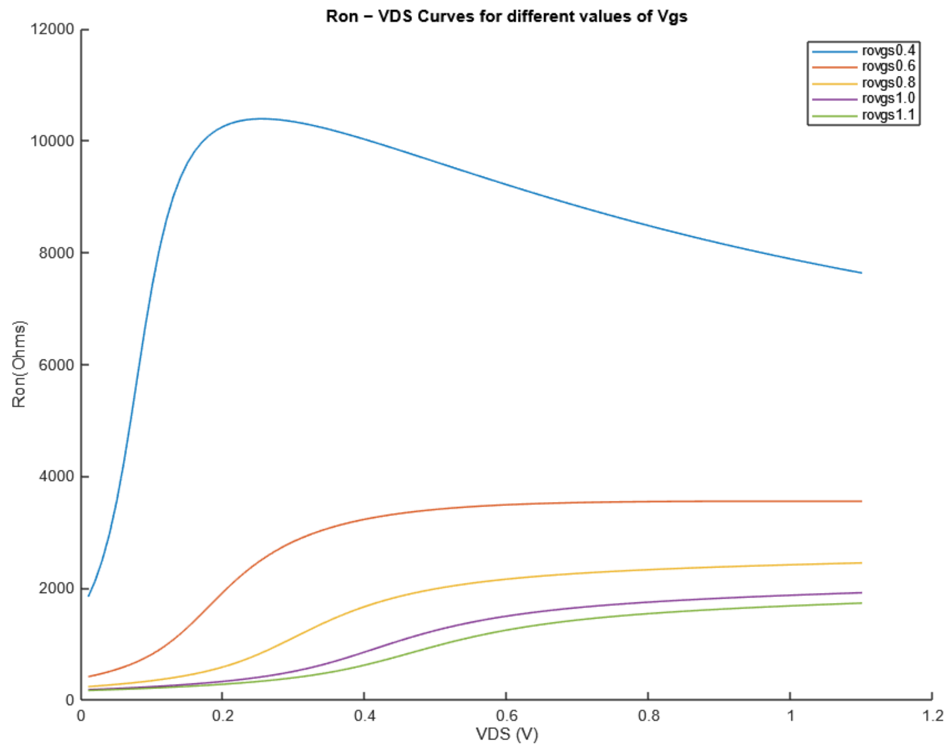


Figure 17.Plot showing Ron Vs Vds when Vgs is varied from 0.4v to 1.1 V in steps of 0.2v

Q2 : Are you able to observe the linear dependence of ID on VDS in the deep triode region? Yes ,In deep triode region , we could see that Id is linearly dependent on Vds.

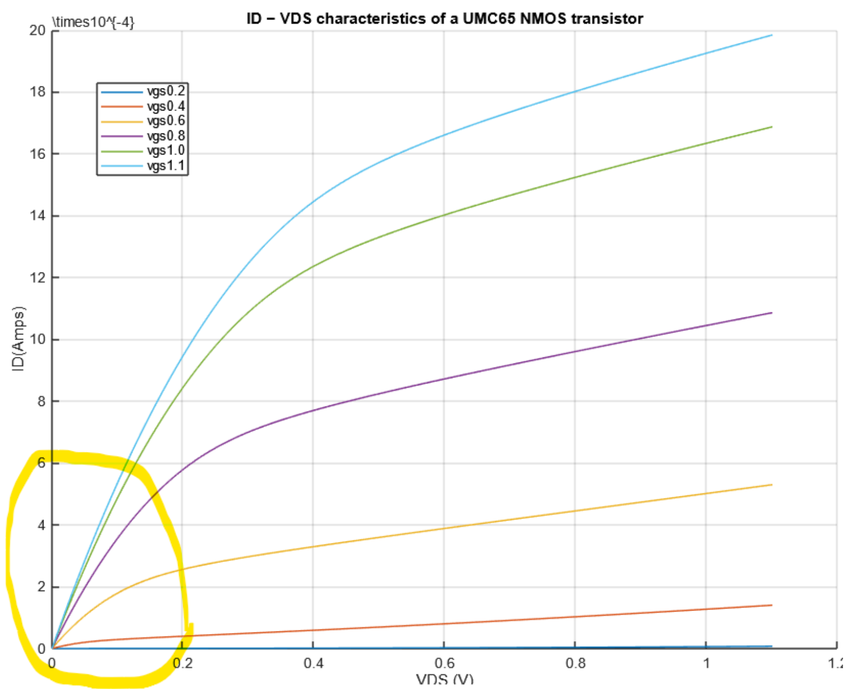


Figure:Plot showing linear dependence of ID on Vds.

3. Simulate the ID – VGS characteristics of a UMC65 NMOS transistor with an aspect ratio of W/L =2µm/60 nm. You have to vary VDS from 0 to 1.1 V in steps of 0.2 V and vary VGS from 0 to 1.1 V.

Plot the family of curves.

1. Vds=0.2v

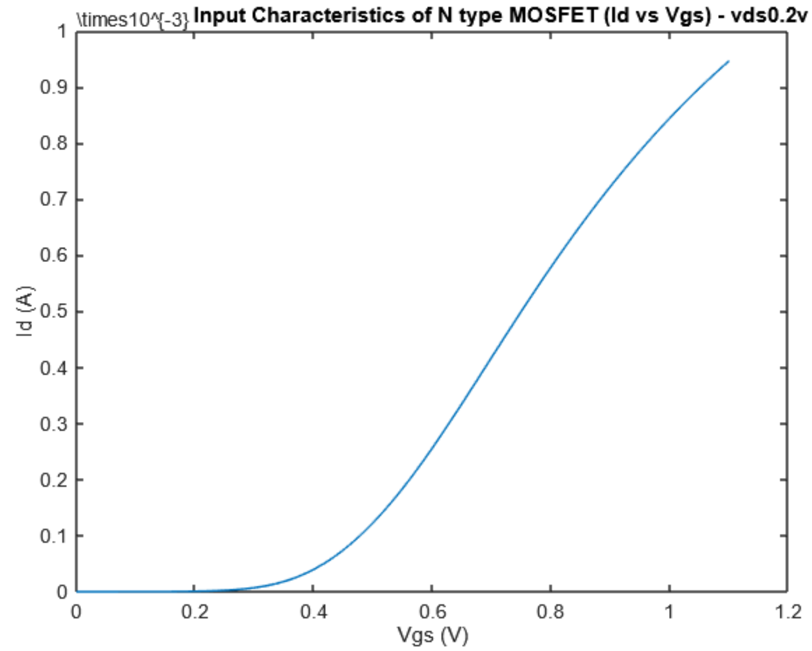


Figure 18.Plot showing ID Vs Vgs when Vds is set to 0.2 V

2. Vds=0.4v

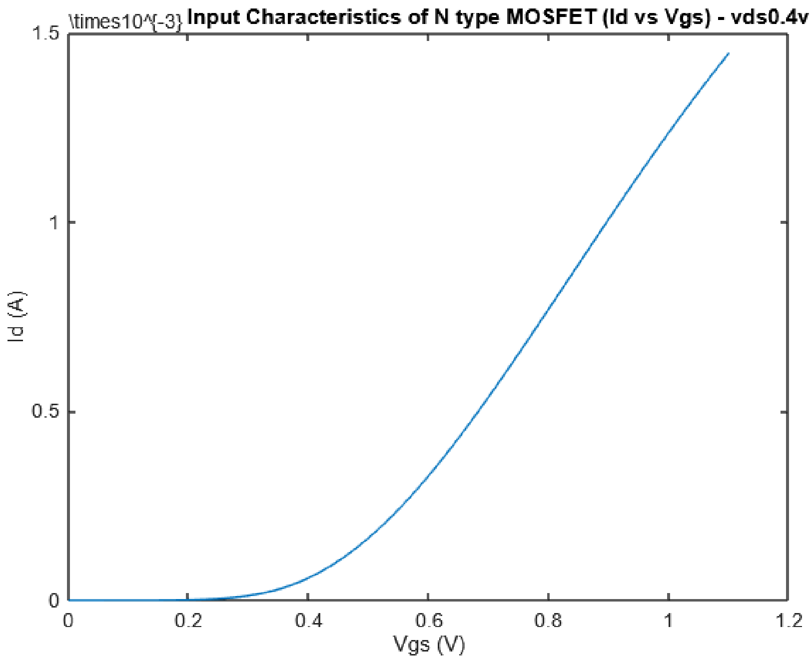


Figure 19.Plot showing ID Vs Vgs when Vds is set to 0.4 V

3.Vds=0.6v

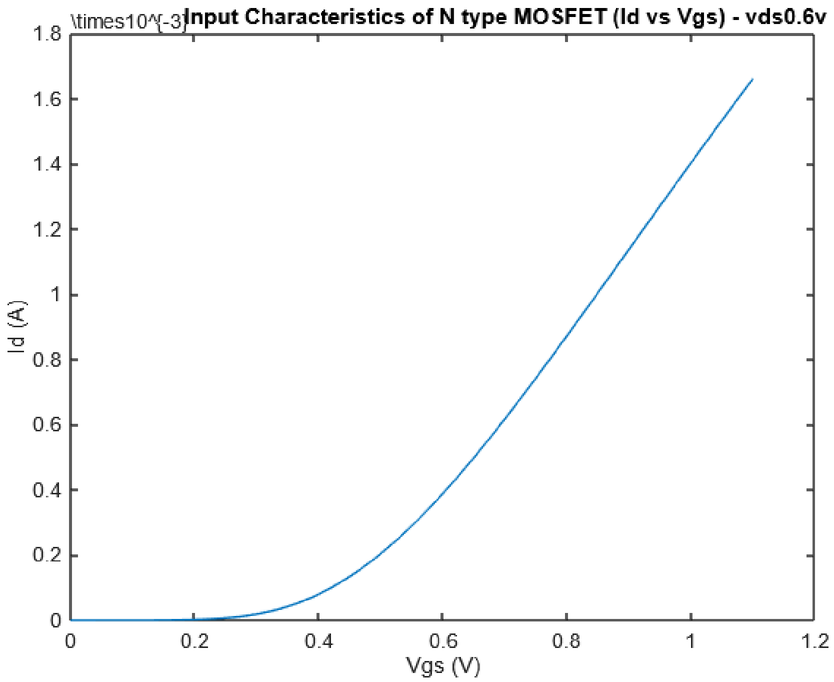


Figure 20.Plot showing ID Vs Vgs when Vds is set to 0.6 V

4.Vds=0.8v

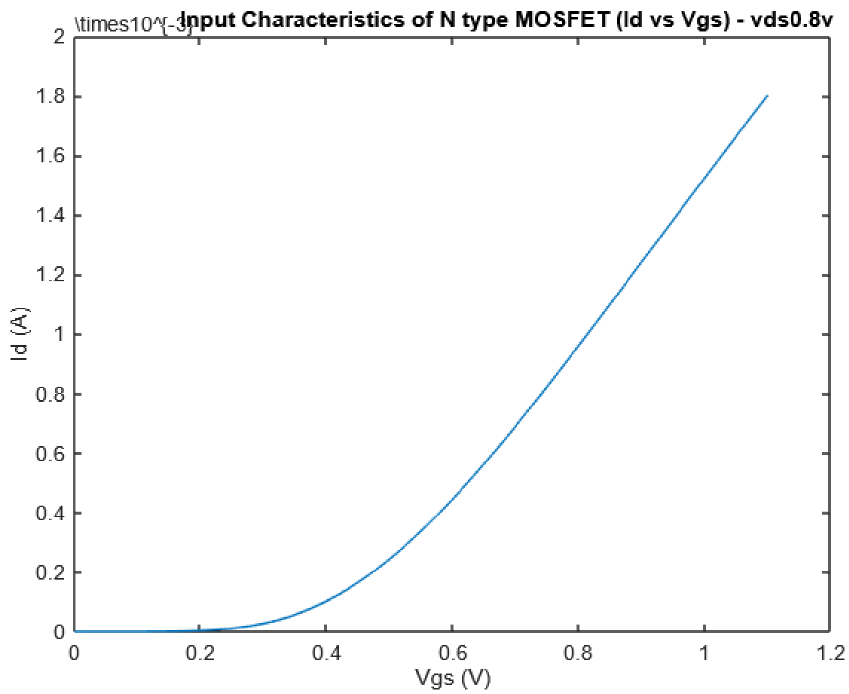


Figure 21.Plot showing ID Vs Vgs when Vds is set to 0.8 V

5.Vds=1.0v

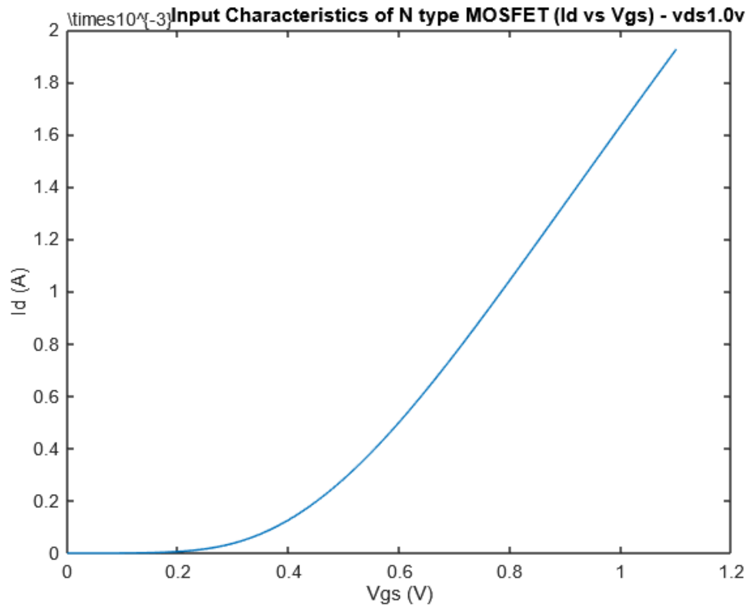


Figure 22.Plot showing ID Vs Vgs when Vds is set to 1.0 V

Vds=1.1v

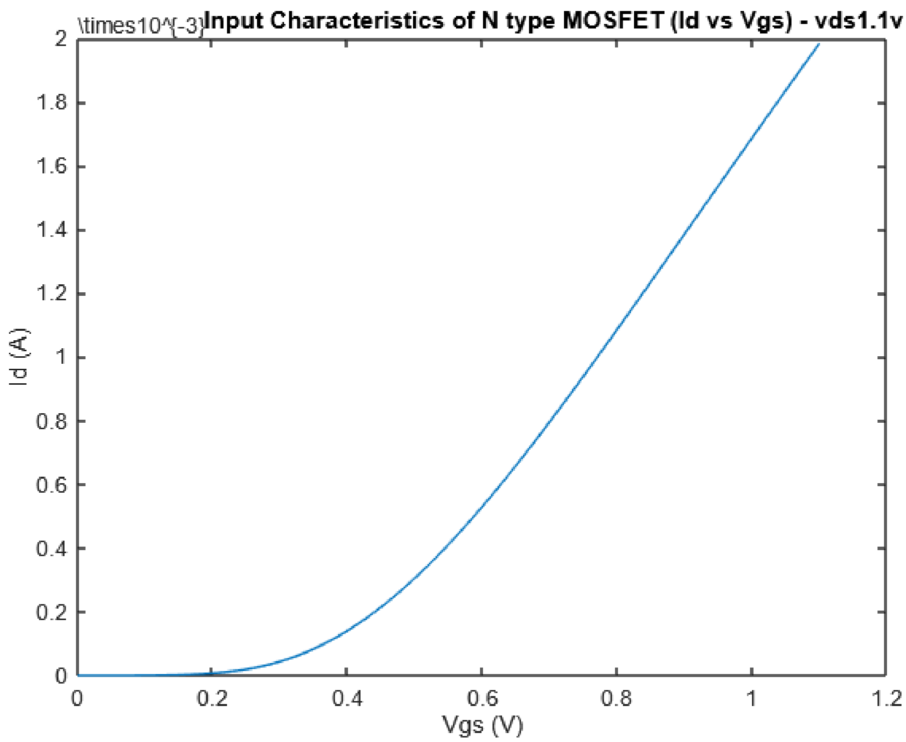


Figure 23.Plot showing ID Vs Vgs when Vds is set to 1.1 V

Id-Vgs when Vds sweeped from 0 to 1.1 V in steps of 0.2v

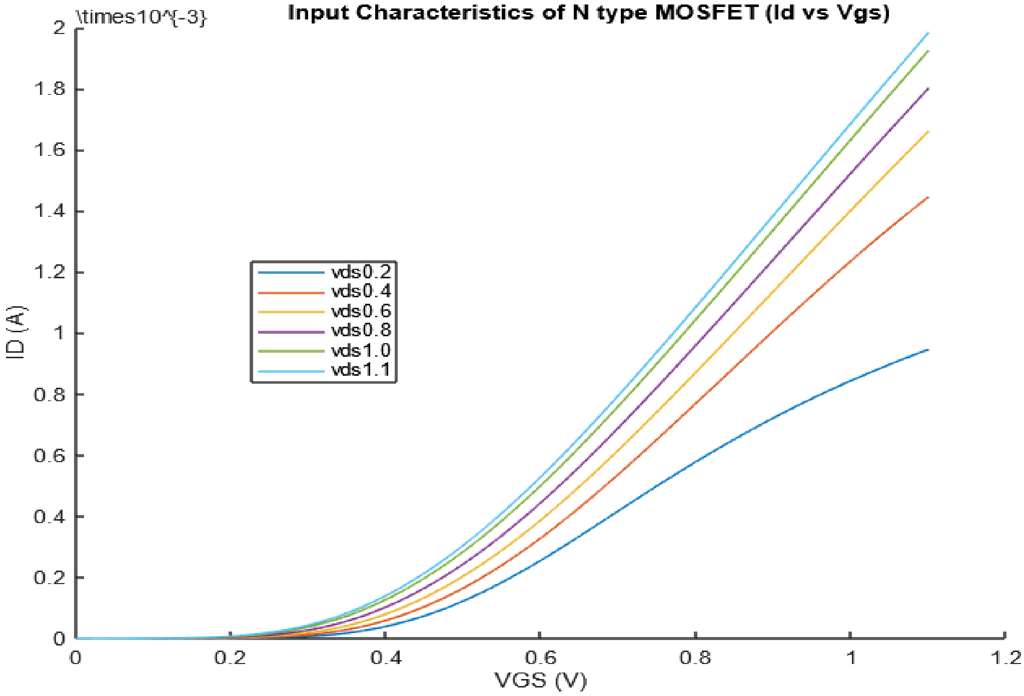


Figure 24.Plot showing ID Vs Vgs when Vds is sweeped from 0 to 1.1 V in steps of 0.2v

4. Using the above simulation results plot an gm – VGS curve for different values of VDS . Can you also calculate the value of VT graphically?

1.Vds=0.2v

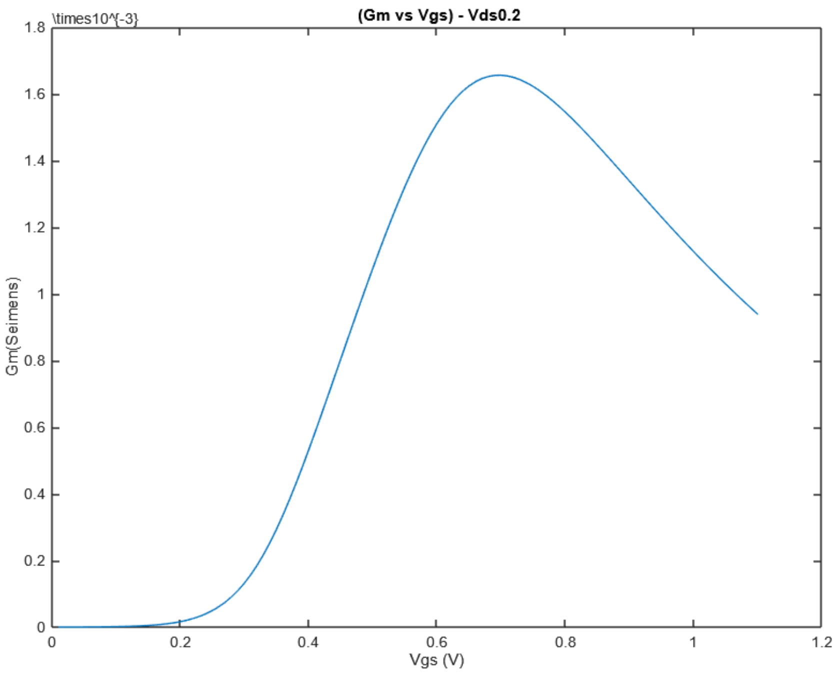


Figure 25.Plot showing Gm Vs Vgs when Vds=0.2v

2.Vds=0.4

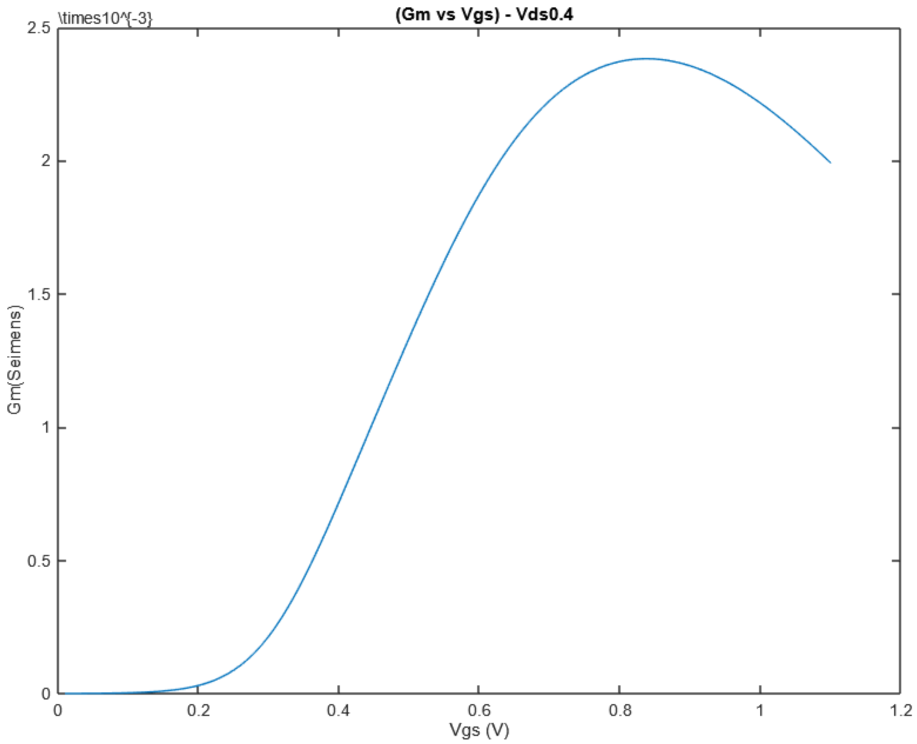


Figure 26.Plot showing Gm Vs Vgs when Vds=0.4v

3.Vds=0.6v

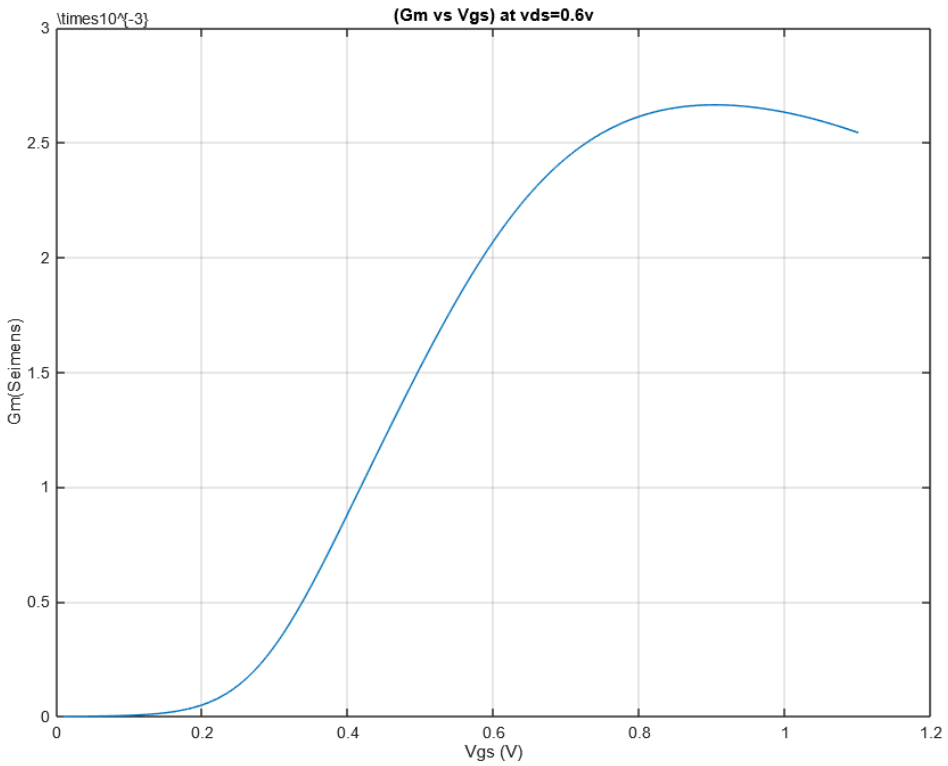


Figure 27.Plot showing Gm Vs Vgs when Vds=0.6v

4.Vds=0.8v

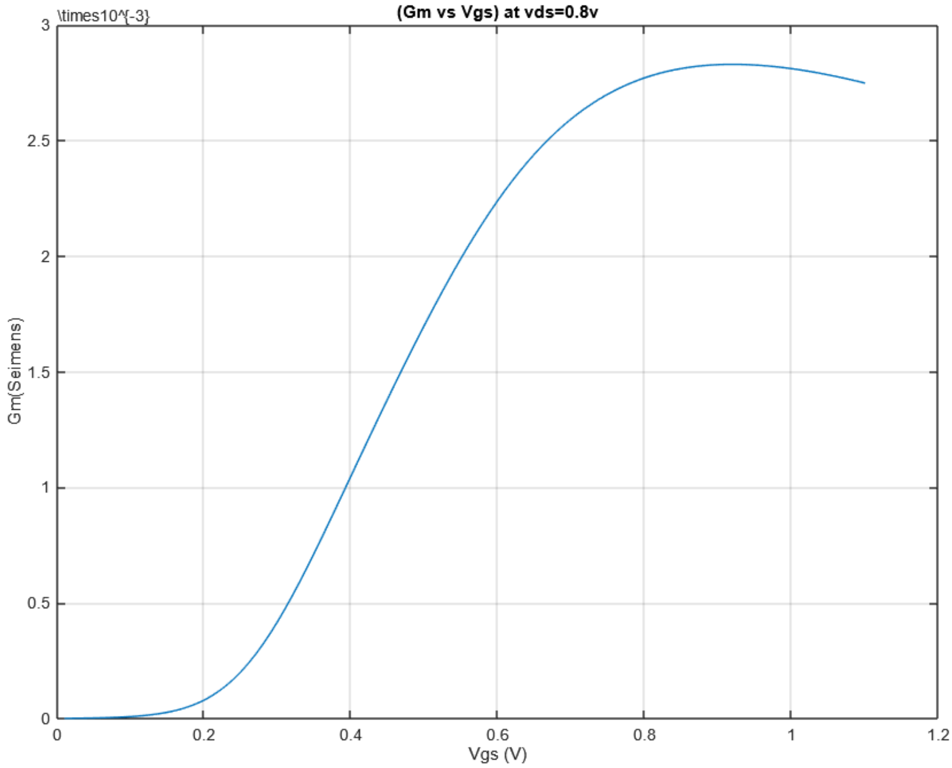


Figure 28.Plot showing Gm Vs Vgs when Vds=0.8v

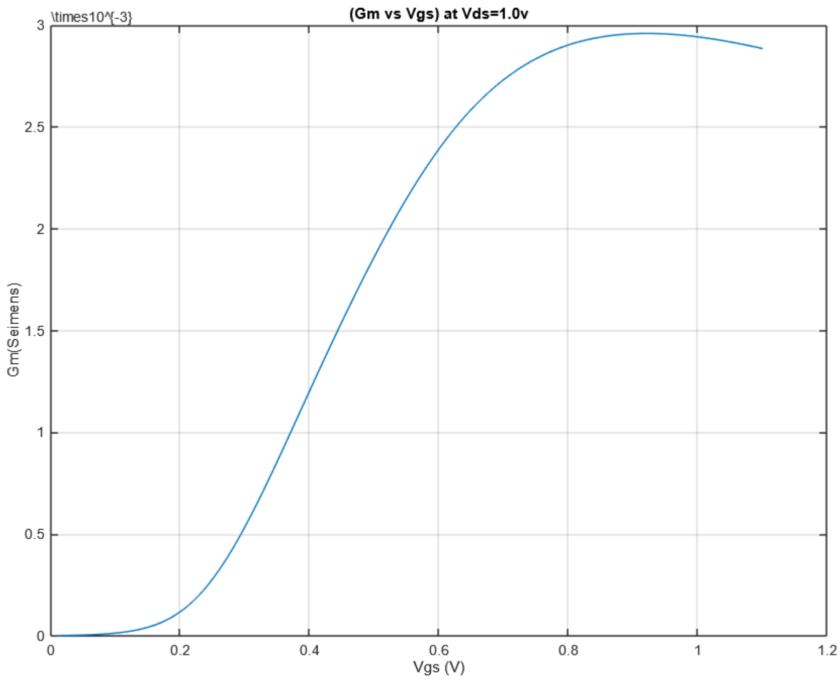


Figure 29.Plot showing Gm Vs Vgs when Vds=1.0v

6.Vds=1.1v

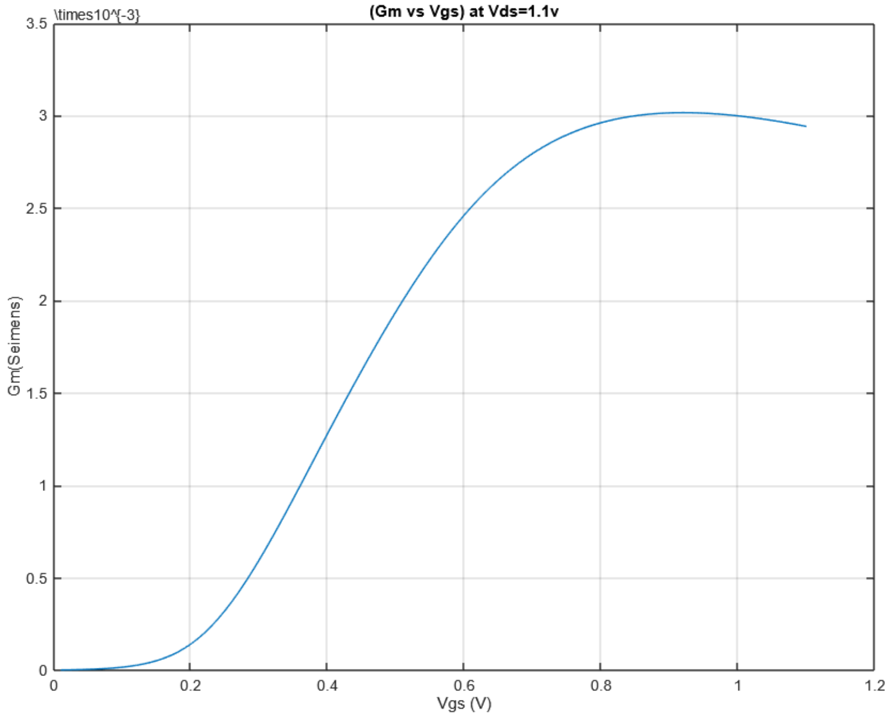


Figure 30.Plot showing Gm Vs Vgs when Vds=1.1v

Simulation Result :Gm Versus Vgs when Vds is sweeped from 0.2 to 1.1v

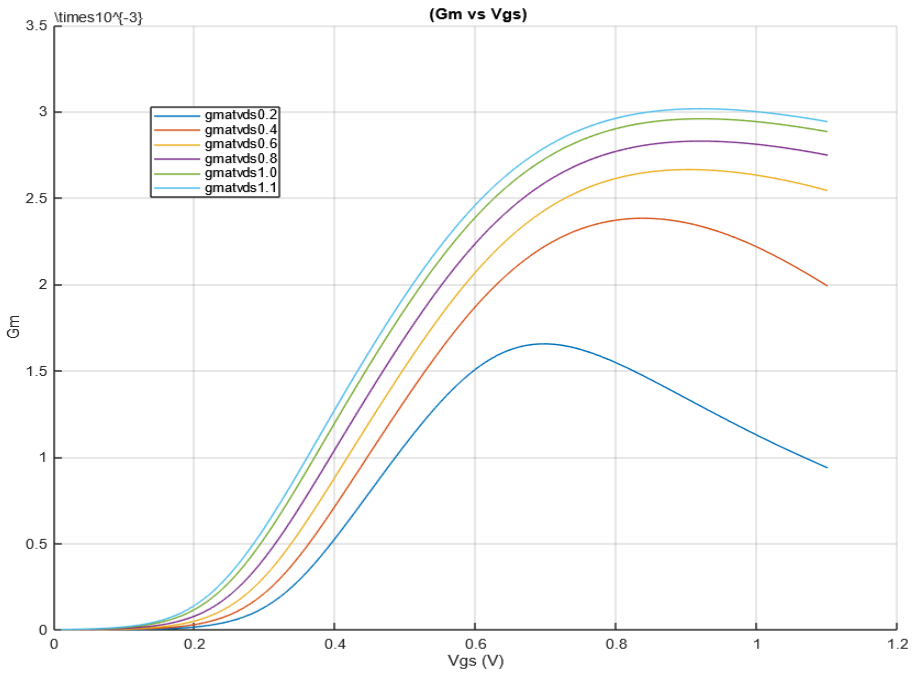


Figure 31.Plot showing Gm Vs Vgs when Vds is sweeped from 0.2 to 1.1v

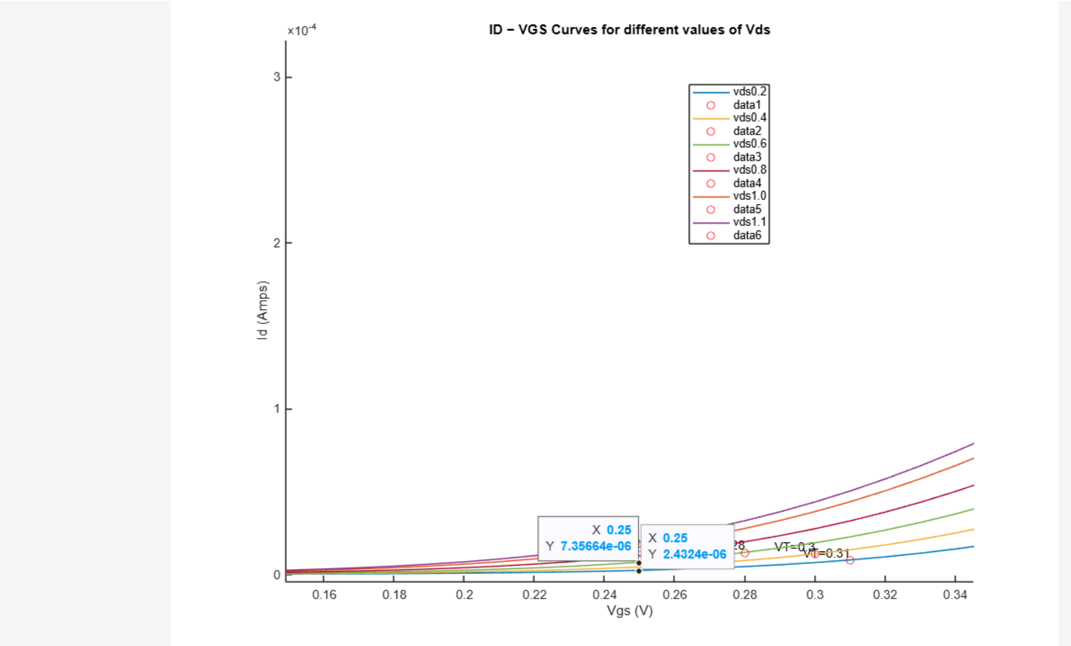


Figure 32: Plot showing Id vs Vgs

From the above plot it is observed that Vt=0.25v.

5. From the above simulations, can you conclude that Ron in the deep triode region is equal to the inverse of gm in the saturation region for the given transistor? Justify your answer.

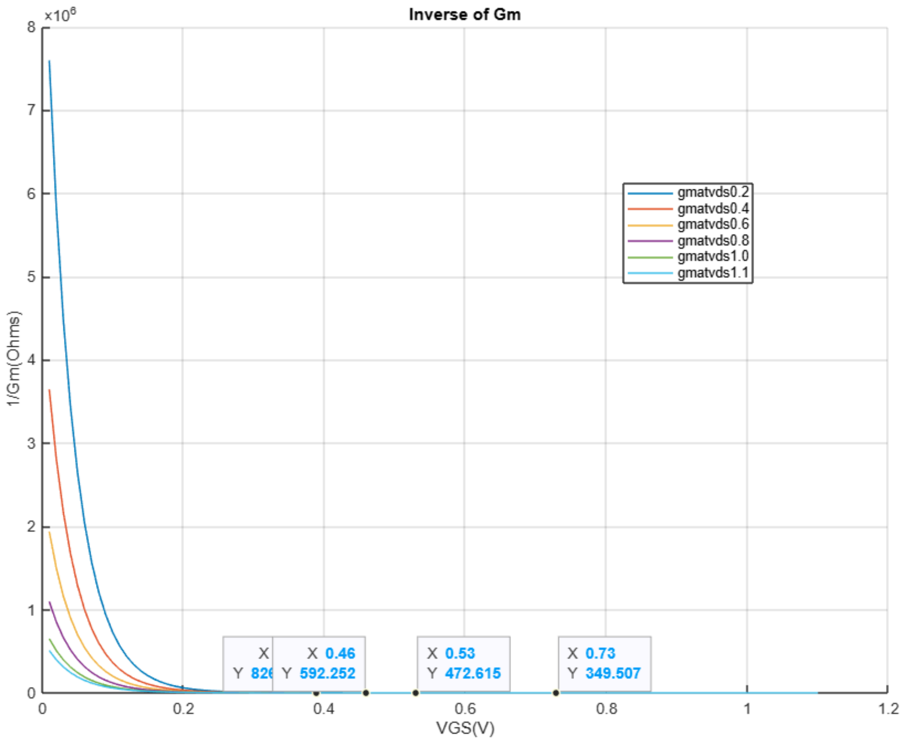


Figure 33.Plot showing 1/Gm Vs Vgs when Vds is sweeped from 0.2 to 1.1v

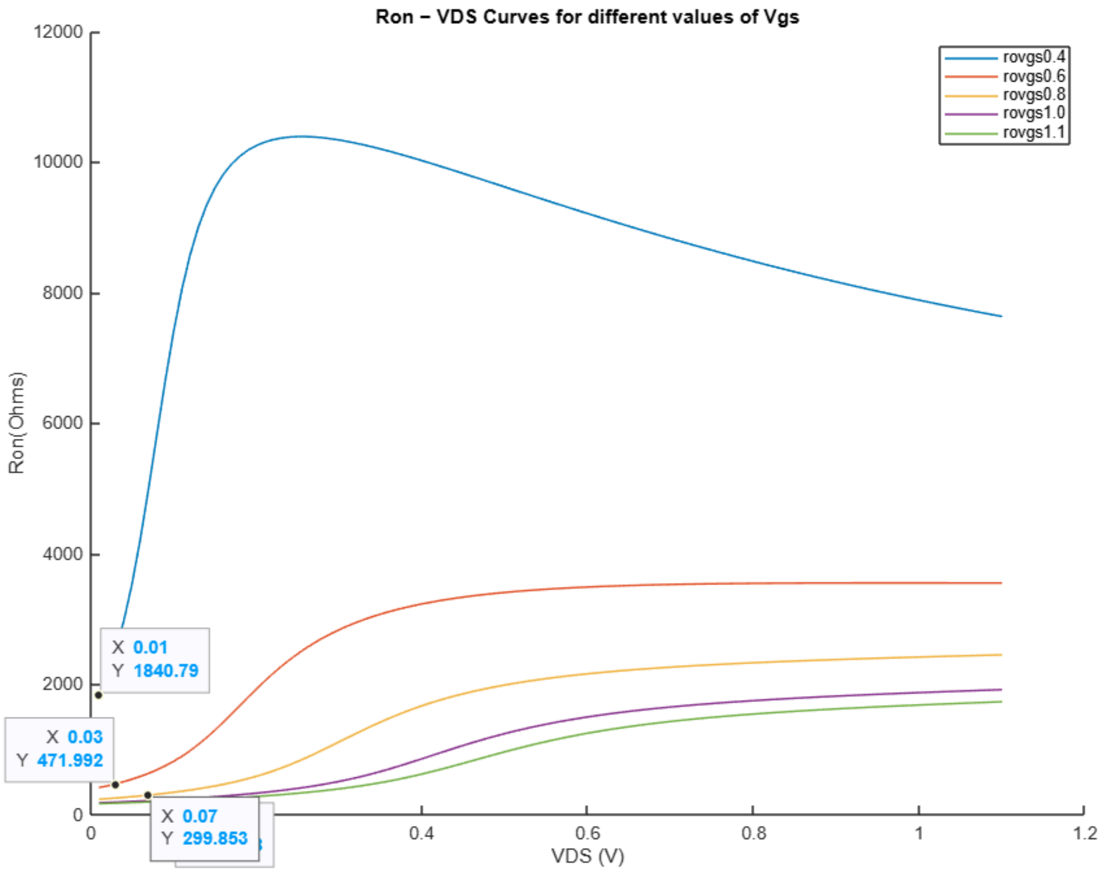


Figure 34.Plot showing Ron Vs Vds when Vgs is sweeped from 0.2 to 1.1v

Observation:In Deep triode region of operation we define Ron . In this region a small change in Vds results in significant change in Ron . Similarly , in Saturation region , gm is defined. If we observe the above figures 33,34 ; Plot shows that small change is Vgs resulting in very high change in 1/gm. Although the values of Ron and 1/gm are not numerically equal , both change as a function of (vgs-vt). Also both exhibiting same resistive behaviour .Hence , we can conclude Ron in the deep triode region is equal to 1/gm in saturation region of operation of MOSFET.