Prelab 1, Analog Integrated Curcuits

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f) Task: Determine the transconductance g\_m of the transistor at VGS = 0.5 V Diagram

Description automatically generated

Simulation of DC-Sweep of G\_gs,dc from 0V to 1V

Plot of I\_d,dc and the slope g\_m= I\_d,dc/V\_gs,dc at G\_gs,dc=0,5V by D(I(IM1)

A screenshot of a computer

Description automatically generated with medium confidence

g\_m= 124 µS @ V\_gs,dc=0,5V

g) Task: Determine the transistor V\_th value by sketching the tangent line at the highest slope of I\_d,dc/V\_gs,dc and determin the voltage of U\_gs,dc at I\_d,dc=0A of the tangent

A screenshot of a computer

Description automatically generated with medium confidence

Simulation of DC-Sweep of G\_gs,dc from 0V to 2V

The highest slope was determined at V\_gs,dc=1,91V with g\_m=230 uS

A linear straight was applied as Tangent to I\_dc,dc (Cursor Y1) with the parameter   
230u \* V\_VGDC – 125u which crossed I\_d,dc = 0A at U\_gs,dc = U\_th = 539mV (Cursor Y2)

A screenshot of a computer

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i) Task: Determine the linear (triode) region of the transistor

To satisfy linear region

* V\_gs,dc < V\_th = 539mV 🡪 always fulfilled because V\_gs,dc = 500mV < 539mV
* and V\_ds,dc < V\_gs,dc – V\_th = 500mV – 539mV = -39mV

Simulation of DC-Sweep of G\_ds,dc from 0V to 2V  
Plot of I\_d,dc

V\_pinch,off ~ 150mV

A screenshot of a computer

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j) Task: Determin small signal output resistance r\_ds = r\_o. Determine slope r\_o = I\_d,dc/D\_ds,dc

* r\_ds = 5,10 kOhm @ V\_ds,dc = 0V
* r\_ds = 8,41 kOhm @ V\_ds,dc = 50mV
* r\_ds = 515,4 kOhm @ V\_ds,dc = 0,9V

Simulation of DC-Sweep of G\_ds,dc from 0V to 2V  
Plot of I\_d,dc and Derivation D(ID(M1))

A screenshot of a computer

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k) Task: Repeat for L=1µm j)

Calculate new V\_th: New threshold value 813mV  
The highest slope was determined at V\_gs,dc=1,67V with g\_m=119 uS

A screenshot of a computer

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To satisfy linear region

* V\_gs,dc < V\_th = 813mV 🡪 always fulfilled because V\_gs,dc = 500mV < 813mV
* and V\_ds,dc < V\_gs,dc – V\_th = 500mV – 813mV = -313mV

Graphical user interface

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V\_pinch,off ~ 100mV

A picture containing graphical user interface

Description automatically generated

r\_0 = 45,8 MOhm, lower channel length modulation as expected, because channel is 4x longer

l, m) Task: Determin I\_d,dc and small signal parameters for steady state by simulation, switched back to L=250nm

I\_d,dc = 16,08µA

m) Task: Compare values of dc sweep and bias point simulation

|  |  |  |
| --- | --- | --- |
|  | Sim DC-sweep | Sim Bias Point (V\_gs,dc=0,9V) |
| V\_th | 539mV | 328mV |
| G\_m | 230µS | 132µS |
| r\_o | 515 kOhm | 512 kOhm |

Deviation on V\_th and g\_m due to selection on V-ds,dc != 0,9V as in bias point simulation