EE236: Experiment 5

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Overview of the experiment

0.1 Aim of the experiment

The aim of this experiment was to understand the workings and characteristics of MOSFETs along with non-idealities.

0.2 Report Pattern

Instead of following the template, I have split the report into sections based on the questions/simulations. Each section is based on one question/simulation, and all associated details are in that section only.

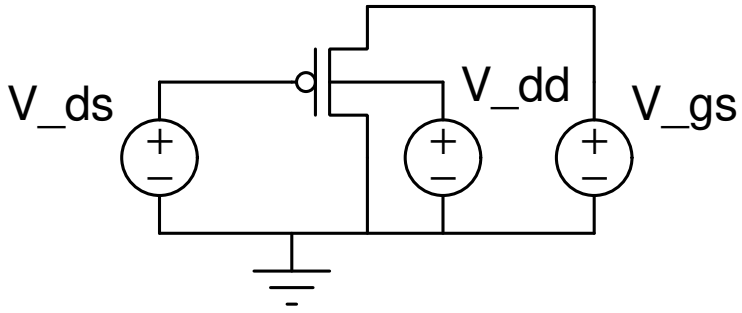

Figure 1: Circuit used. The same circuit has been used for all parts and the values of the voltages have changed, as can be seen in the code

1 $I_d - V_{ds}$ characteristics

Netlist used:

```
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.include pmos.txt

** 1 2 3 4: drain gate source body
m1 1 2 0 4 ALD1107
v_dd 4 0 2
v_id 10 1 0
v_ds 10 0
v_gs 2 0


.dc v_ds -5 0 0.1 v_gs -4 -2.5 0.5

* start control
.control
set color0 = rgb:f/f/e
set color1 = rgb:1/1/1

run

plot i(v_id) vs v(10)

** rds by seeing dx/dy near origin:
** -2.5: 3.8k, -3: 2.9k, -3.5: 2.3k, -4: 1.8k

** r_0 by seeing dx/dy in saturation:
** -2.5: 168302, -3: 92307, -3.5: 59446, -4: 40978

** early voltage:
** sat dy/dx = 1.70246e-05, x0 = -4.68615, y0 = -0.000619565
** c = y-mx = -0.000619565 - 1.70246e-05*(-4.68615) = -5.39785e-04
** v_a = -c/m = 3.170618e+01
```

```
.endc

.end
```

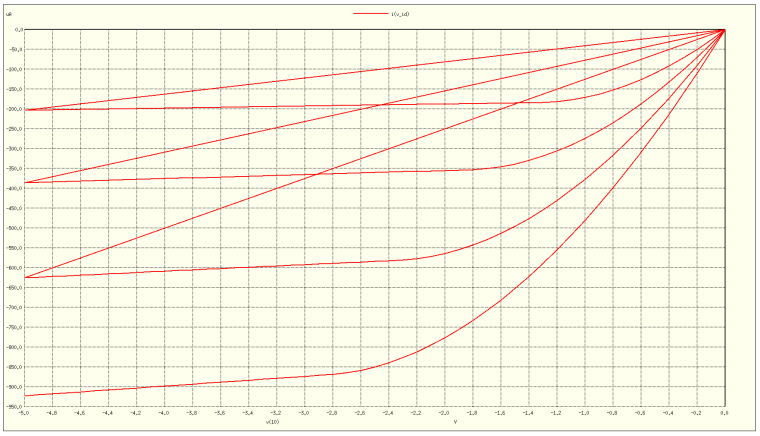

Figure 2: IV Characteristics

Calculation and values of R_{ds}, R_0, V_A have been mentioned in code

2 V_t and gm measurement

2.1 Linear Region

```
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.include pmos.txt

** 1 2 3 4: drain gate source body
m1 1 2 0 4 ALD1107
v_dd 4 0 0
v_id 10 1 0
v_ds 10 0 -0.2
v_gs 2 0


.dc v_gs -5 0 0.1

* start control
.control
set color0 = rgb:f/f/e
set color1 = rgb:1/1/1

run

plot i(v_id) vs v(2)

** v_t by extrapolating linear region: -0.91
** gm = 4.03441e-05
.endc

.end
```

All measured values are mentioned in the code

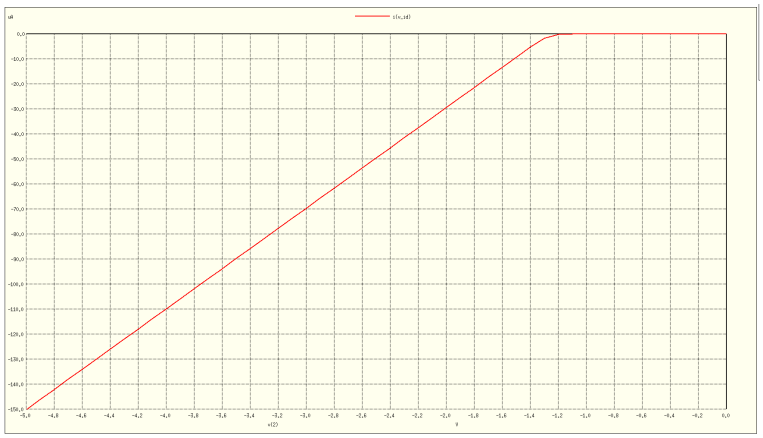

Figure 3: I vs V plot in linear region

2.2 Saturation Region

```
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.include pmos.txt

** 1 2 3 4: drain gate source body
m1 1 2 0 4 ALD1107
v_dd 4 0 2
v_id 10 1 0
v_ds 10 0 -5
v_gs 2 0


.dc v_gs -5 0 0.1

* start control
.control
set color0 = rgb:f/f/e
set color1 = rgb:1/1/1

run

plot (i(v_id)) vs v(2)

** v_t by linear region's intercept: -1.18
** gm = 2Id/(vds - vt) = 6e-4
** K = 2 * slope * slope = 2.321322e-04 A/V^2
.endc

.end
```

All measured values are mentioned in the code

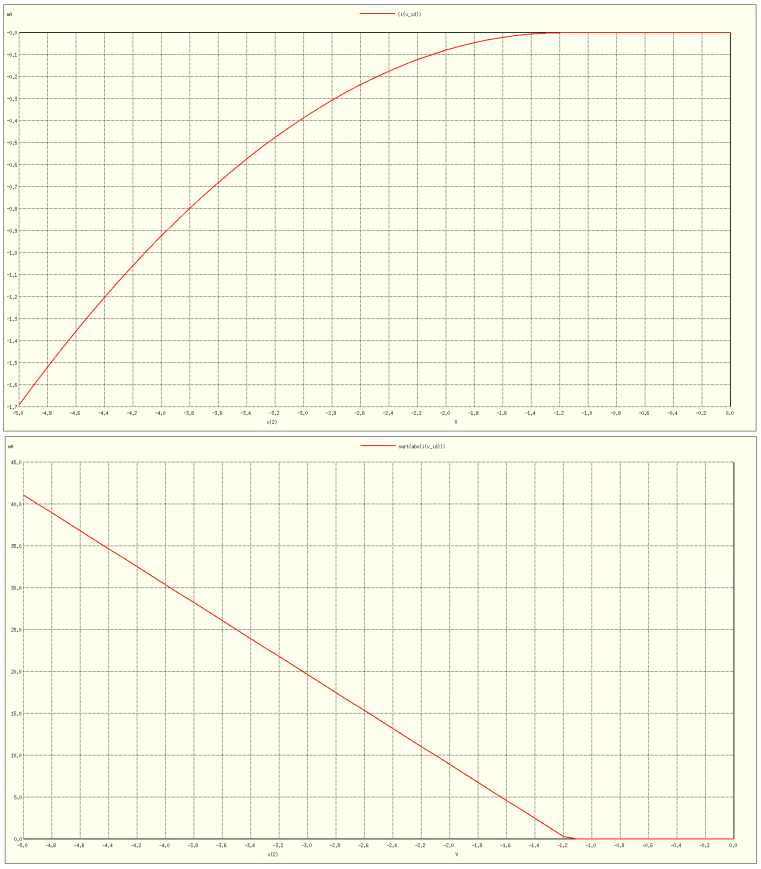

Figure 4: I vs V plot, $\sqrt{|I|}$ vs V plot in saturation region

3 Effect of body bias

```
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.include pmos.txt

** 1 2 3 4: drain gate source body
m1 1 2 0 4 ALD1107
v_dd 4 0
v_id 10 1 0
v_ds 10 0 -0.2
v_gs 2 0


.dc v_gs -5 0 0.1 v_dd 0 4 1

* start control
.control
set color0 = rgb:f/f/e
set color1 = rgb:1/1/1

run

plot i(v_id) vs v(2)

** v_t by extrapolating linear region:
** 0: -0.9,-1: -1.13, -2: -1.26, -3: -1.36, -4: -1.48
** v_t increases in magnitude as v_sb increases in magnitude

** -0.9 = v_to
** -1.48 = -0.9 + gamma(sqrt(4.8) - sqrt(0.8))
** gamma = -0.447
.endc

.end
```

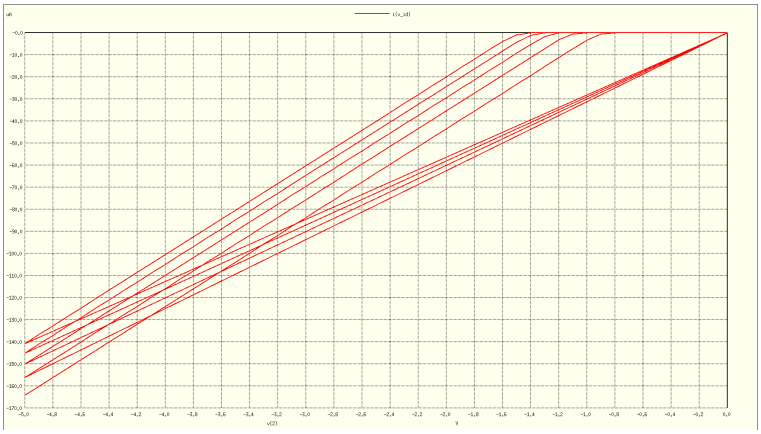

Figure 5: I vs V_{gs} plot as V_{sb} changes
Measurements and calculations are mentioned in the code

4 Experiment completion status

I was able to complete all parts of the experiment.