EE103 Intro to VLSI Design

Lab 2 Study of Characteristics of a MOS Transistor

Objective

- Lab 2 will be using HSPICE and WaveView to measure and calculate some key parameters about a transistor.
- The **DUE DATE** for this Lab 2 report is **POSTED ON CANVAS**.

Laboratory Tasks

- Calculate the parameters in the Assignment section.

Assignment:

*Comment: USE **W/L = 300nm/100nm, T=25C** for all the transistor measurement, probing and calculation.

*Comment: You may use the solved parameters to solve the subsequent problems. For example, you can use the $\boldsymbol{V_{DSat}}$ from the problem 3 and use it in problem 8.

*Comment: Choose .PRINT and .PROBE Wisely.

1. Use the Ids Versus Vds graph (for fixed Vgs) to calculate the **channel length modulation coefficient** (**λ**) (NMOS):
    - Vgs: 1.05; Vds: [0,1.05]
    - Hint: You can use your curve to solve λ.
    - Use *VLSI-transistor.pdf* p.26 and p.28 as a reference
2. Calculate **velocity saturation ($\boldsymbol{c_{ox} * \nu_{sat}}$)** (NMOS):
    - Vgs: 1.05; Vds:1.05; vbs:0;
    - Use *VLSI-transistor.pdf* p.31 as a reference
3. Print a set of **Saturation Voltage ($\boldsymbol{V_{DSat}}$)** (NMOS):
    - Vgs: 0:0.2:1.05; Vds:1.05; vbs:0;
    -

VTH	LV9	Threshold voltage (bias dependent)
VDSAT	LV10	Saturation voltage (VDSAT)

    - Show the results in '.lis' file.
    - Manually plot the set of V_{DSat} dots on the Ids versus Vds plot for different Vgs, we did this plot in the lab 2 assignment, part 2. (use *Measurement Tool -> Data(x,y)* in WaveView)
4. Measure the **Sub-threshold slope factor** (NMOS):
    - Vgs: [0,1.05]; Vds: 1.05; Vbs: 0;
    - Use *VLSI-transistor.pdf* p.41 as a reference (S is ΔVgs for Id2/Id1 = 10)
5. Measure the **Body effect ($\boldsymbol{k_\gamma}$)** (NMOS):
    - Vgs:1.05; Vds:1.05; Vsb: [-1.05,1.05];
    - Use *VLSI-transistor.pdf* p.13 and p.40 as a reference

6. Calculate **Beta (β)** (NMOS) (Consider the Channel Length Modulation):
    - Vgs: 1.05; Vds: 1.05; Vbs: 0;
    - Use *VLSI-transistor.pdf* p.28 as a reference
7. Calculate the **NMOS and PMOS mobility ratio ($\frac{\mu_n}{\mu_p}$)**:
    - Vgs: 1.05; Vds: 1.05; Vbs: 0 for NMOS;
    - Vgs: -1.05; Vds: -1.05; Vbs: 0 for PMOS
    - Use *VLSI-transistor.pdf* p.21 and p.25 as a reference
8. Calculate Critical Voltage: $\boldsymbol{Vc = E_c * L}$ (NMOS):
    - Vgs: 1.05; Vds: 1.05; Vbs: 0;
    - Use the Equation: $V_{DSat} = \frac{(Vgs-Vth)*E_c*L}{(Vgs-Vth)+E_c*L}$
9. Calculate $\boldsymbol{I_{DSat}}$ (NMOS):
    - Vgs: 1.05; Vds: 1.05; Vbs: 0;
    - $t_{ox} = 3nm$
    - Use Equation: $I_{DSat} = \frac{W}{L} * \frac{\mu_{eff}*C_{ox}*E_c*L}{2} \frac{(Vgs-Vth)^2}{(Vgs-Vth)+E_c*L}$
    - Use | MOBEFF | LX282 | Effective mobility at the specified analysis temperature. | to measure the μ_{eff}

<u>Submission Requirement</u>

- If you used HSPICE WaveView to extract any variable measurement, you need to attach a screenshot or use the '.lis' file of the measurement result to exactly show the measurement you get. For the calculation part, you need to show the derivation details and the results. You can write the derivation using Microsoft Word or LaTeX, or you also can handwrite and scan it.

WaveView Measurement Example

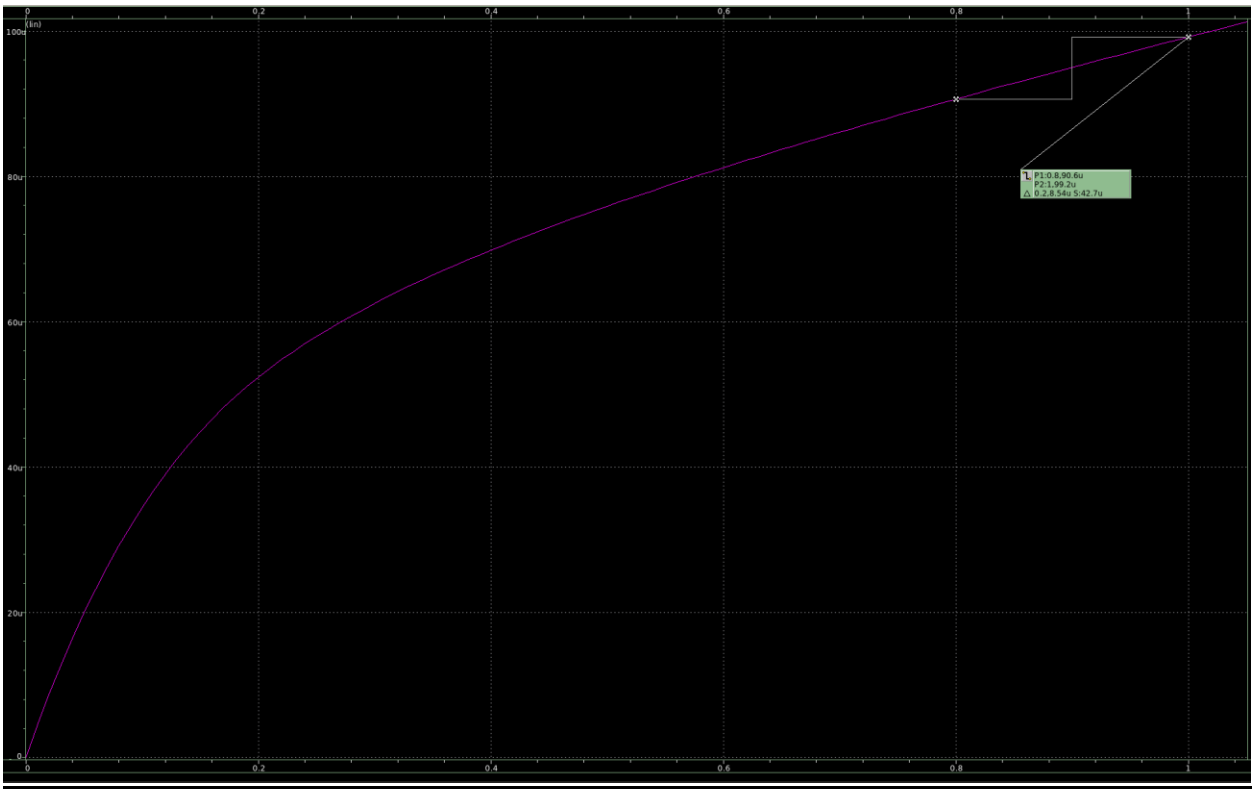

Figure 1. I-V Characteristic of the NMOS Transistor

Measuring the Slope: