# EE105 – Microelectronic Devices and Circuits
## Spring 2026, Homework #8

Assigned: **March 31, 2026**
Due: **April 7, 2026 at 11:59 PM on Gradescope**

# 1 Notes

Upload your notes from Lectures 16 and 17.

# 2 Problem Set

## 2.1 Problem 1: Small Signal Parameters (with Body Effect)

**Given:**

$$V_{GS} = 1\,\text{V}, \quad V_{DS} = 1\,\text{V}, \quad V_{SB} = 0.2\,\text{V}, \quad V_{TN} = 0.5\,\text{V}.$$

**Device Parameters:**

$$W = 10\,\mu\text{m}, \quad L = 1\,\mu\text{m},$$
$$\mu_n = 400\,\text{cm}^2/\text{V·s}, \quad C_{ox} = 3.45 \times 10^{-3}\,\text{F/m}^2,$$
$$L_j = 2\,\mu\text{m}, \quad L_{ov} = 0.05\,\mu\text{m}, \quad \lambda = 0.01\,\text{V}^{-1}.$$

**Capacitance Parameters:**

$$C_{j0} = 1 \times 10^{-3}\,\text{F/m}^2, \quad C_{jsw0} = 4 \times 10^{-10}\,\text{F/m}, \quad C_{\text{fringe}} = 1\,\text{fF}.$$

**Body Effect Parameters:**

$$\gamma = 0.053\,\text{V}^{1/2},$$
$$\phi_b = 0.9\,\text{V} \quad (\text{for } C_{db},\, C_{sb}), \quad \phi_b = 0.3\,\text{V} \quad (\text{for } g_{mb}).$$

**Notes:**
Use the equations provided in Chapter 9 and 10 of the reader. In the reader, $\phi_b = -\phi_p$. Calculate the following parameters to construct a NMOSFET's small signal model:

(a) $g_m$

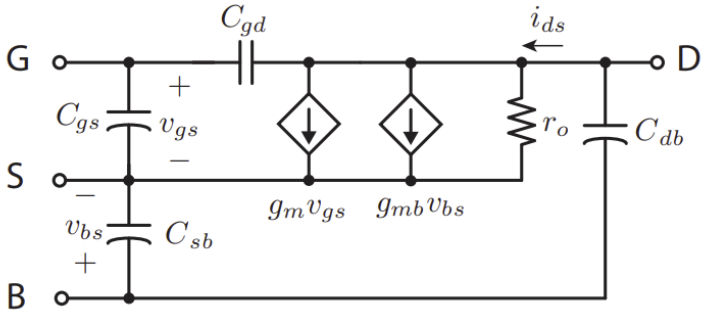
(b) $g_{mb}$

(c) $C_{gs}$

(d) $C_{gd}$

(e) $C_{db}$

(f) $C_{sb}$



## 2.2 Problem 2: NMOS Common Source Amplifier

An n-channel MOSFET has the following parameters:

$$W = 10\,\mu\text{m}, \quad L = 1\,\mu\text{m}, \quad V_T = 0.5\,\text{V},$$

$$\mu_n = 400\,\text{cm}^2/\text{V·s}, \quad C_{ox} = 4 \times 10^{-7}\,\text{F/cm}^2, \quad \lambda = 0.01\,\text{V}^{-1}.$$

You may neglect capacitances and any body effect.

(a) Calculate $g_m$ at

$$V_{GS} = 1\,\text{V}, \quad V_{DS} = 1.2\,\text{V}.$$

(b) Calculate $r_o$ at

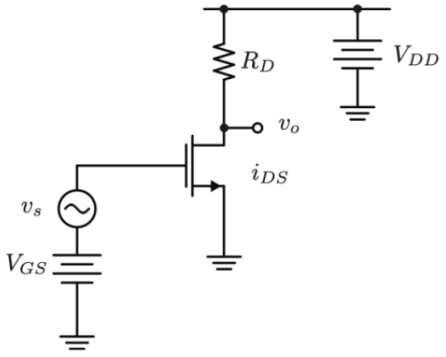
$$V_{GS} = 1\,\text{V}, \quad V_{DS} = 1.2\,\text{V}.$$

(c) Draw the small-signal equivalent circuit and find the numerical gain

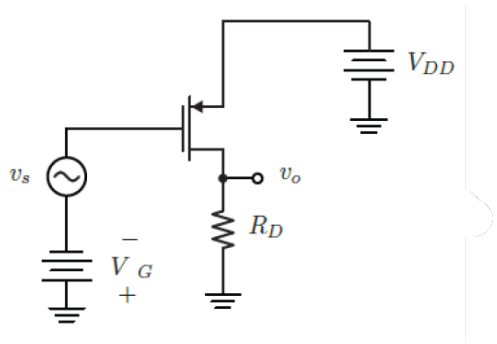
$$A_v = \frac{v_o}{v_s}$$

With the following DC bias point:

$$V_{GS} = 1\,\text{V}, \quad R_D = 1\,\text{k}\Omega, \quad V_{DD} = 1.4\,\text{V}.$$



## 2.3 Problem 2: PMOS Common Source Amplifier




For a PMOS common-source amplifier with $\lambda = 0$, answer the following questions:

(a) If $V_{SG} - |V_{TP}| = V_{ov}$, find the maximum $R_D$ symbolically such that the PMOS operates in the saturation region. Write your answer in terms of $V_{DD}$, $V_{ov}$ and $\mu_p C_{ox} \dfrac{W}{L}$.

(b) Draw the small-signal equivalent circuit and find the gain

$$A_v = \frac{v_o}{v_s}$$

symbolically in terms of $R_D$, $g_m$, $r_o$. The body is grounded.

(c) For the same circuit as in part (b), but with the body connected to the small-signal output $v_o$, re-draw an updated small-signal model and calculate the updated $A_v = \frac{v_o}{v_s}$ symbolically in terms of $R_D$, $g_m$, $g_{mb}$, $r_o$.