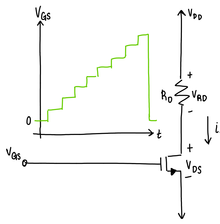
Prelab 3

Wednesday, September 4, 2024 23:04

Curve tracer overview

general concept

- starts by setting $V_{GS} = 0$
- V_{DS} swept from 0 to V_{DD} } producing 1 trace
- V_{GS} stepped by a constant amount
  - → repeated until reaches maximum V_{GS}
    - ° starts over again at $V_{GS} = 0$
    - → endlessly repeats process



curve tracer concept

small signal transconductance

→ small signal parameter used to describe behavior of a device near a certain bias point

$$g_m = \frac{d i_D}{d V_{GS}}$$

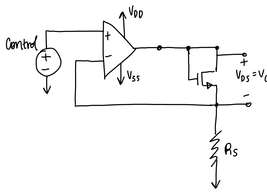
to estimate from a curve tracer:

$$g_m = \frac{\Delta i_D}{\Delta V_{GS}}$$

Threshold voltage tester

can build simple op-amp circuit to automatically bias the transistor to V_θ

→ makes measuring V_θ very simple



automatic threshold voltage tester

- forces $V_{DS} = V_{GS}$ by connecting Gate & Drain
  - → automatically sets voltage @ drain & gate node to desired i_D
  - → i_D programmed by changing $V_{control}$ and R_S

Measured value of V_{GS} = threshold voltage of device

- ° opamp ensures correct amount of current flowing

Prelab 3.6.1

- N-channel MOSFET

$V_\theta = 1\,V$
$V_{GS} = 1.5\,V$
$i_D = 10\,mA$
what is K_n?

$$K_n = \frac{2\, i_D}{(V_{GS} - V_T)^2} = \frac{20}{(1.5-1)^2} = 80$$

$K_n = 80$

use 3.3 & 3.4 to calculate the ideal value of g_m in terms of V_{GS}, K_n, V_θ

$$i_D = \frac{K_n}{2}(V_{GS} - V_\theta)^2 \quad (K = \text{const}, \theta = \text{const})$$

$$g_m = \frac{d i_D}{d V_{GS}}$$

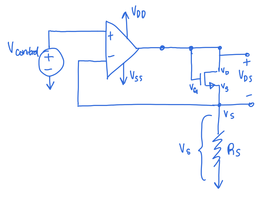
$$y = \frac{C_2}{2}(x - C_2)^2$$

$$\frac{C_2}{2} 2(x - C_2) \cdot 1$$

$$i_D' = \frac{K_n}{2}(V_{GS} - V_\theta) = g_m$$

$$g_m = K_n(V_{GS} - V_\theta)$$

Virtual short circuit analysis on the circuit 3.2 to find i_D in terms of R_S & V_{ctrl}



assuming Vt & V- same

makes $V_{control} = V_D$

Voltage drop across $R_S = V_S$

$V_S = V_{control}$ → makes $V_D = V_S$

$$i_D = \frac{V_S}{R_S}$$

$$i_D = \frac{V_{control}}{R_S}$$

$R_S = 100K$ what should $V_{control}$ be for i_D to be $1\mu A$

$$1\mu A = \frac{V_{ctrl}}{100K\Omega} = 0.1 = V_{ctrl}$$