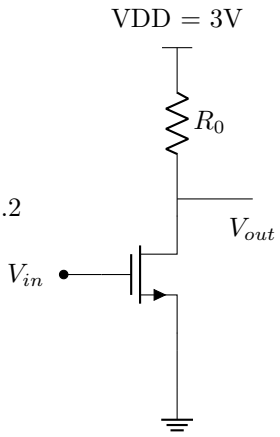
EE-320 – Exercise 7 Solutions - Fall 2025

1



The min V_{out} to keep M_1 in Sat $=$

$$= V_{GS} - V_{TH}$$

$$= V_{GS} - 0.5 = 0.2$$

(a) DC level of $V_{in} \Rightarrow V_{GS} = 0.7V$

$$P = V_{DD} I_D = 3mW \qquad V_{DD} = 3V \Rightarrow I_D = 1mA$$

$$I_D = \frac{1}{2}\mu_n C_{ox} \frac{W}{L}(V_{GS} - V_{TH})^2$$

$$1mA = \frac{1}{2}\frac{1mA}{V^2} \times \frac{W}{0.5\mu}(0.2)^2$$

(b) $\Rightarrow W = 25\mu m$

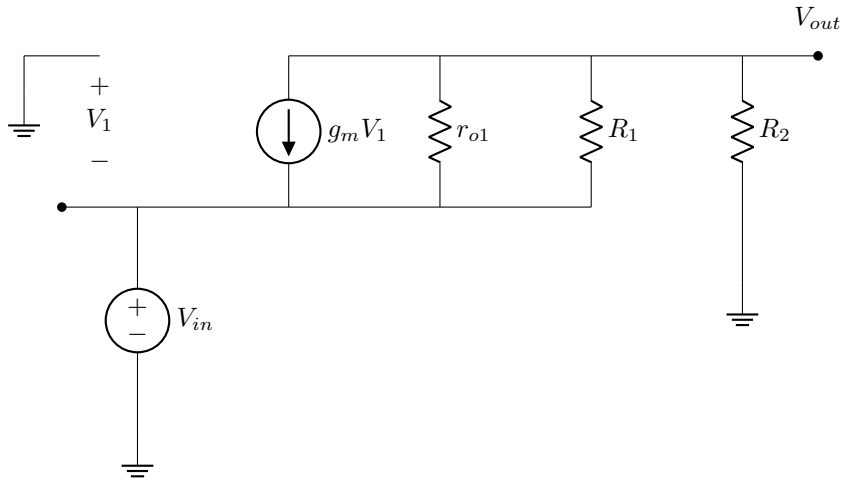
$$|A_V| = |-g_m R_D| = 15 \qquad g_m = \frac{2I_D}{V_{GS} - V_{TH}} = \frac{2 \times 1mA}{0.2} = 10mS$$

(c) $\Rightarrow R_D = 1.5K\Omega$

(d) $\Rightarrow V_{out(DC)} = V_{DD} - R_D I_D = 3 - 1.5k \times 1mA = 1.5V$

2

(a)



V_b = ac ground

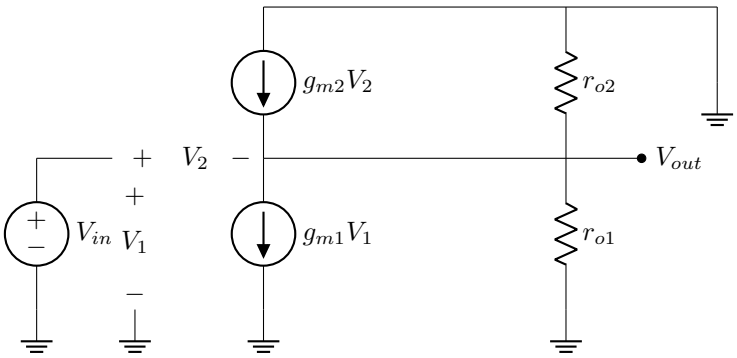
$$V_{in} = -V_1$$

$$\text{KCL @ } V_{out}: \frac{V_{out} - V_{in}}{R_1 || r_{o1}} + \frac{V_{out}}{R_2} + g_{m1}(-V_{in}) = 0$$

$$\frac{V_{out}}{r_{o1}} + \frac{V_{out}}{R_1} + \frac{V_{out}}{R_2} = \frac{V_{in}}{R_1} + \frac{V_{in}}{r_{o1}} + g_{m1}V_{in} \Rightarrow \frac{V_{out}}{V_{in}} = \frac{g_{m1} + \frac{1}{r_{o1}} + \frac{1}{R_1}}{\frac{1}{r_{o1}} + \frac{1}{R_1} + \frac{1}{R_2}}$$

(The gain of a CG is positive)

(b)



$$V_2 = V_{in} - V_{out} \qquad V_{in} = V_1$$

$$\text{KCL @ } V_{out}: \frac{V_{out}}{r_{o1}} + \frac{V_{out}}{r_{o2}} + g_{m1}V_{in} - g_{m2}(V_{in} - V_{out}) = 0$$

$$A_V = \frac{V_{out}}{V_{in}} = -\frac{g_{m1} - g_{m2}}{\frac{1}{r_{o1}} + \frac{1}{r_{o2}} + g_{m2}}$$