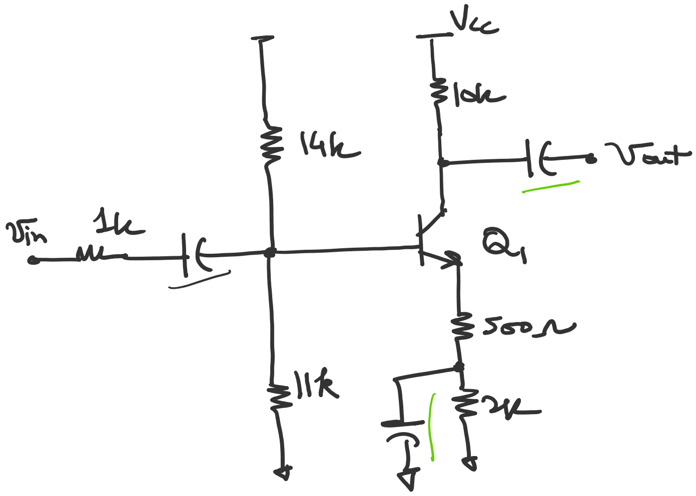
ECE 310 - Lecture 34.

Friday, April 20, 2018 10:30 AM

Problem 5.52 (c)

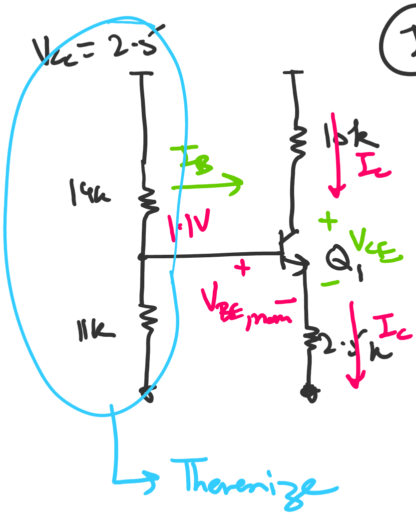
$V_{cc} = 2.5V$, $I_S = 8\times10^{-16}A$, $\beta = 100$, $V_A \to \infty$.

$V_{BE,nom} = 0.7V$



Dc picture:

$\beta = 100$



(I) I_{gnore} base current:

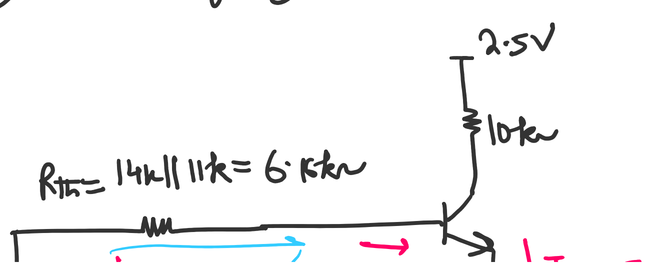
$$I_c \simeq I_E = \frac{1.1 - 0.7}{2.5k\Omega} = \boxed{0.16\,mA}$$

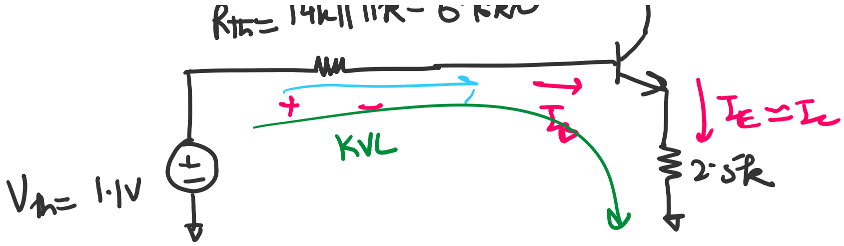
$$V_{CE} = 2.5 - 0.16mA\,(12.5k) = \underline{0.5V} \leftarrow \text{SAT.}$$

$$g_m = \frac{I_c}{V_T} \qquad r_o \to \infty$$

$$r_\pi = \frac{\beta}{g_m}$$

(II) Not ignoring base current





$$V_{th} - I_B \cdot R_{th} - V_{BE,nom} - I_C \cdot 2.5k = 0$$

$$I_B = \frac{1.1V - V_{BE,nom} - I_C \cdot 2.5k}{6.16k\Omega}$$

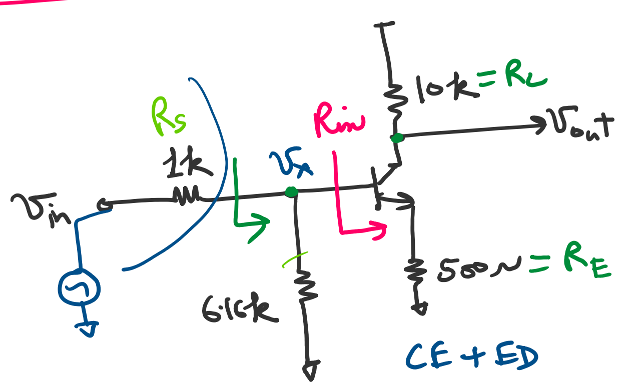
$$I_C = \beta I_B = \frac{100\left(1.1 - 0.7 - I_C \times 2.5k\right)}{6.16k\Omega}$$

$$\boxed{I_C = 0.156\,mA}$$

$$g_m = \frac{I_C}{V_T} = 6\,\frac{mA}{V}$$

$$r_\pi = \frac{\beta}{g_m} = 16.67\,k\Omega$$

AC picture:



$$\frac{v_{out}}{v_{in}} = \left(\frac{v_x}{v_{in}}\right) \times \left(\frac{v_{out}}{v_x}\right)$$

$$R_{in} = r_\pi + (\beta+1) R_E$$

$$= 16.67k + 101 \times 0.5k$$

$= 16.67k + 101 \times 0.5k$

$= 67.17 k\Omega$

$\frac{v_x}{v_{in}} = \frac{R_{in} \| 6.16k}{1k + R_{in} \| 6.16k} = 0.85$

$\frac{v_{out}}{v_x} \simeq - \frac{g_m R_C}{1 + \left(\frac{1}{r_\pi} + g_m\right) R_E}$

$\simeq - \frac{R_C}{\frac{1}{g_m} + R_E} \qquad \because \beta >> 1$

$= - 59.82$

$A_v = 0.85 \times (-59.82) = -50.84$

$20 \log_{10}(\quad) = x \text{ dB}$

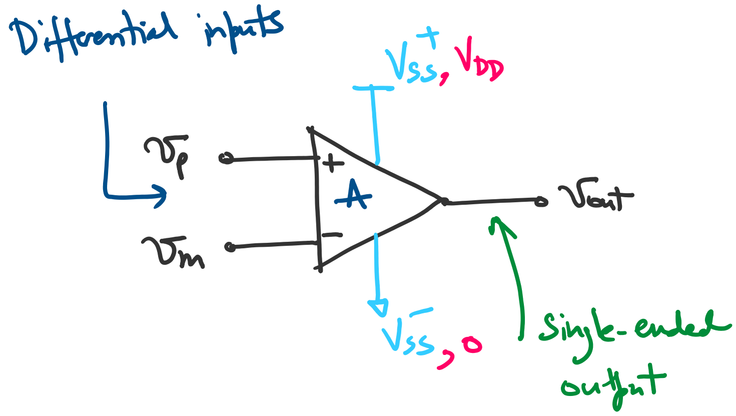
Input Resistance $\Rightarrow$ $R_{in} \| 6.16k\Omega = 5.64 k\Omega$

Chapter 8 – Operational Amplifiers (Opamps)

Friday, April 20, 2018 10:56 AM

MOSFETs
BJTs
JFET

Ideal opamp:



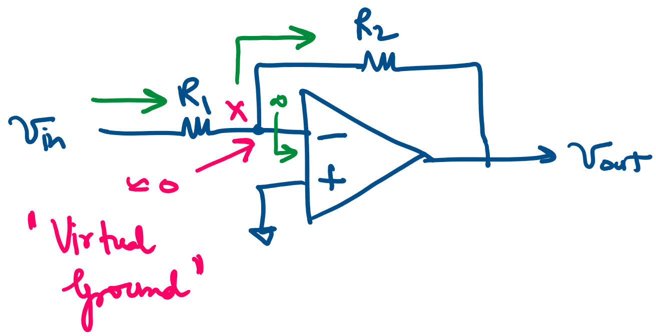
low-frequency idealized model

$$v_{out} = A(\underbrace{v_p - v_m}_{\simeq 0})$$

v_{out}: finite, $0 < \quad < V_{DD}$

$\hookrightarrow A \to \infty$

for finite $v_{out} \Rightarrow v_p \simeq v_m$

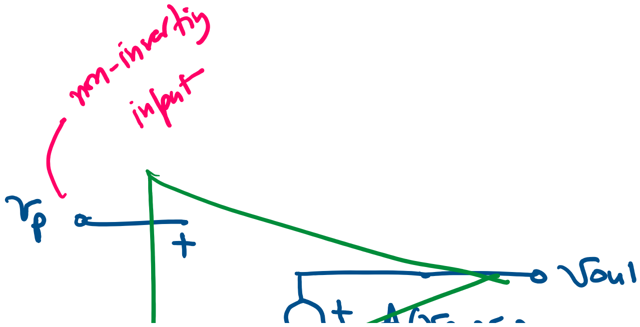


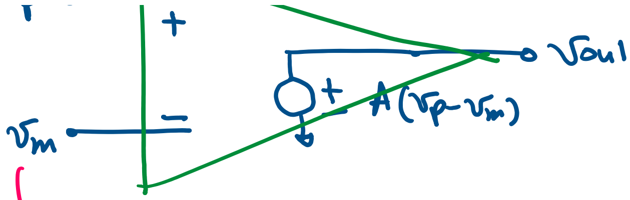
$$\frac{v_{in}}{R_1} = \frac{(\cancel{v_x}^{\,0} - v_{out})}{R_2}$$

$$\frac{v_{in}}{R_1} = -\frac{v_{out}}{R_2}$$

$$\Rightarrow \frac{v_{out}}{v_{in}} = -\frac{R_2}{R_1} \quad \text{very precise}$$

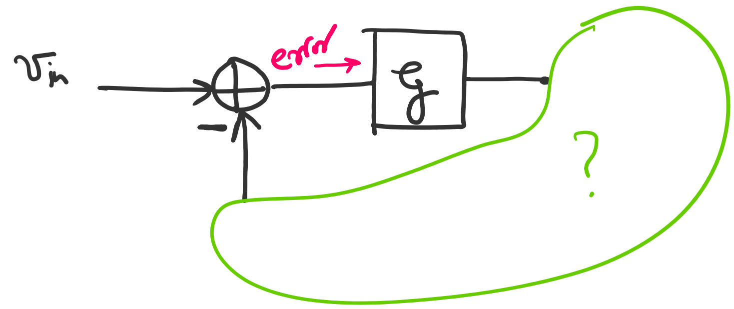
$\hookrightarrow$ independent of A





inverting input

Control system



Ideal Opamp:

* $A \longrightarrow \infty$
* $R_{in} \longrightarrow \infty$
* $R_{out} \longrightarrow 0$
* infinite speed $\rightarrow$ ∞ bandwidth