MILLER'S THEOREM

⇒ "MILLER EFFECT" DESCRIBED BY JOHN MILLER IN 1920

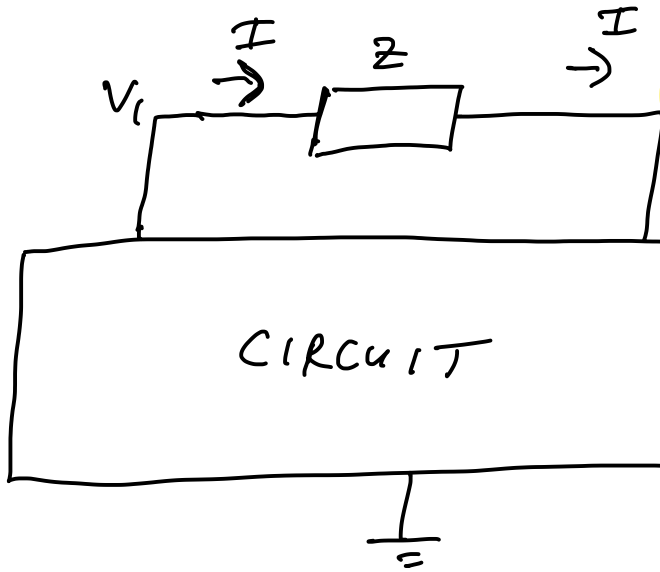
⇒ FORMALIZED IN 1972 AS "MILLER'S THEOREM"

⇒ USED TO CHANGE A SINGLE IMPEDANCE BETWEEN 2 NODES INTO 2 GROUNDED IMPEDANCES

⇒ A COMMON EXAMPLE IS C_{gd} IN A TRANSISTOR AND WANT TO FIND C_g CAPACITANCE TO GROUND

MILLER'S THEOREM

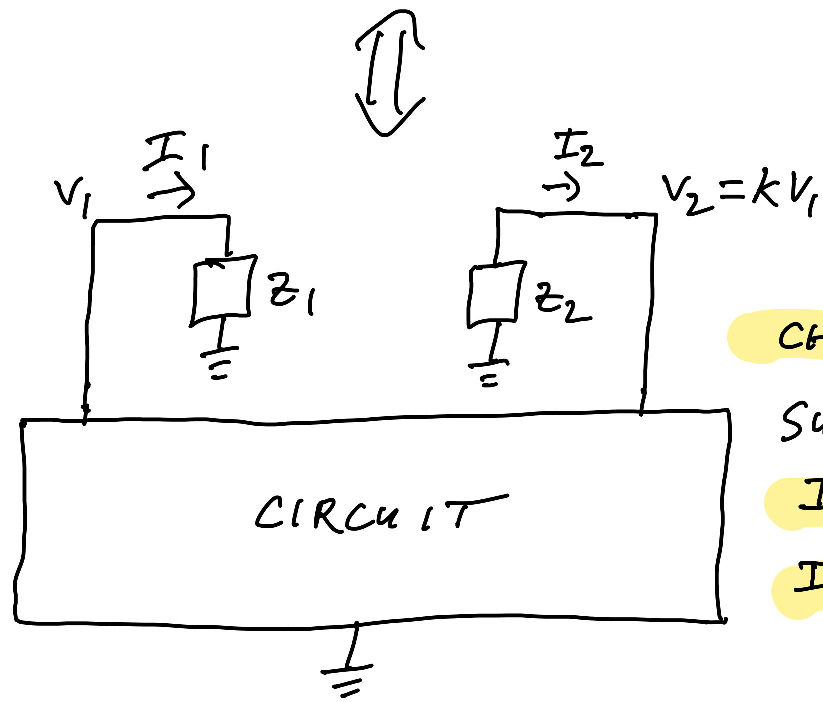
⇒ USED TO BREAK UP A COUPLING IMPEDANCE BETWEEN 2 NODES



$V_2 = kV_1$

$$I = \frac{V_1 - V_2}{Z}$$

$$I = \frac{V_1 - kV_1}{Z}$$



CHOOSE Z_1 + Z_2

SUCH THAT

$I_1 = I$

$I_2 = I$

$$Z_1 = \frac{Z}{1-k}$$

$$Z_2 = \frac{Z}{\left(1 - \frac{1}{k}\right)}$$

PROOF

$$I = \frac{V_1 - kV_1}{Z} \qquad I_1 = \frac{V_1}{Z_1}$$

FOR $I_1 = I \Rightarrow \frac{V_1}{Z_1} = \frac{V_1 - kV_1}{Z}$

$$\Rightarrow Z_1 = \frac{Z}{1-k}$$

ALSO $I_2 = \frac{0 - V_2}{Z_2} = \frac{0 - kV_1}{Z_2}$

FOR $I_2 = I \Rightarrow \frac{-kV_1}{Z_2} = \frac{V_1 - kV_1}{Z}$

$$\Rightarrow Z_2 = \frac{Z}{\left(1 - \frac{1}{k}\right)}$$

IF $Z = R \Rightarrow R_1 = \frac{R}{1-k}$

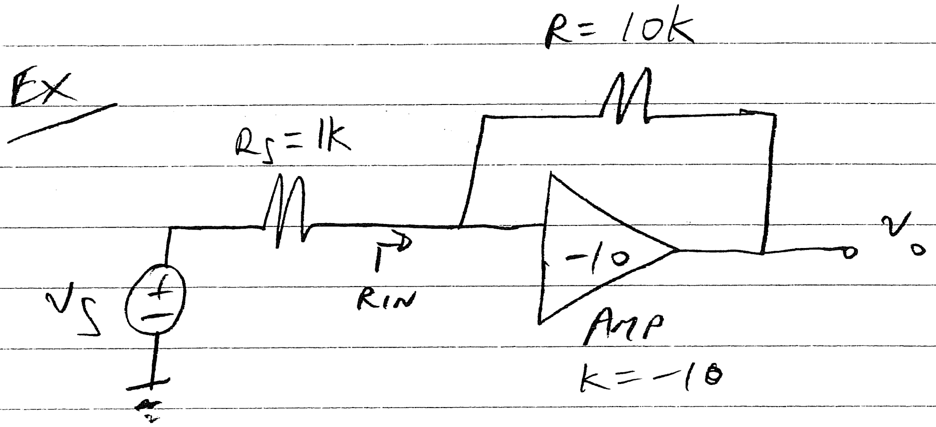
$$R_2 = \frac{R}{\left(1 - \frac{1}{k}\right)}$$

IF $Z = \frac{1}{SC} \Rightarrow C_1 = C(1-k)$

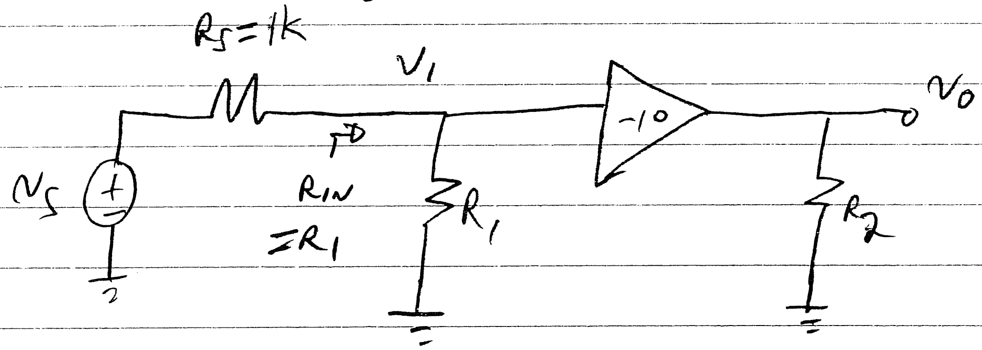
$$C_2 = C\left(1 - \frac{1}{k}\right)$$

MT3

Ex



⇓



$$R_1 = \frac{R}{1-K} = \frac{10k}{1-(-10)} = \frac{10k}{11} = 909.1\,\Omega$$

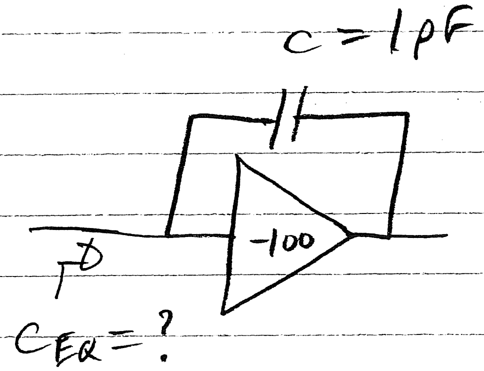
$$V_1 = \frac{R_1}{R_1+R_S} V_S = 0.476\, V_S$$

$$V_0 = -10\, V_1 = -4.76\, V_S$$

$$R_2 = \frac{R}{1-1/K} = \frac{10k}{1+\left(\frac{1}{10}\right)} = 9.1k \approx R$$

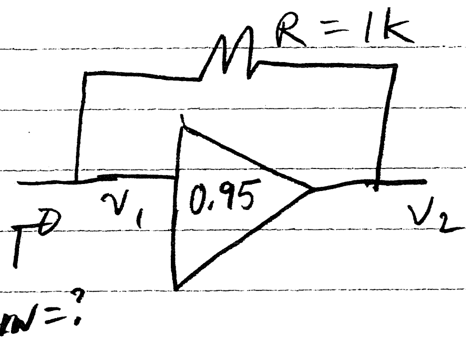
NOT MUCH CHANGE

Ex



$$C_{EQ} = C(1+100) = 101C = 101\,pF$$

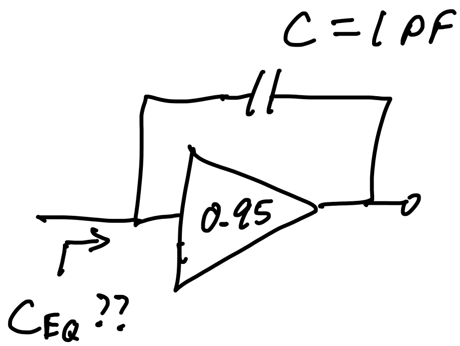
Ex BOOTSTRAPPING



$$R_{IN} = \frac{R}{1-0.95} = \frac{R}{0.05} = 20R = 20k\Omega$$

SINCE $V_2 \simeq V_1$ LITTLE CURRENT FLOWS THROUGH R AND IMPEDANCE INCREASED

EX BOOTSTRAPPING WITH A CAPACITOR



$$C_{EQ} = C(1-0.95) = C(0.05) = 50\ fF$$