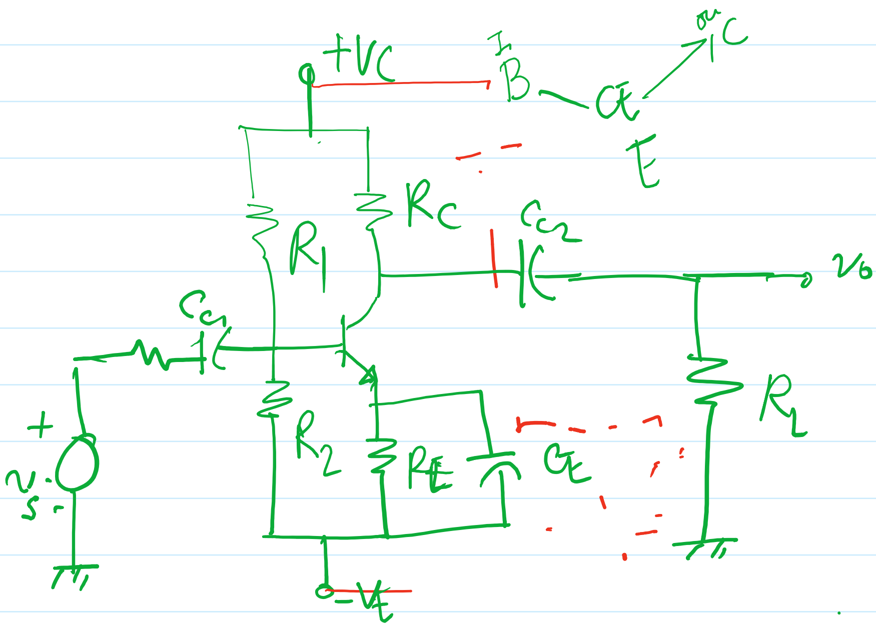
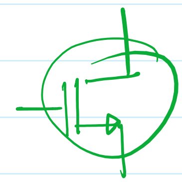
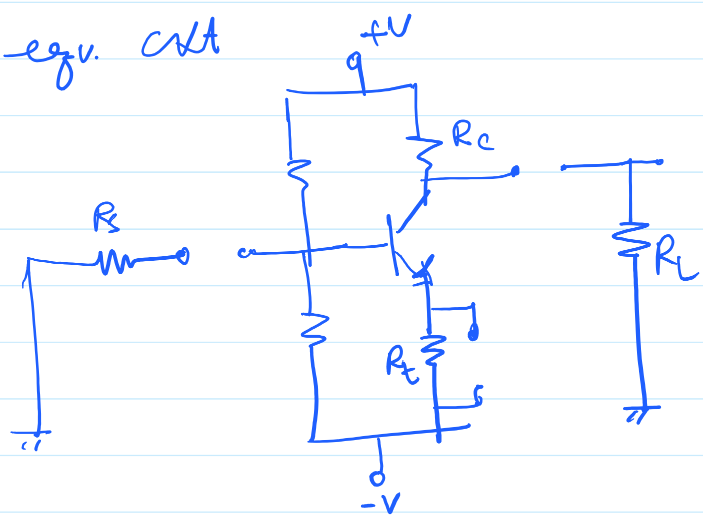
# Frequency Response

Thursday, February 2, 2017 2:30 PM

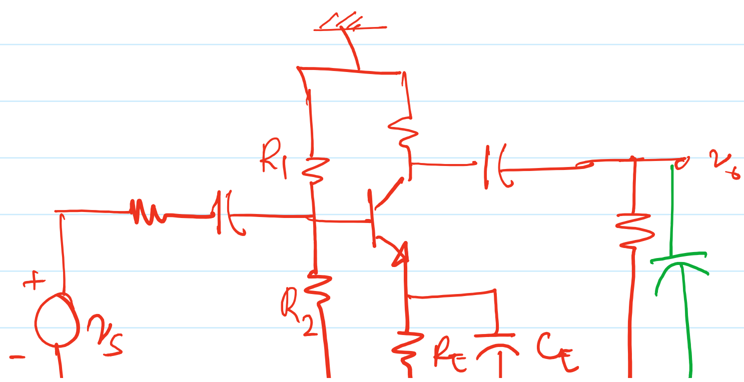


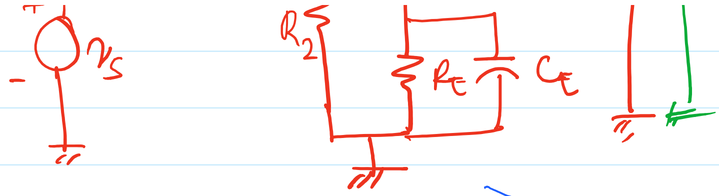



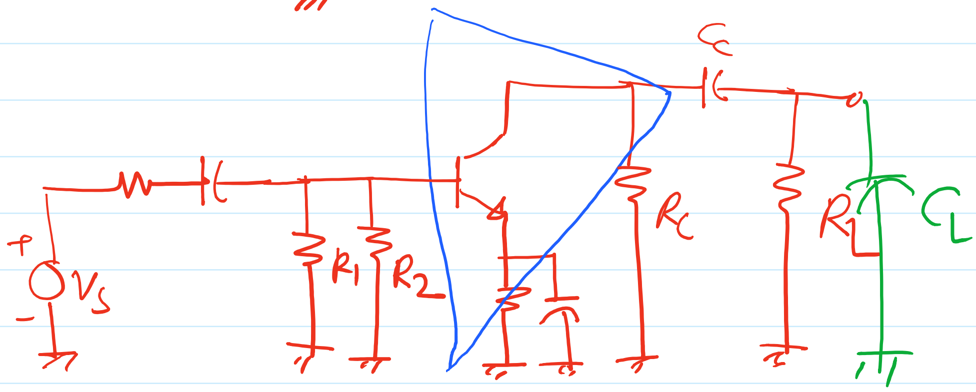
DC equ. ckt

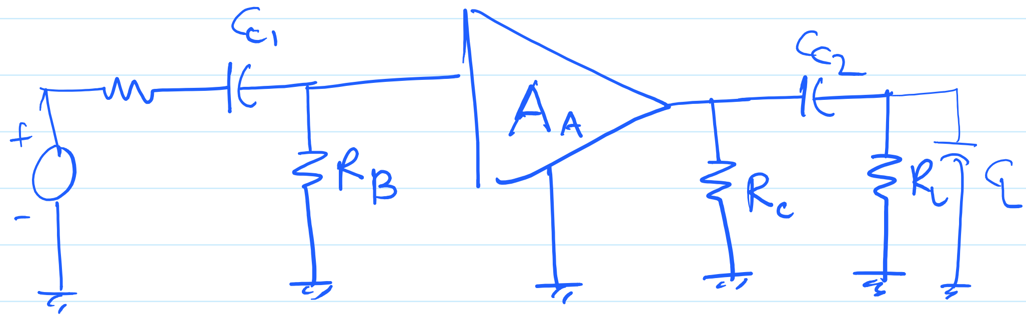


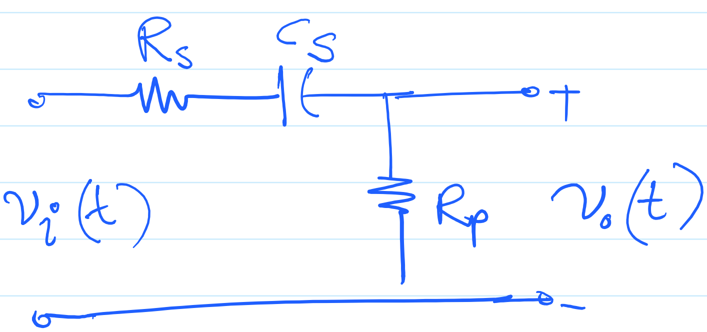

AC equivalent circuit

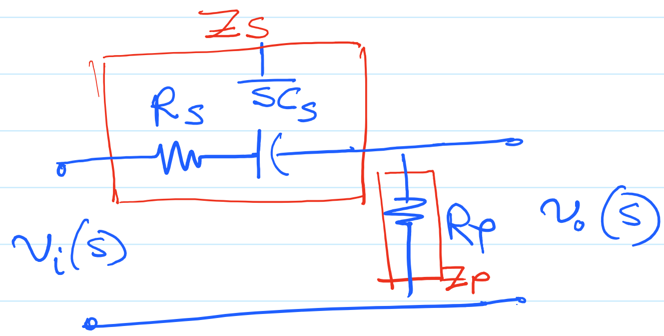




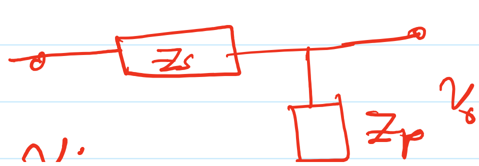



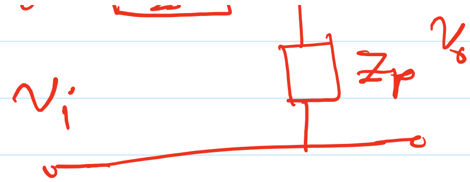




$$T(s) = \frac{v_o(s)}{v_i(s)}$$



$$\overline{v_i(s)}$$

$$= \frac{Z_p}{Z_p + Z_s}$$




$$Z_p = R_p$$

$$Z_s = R_s + \frac{1}{sC_s}$$

$$Z_p + Z_s = R_p + R_s + \frac{1}{sC_s}$$

$$= \frac{1 + (R_p + R_s) sC_s}{sC_s}$$

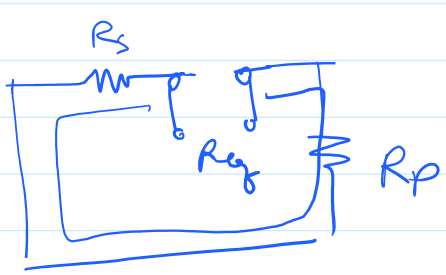
$$\therefore T(s) = \frac{R_p}{\frac{1 + (R_p + R_s) sC_s}{sC_s}} = \frac{R_p \; sC_s}{1 + sC_s(R_p + R_s)}$$

$$= \frac{R_p}{R_p + R_s} \cdot \frac{s \cdot C_s (R_p + R_s)}{1 + sC_s(R_p + R_s)}$$

$$= \frac{R_p}{R_p + R_s} \cdot \frac{s\tau_s}{1 + s\tau_s} = K \cdot \frac{s\tau_s}{1 + s\tau_s}$$

$\tau_s = C_s (R_p + R_s)$ time constant

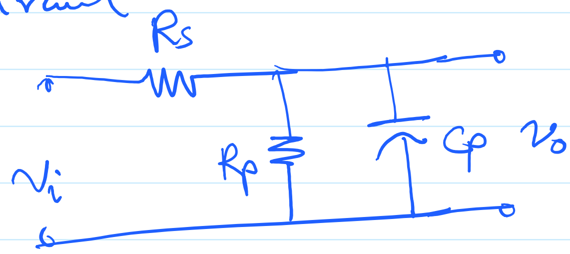
$$T_{s \to \infty} = K \frac{1}{1 + \frac{1}{s\tau_s}} = K$$

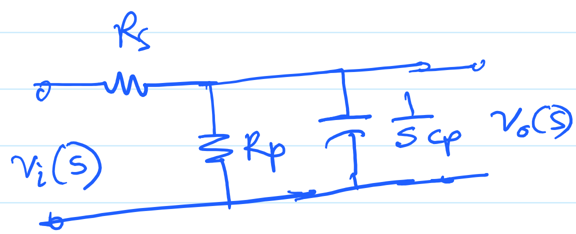


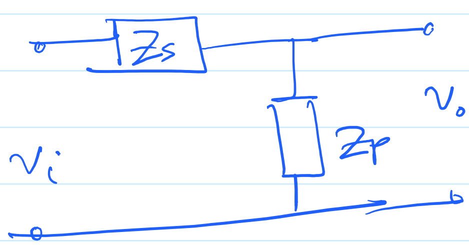

$$\tau_s = C_s R_{eq}$$

$$= C_s (R_s + R_p)$$

* Derive the transfer function of the following circuit




$$Z_s = R_s$$

$$Z_p = R_p \,\|\, \left(\frac{1}{sC_p}\right)$$

$$= \frac{R_p \frac{1}{sC_p}}{R_p + \frac{1}{sC_p}}$$

$$= \frac{R_p}{1 + sC_pR_p}$$

$$T(s) = \frac{Z_p}{Z_p + Z_s}$$

$$Z_p + Z_s = \frac{R_p}{1 + sC_pR_p} + R_s$$

$$= \frac{R_p + R_s + sC_pR_pR_s}{1 + sC_pR_p}$$

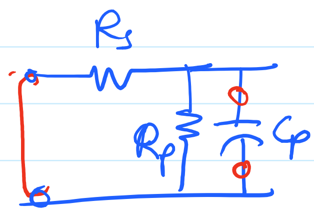
$$\therefore T(s) = \frac{\dfrac{R_p}{\cancel{1 + sC_pR_p}}}{\dfrac{R_p + R_s + sC_pR_pR_s}{\cancel{1 + sC_pR_p}}}$$

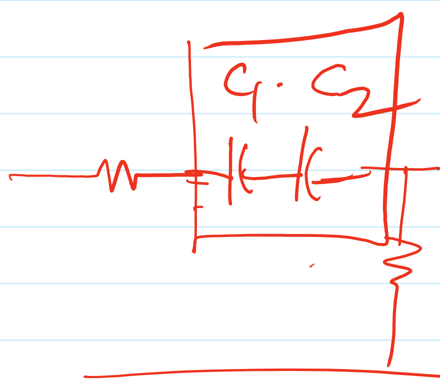
$$= \frac{R_p}{R_p + R_s + sC_pR_pR_s}$$

$$= \frac{R_p}{(R_p+R_s)\left[1 + \frac{s C_p R_p R_s}{R_p+R_s}\right]}$$

$$T = K \cdot \frac{1}{1 + s\tau_p} \qquad \tau_p = C_p R_{eq}$$

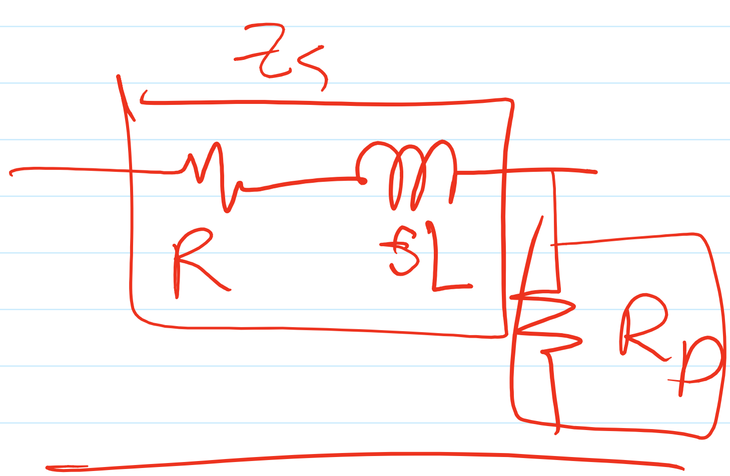
$$= C_p \left(R_p \| R_s\right)$$




$$C_s = C_1 + C_2$$

$$C_s = \frac{C_1 C_2}{C_1 + C_2}$$




$Z_1 \| Z_2$

$j\omega L$

$X_c = \frac{1}{\omega C}$

$Z_1 \| Z_p$

$\frac{1}{\omega C_1} \| \frac{1}{\omega C_2}$

$= C_1 + C_2$