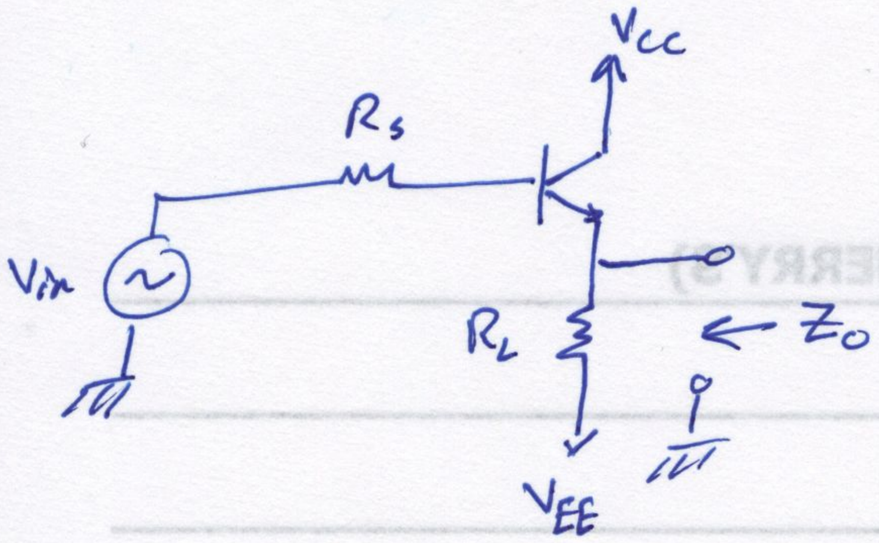
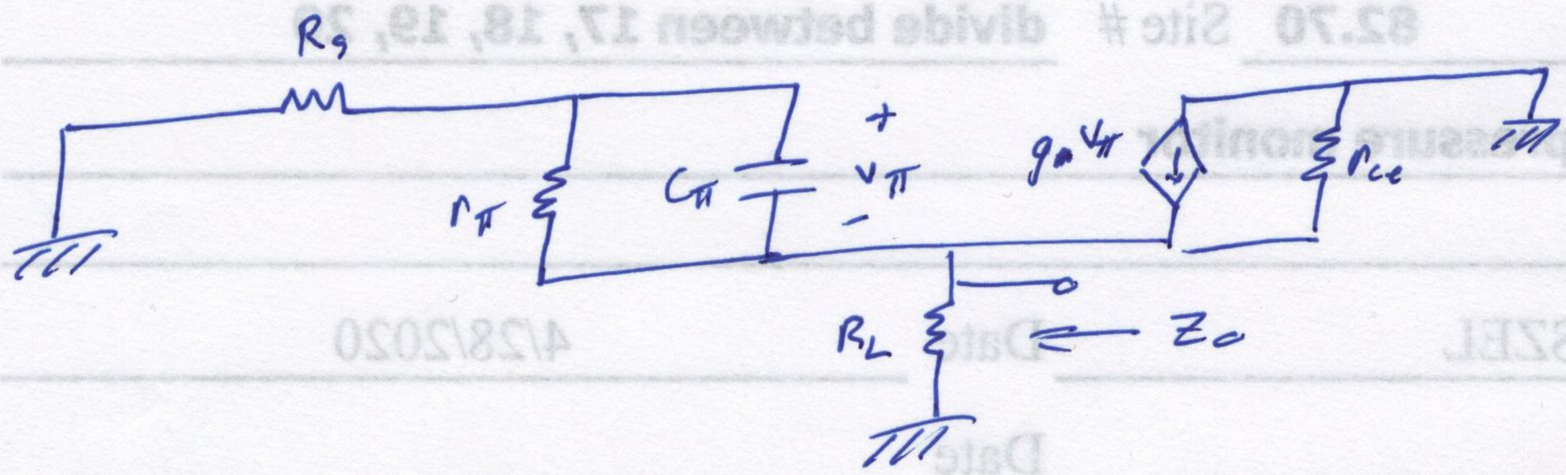
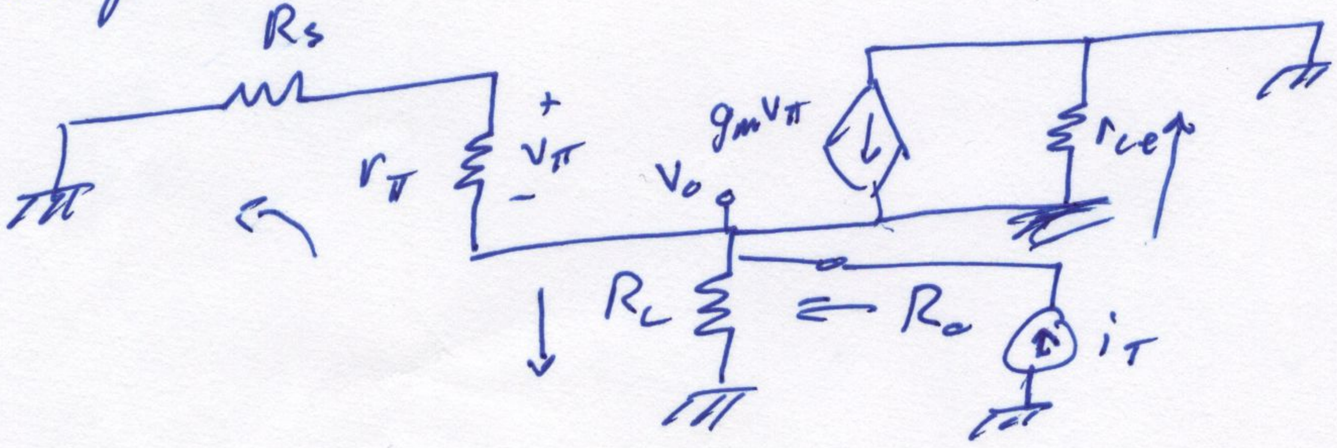
Voyerian EET problem 3.9





$$Z_o = R_o \frac{1 + \frac{s}{\omega_1}}{1 + \frac{s}{\omega_2}} = ?$$

Take C_π as the extra element. ($\frac{1}{sC} \to \infty$, low frequency asymptote)
Resulting circuit.



$$R_o = \frac{V_o}{i_T}$$

$$R_o = \frac{V_o}{i_T}$$

$$\frac{V_o}{(R_s + r_\pi) \| R_L \| r_{ce}} = g_m V_\pi + i_T$$

$$V_\pi = - \frac{V_o \, r_\pi}{R_s + r_\pi}$$

$$\frac{V_o}{(R_s + r_\pi) \| R_L \| r_{ce}} = g_m \left(- \frac{V_o r_\pi}{R_s + r_\pi} \right) + i_T$$

$$V_o \left(\frac{1}{(R_s + r_\pi) \| R_L \| r_{ce}} + \frac{g_m r_\pi}{R_s + r_\pi} \right) = i_T$$

$$V_o \left(\frac{1 + g_m r_\pi}{R_s + r_\pi} + \frac{1}{R_L \| r_{ce}} \right) = i_T$$

$$V_o \underbrace{\left(\frac{1}{\frac{R_s + r_\pi}{1 + g_m r_\pi}} + \frac{1}{R_L \| r_{ce}} \right)} = i_T$$

$$\frac{1}{R_L \| r_{ce} \| \frac{R_s + r_\pi}{1 + g_m r_\pi}}$$

$$\boxed{R_o = \frac{V_o}{i_T} = R_L \| r_{ce} \| \frac{R_s + r_\pi}{1 + g_m r_\pi}}$$