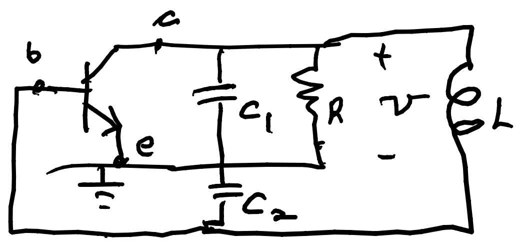
Colpitts Oscillator

pp. 1179 – 1182

EE303
Tu 10/07/08

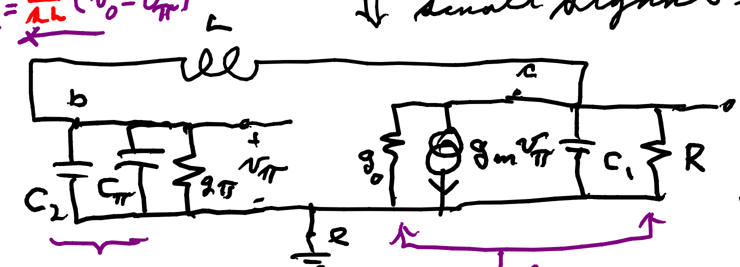
RFC = radio frequency choke

"ac" circuit



⇓ small signal equivalent circuit
P. 1180

$i_L = \frac{1}{sL}(v_o - v_\pi)$



KVL
KCL
laws of devices

$C_2 = C_2 + C_\pi$ $\quad G_o = g_o + G$

KCL @ b

$$i_L = sC_2 v_\pi + g_\pi v_\pi = \frac{1}{sL}(v_o - v_\pi)$$

$$[1 + sL(sC_2 + g_\pi)] v_\pi = v_o$$

2 eqs in 1 unkn.

KCL @ c: $\quad -i_L = G_o v_o + sC_1 v_o + g_m v_\pi$

$$-(sC_2 + g_\pi) v_\pi$$

$$(-g_m - g_\pi - sC_2) v_\pi = (G_o + sC_1) v_o$$

$$-(g_m + g_\pi + sC_2) \cdot \frac{v_o}{[1 + sL(sC_2 + g_\pi)]} = (G_o + sC_1) v_o$$

$$\{[G_o + sC_1][1 + sL(sC_2 + g_\pi)] + (g_m + g_\pi + sC_2)\} v_o = 0$$

$$\{G_o + G_o s^2 L C_2 + G_o s L g_\pi + sC_1 + s^3 C_1 L C_2 + s^2 L C_1 g_\pi + sC_2 + (g_m + g_\pi)\} v_o = 0$$

$$\left\{C_1 C_2 L s^3 + [G_0 L C_2 + L C_1 g_\pi] s^2 + [G_0 L g_\pi + C_1 + C_2] s + [G_0 + g_m + g_\pi]\right\} v_0 =$$

Get a solution $v_0(t) = V_0 e^{st}$ if $\{\cdot\} = 0$

$$P(s) = s^3 + \frac{1}{C_1 C_2}[G_0 C_2 + g_\pi C_1] s^2 + \frac{1}{L C_1 C_2}[G_0 L g_\pi + C_1 + C_2] s + \frac{[G_0 + g_m + g_\pi]}{L C_1 C_2}.$$

$$p(s) \cdot v_0(t) = 0$$ [uses initial conditions to work

desire s such that $P(s) = 0$

Here are designing to get sinusoidal outputs

$$V_0 e^{j\omega t} = V_0(\cos\omega t + j\sin\omega t)$$

$\therefore$ desire $P(j\omega_0) = 0$

1) $-j\omega^3 + j\frac{1}{L C_1 C_2}[G_0 L g_\pi + C_1 + C_2]\omega = 0$ (set imaginary & real part to 0)

2) $\frac{-1}{C_1 C_2}[G_0 C_2 + g_\pi C_1]\omega^2 + \frac{[G_0 + g_m + g_\pi]}{L C_1 C_2} = 0$

from 1) $\omega^2 = \left[\frac{G_0 L g_\pi}{L C_1 C_2} + \frac{C_1 + C_2}{L C_1 C_2}\right]$ if $g_\pi = 0$

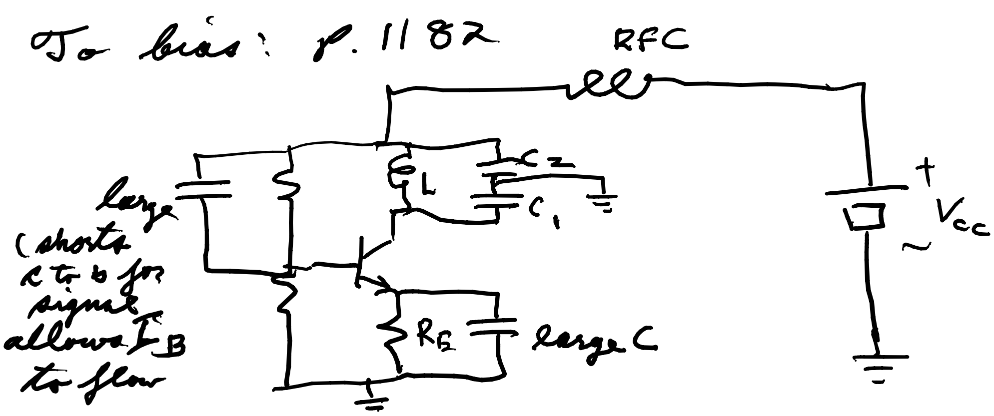
$$\omega_0 = \sqrt{\frac{C_1 + C_2}{C_1 C_2 \cdot L}} = \sqrt{\frac{1}{L C_{\parallel}}}$$

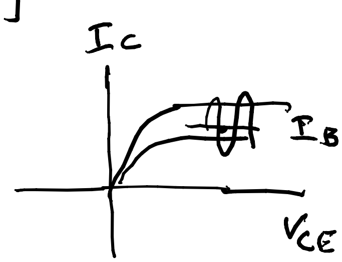
from 2)

$$G_0 + g_m + g_\pi = L[G_0 C_2 + g_\pi C_1]\omega^2$$

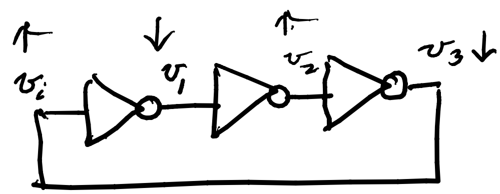
$$\Rightarrow \quad g_m = L[G_0 C_2 + g_\pi C_1]\left[\frac{G_0 L g_\pi + C_1 + C_2}{L C_1 C_2}\right] - G_0 - g_\pi$$

To bias: p. 1182



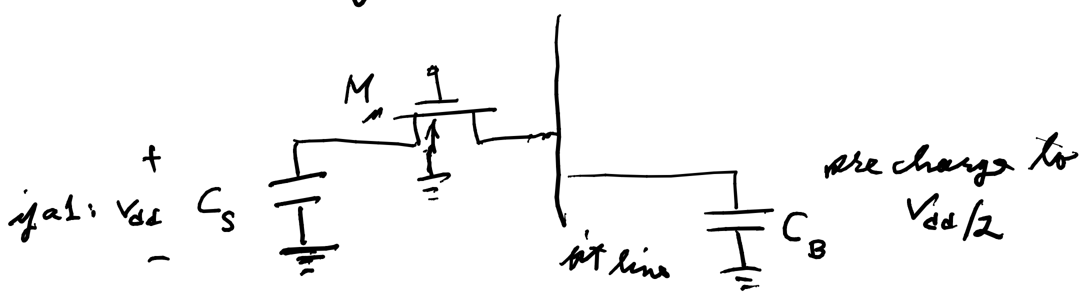


Ring oscillators



Dynamic Memory

p. 1036



$$Q_S = C_S V_{dd} \qquad Q_B = C_B \cdot V_{dd}/2$$

after connect with a readout pulse on the pass transistor:

$$V_B = \boxed{\frac{1}{(C_S + C_B)}} Q_{SB} =$$

$$Q_{SB} = C_S V_{dd} + C_B V_{dd}/2$$ = total charge, preserve before & after connect

after connect

$$V_B = \frac{1}{C_S + C_B}\left[C_S + C_B/2\right] V_{dd}$$

$$-\Delta V_{\text{on } C_B} = \frac{V_{dd}}{2} - \frac{C_S + C_B/2}{C_S + C_B} \cdot V_{dd} = \frac{\left(\frac{C_S}{2} + \cancel{\frac{C_B}{2}} - C_S - \cancel{\frac{C_B}{2}}\right)}{C_S + C_B} V_{dd}$$

$$= -\frac{C_S/2}{C_S + C_B} \cdot V_{dd}$$

here $C_B >> C_S$ $\Rightarrow$ $\Delta V_{\text{on } C_B} = +\frac{C_S}{2C_B} \cdot V_{dd}$

sign so $V_{C_B}^{\text{new}} = V_{C_B}^{\text{old}} + \Delta V_{C_B}$