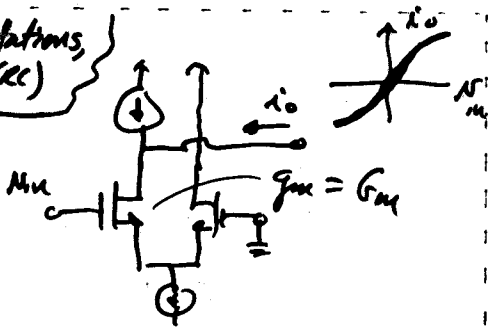
Oscillators

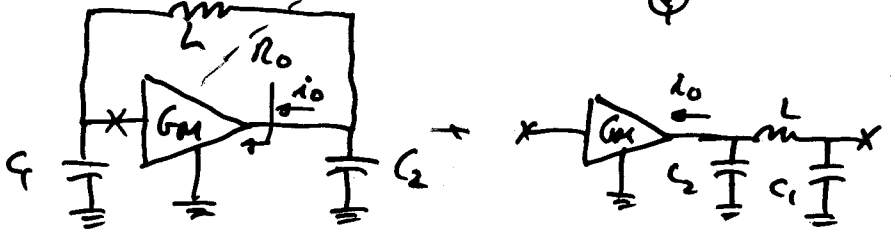
{ Quiz 13 - Open loop calculations, stability, oscillation (RC)

RC

LC Oscillator

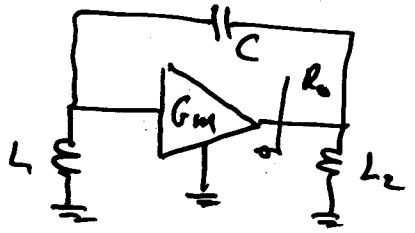


1.) Colpitts Oscillator



$$\omega_0 = \frac{1}{\sqrt{L\left(\frac{C_1 C_2}{C_1 + C_2}\right)}} \quad \& \quad G_m R_o = \frac{C_2}{C_1}$$

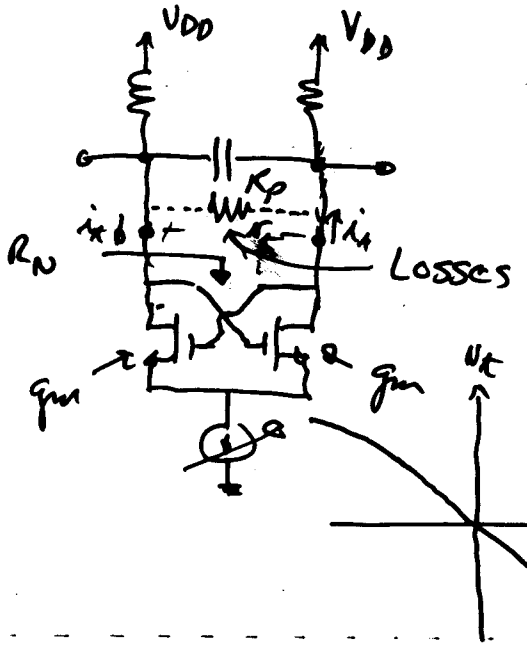
2.) Hartley Oscillator



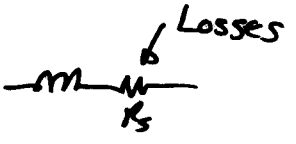
$$\omega_0 = \frac{1}{\sqrt{C(L_1 + L_2)}}$$

$$G_m R_o = \frac{L_1}{L_2}$$

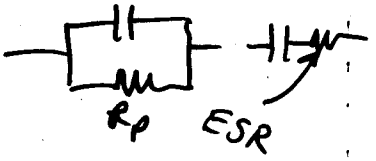
3.) LC oscillator



$$Q_L = \frac{\omega L}{R_s}$$

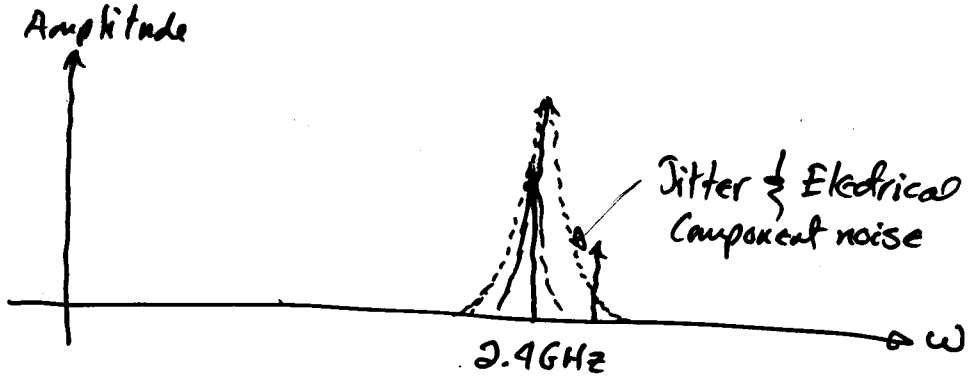


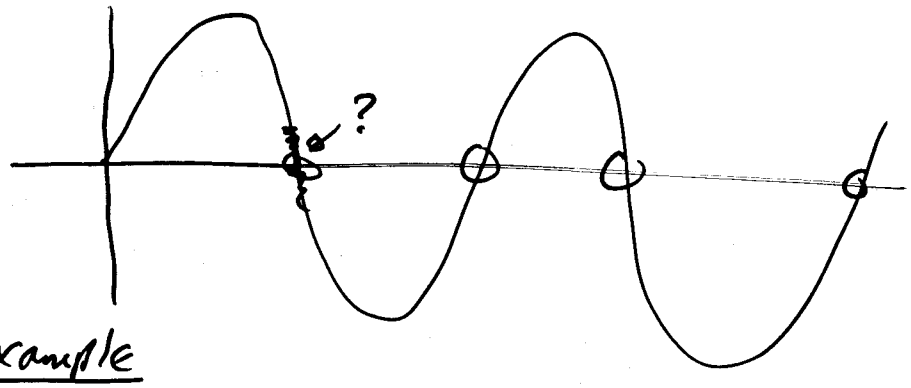
$$Q_C = \omega C R_p$$



$$R_N = \frac{2}{g_m} \leftarrow \sqrt{2IK'\frac{W}{L}}$$

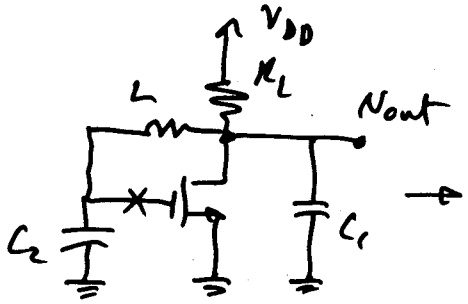
Phase Noise -



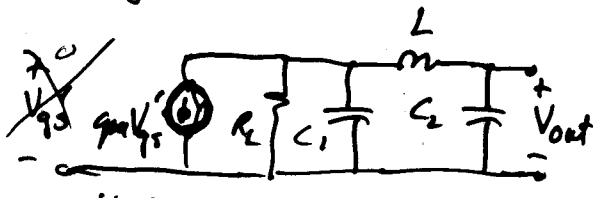


Example

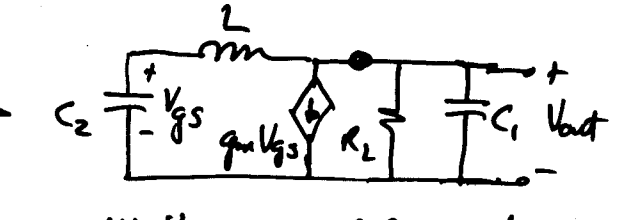
An LC oscillator is shown. Find an expression for the fose and the value of $g_m R_L$ necessary for oscillation. Assume $r_{ds} = \infty$



Opening the loop -



$\frac{V_{out}}{V_{gs}'} = T(s)$



Writing a nodal eq. above

$$g_m V_{gs} + G_L V_{out} + sC_1 V_{out} + \frac{V_{out} - V_{gs}}{sL} = 0$$

and $\underbrace{\frac{V_{out} - V_{gs}}{sL} = sC_2 V_{gs}}$

$$V_{out} = V_{gs}(1 + s^2 LC_2)$$

Continuing -

$$g_m V_{gs} + \left(G_L + sC_1 + \frac{1}{sL}\right)\left(1 + s^2 LC_2\right)V_{gs} - \frac{V_{gs}}{sL} = 0$$

$$g_m + \left(G_L + sC_1 + \frac{1}{sL}\right)\left(1 + s^2 LC_2\right) - \frac{1}{sL}$$

$$= g_m + G_L + sC_1 + \frac{1}{sL} + s^2 LC_2 G_L + s^3 LC_1 C_2 + sC_2 - \frac{1}{sL}$$

$$= (g_m + G_L) + s\left[C_1 + C_2\right] + s^2 LC_2 G_L + s^3 LC_1 C_2$$

$$= \left(g_m + G_L - \omega^2 LC_2 G_L\right) + j\omega\left[C_1 + C_2 - \omega^2 LC_1 C_2\right]$$

$$\omega_{osc} = \sqrt{\frac{C_1 + C_2}{LC_1 C_2}}$$

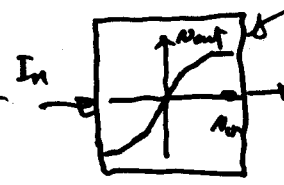
$$g_m + G_L = LG_L C_2 \omega_{osc}^2 = G_L\left(1 + \frac{C_2}{C_1}\right)$$

$$g_m + G_L = G_L + G_L \frac{C_2}{C_1}$$

$$\underline{g_m R_L = \frac{C_2}{C_1}}$$

CHAPTER 12, SECTIONS

1.) Waveshaping circuits — Diodes



2.) Non sinusoidal oscillators
- Sq. wave
- Triangular wave