Quiz #13 will be given on Wednesday, Dec. 4, 2002

Content will be on Homework Assign No. 14

Oscillators

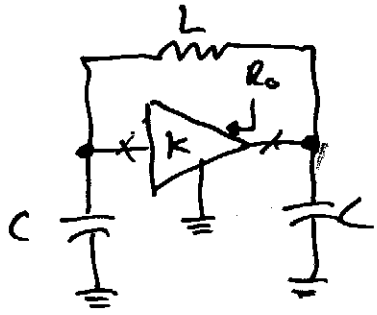
Tuned Untuned

RC LC

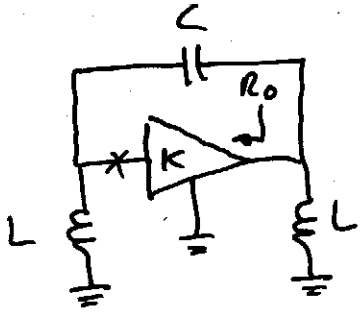
< 1MHz > 1MHz

$\omega_{osc} \propto \frac{1}{RC} \propto \frac{1}{\sqrt{LC}}$

Colpitts Oscillator

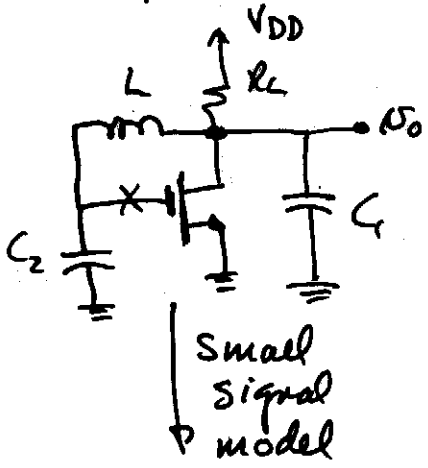


Hartley Oscillator



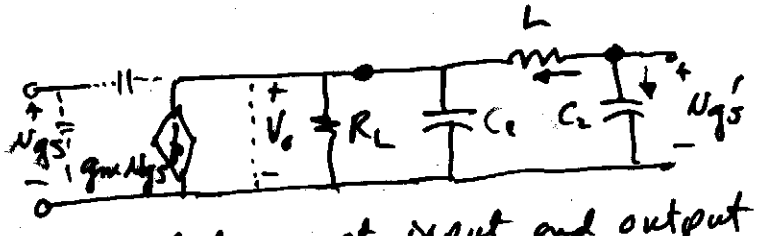
LC Oscillators

Example –



Small signal model

Find an expression for the freq. of oscillation and the value of $g_m R_L$ necessary for oscillation. Neglect r_{ds}.



$$\frac{V_{gs}'}{V_{gs}} = \frac{V_r}{V_x}$$

Write a nodal eq. at input and output.

$$g_m V_{gs} + G_L V_o + sC_1 V_o + \frac{V_o - V_{gs}'}{sL} = 0 \qquad \frac{V_{gs}' - V_o}{sL} + sC_2 V_{gs}' = 0$$

$$V_{gs}' - V_o + s^2 LC_2 V_{gs}' = 0 \quad + V_o = V_{gs}' + s^2 LC_2 V_{gs}'$$

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

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

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

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

$$\frac{V_{gs}'}{V_{gs}} = \frac{-sg_mL}{(1+s^2LC_2)(sLG_L + s^2C_1L + 1) - 1}$$

$$= \frac{-sg_mL}{sLG_L + s^2G_L + 1 + s^3L^2G_LC_2 + s^4L^2C_2C_1 + s^2LC_2 + 1}$$

$$T(j\omega) = \frac{-j\omega g_mL}{\underbrace{\left[-\omega^2C_1L + \omega^2LC_2 + \omega^4L^2C_2C_1\right]}_{=0} + j\left[\omega LG_L + \omega^3L^2G_LC_2\right]} = 1 + j0$$

~~$\omega^2LC_2 = \omega^4L^2C_1C_2 + \omega^2LC_1$~~ Mistake

$$\omega^2LC_2 = C_2 + C_1$$

$$\boxed{\omega_{osc} = \sqrt{\frac{C_1+C_2}{LC_1C_2}} = \frac{1}{\sqrt{L\frac{C_1C_2}{C_1+C_2}}}}$$

Next step,

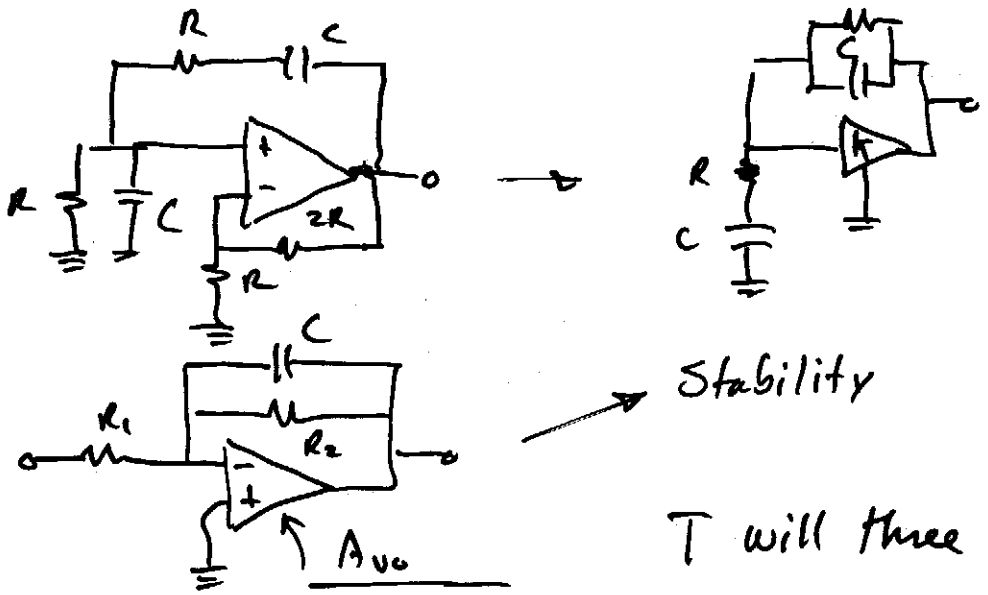
$$\frac{-\omega g_mL}{\omega LG_L + \omega^3L^2G_LC_2} = \frac{1}{} + \quad -g_m = G_L - \omega^2LG_LC_2$$

$$g_m = -G_L + \left(\frac{C_1+C_2}{C_1C_2L}\right)LG_LC_2 = -G_L + \left(\frac{C_1+C_2}{C_1}\right)G_L$$

$$g_m = G_L\left[1 + \frac{C_2}{C_1}\right] = G_L\frac{C_2}{C_1}$$

$$\boxed{g_mR_L = \frac{C_2}{C_1}}$$

OSCILLATORS



→ Stability

T will three poles

$$\frac{A_{vo}}{\left(\frac{s}{\omega_1}+1\right)\left(\frac{s}{\omega_2}+1\right)}$$

Quiz #13

1.) Influence of negative fb. on freq. response
2.) Calculating the open-loop gain (direct method) for purposes of determing stability.

12.12 § 12.13