Osciladores y Generadores de Señal

(2a parte)

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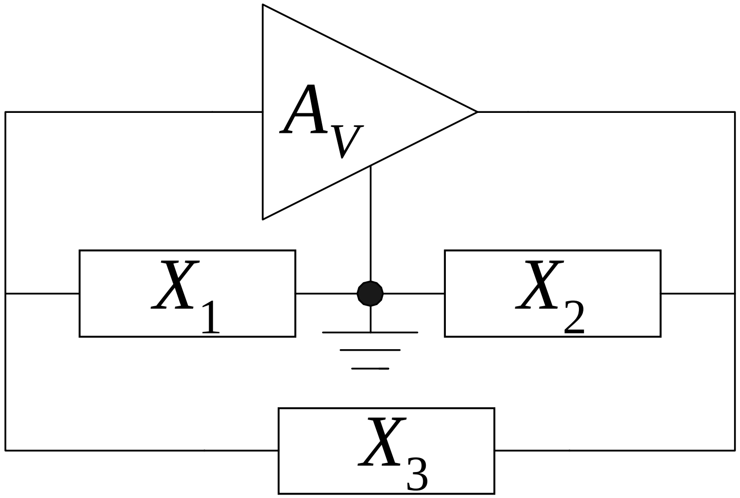
Algunas de las figuras de esta presentación fueron tomadas de la página de internet del autor del texto:

A.R. Hambley, *Electronics: A Top-Down Approach to Computer-Aided Circuit Design*. Englewood Cliffs, NJ: Prentice Hall, 2000.

Osciladores LC

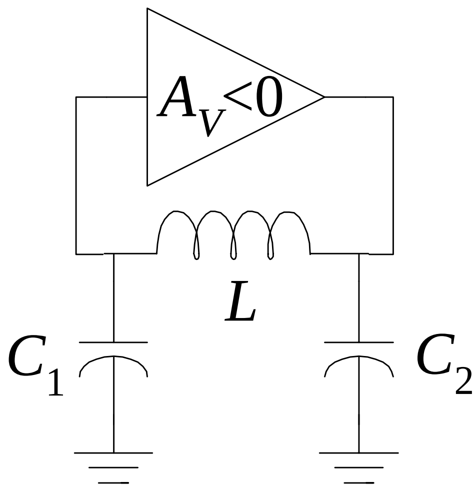
- Pueden operar a mayor frecuencia que los osciladores RC
- Son más adecuados para implementarse con dispositivos discretos (BJTs, FETs, etc.)
- Su frecuencia de oscilación es más difícil de controlar (generalmente operan a la frecuencia de resonancia de un circuito tanque)

Tipos de Osciladores LC

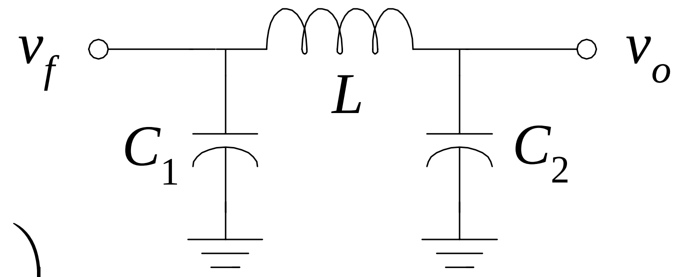


X_1	X_2	X_3	Tipo de Oscilador
C	C	L	Colpitts
L	L	C	Hartley
LC	LC		E/S Sintonizas
C	C	LC	Clapp

Oscilador Colpitts

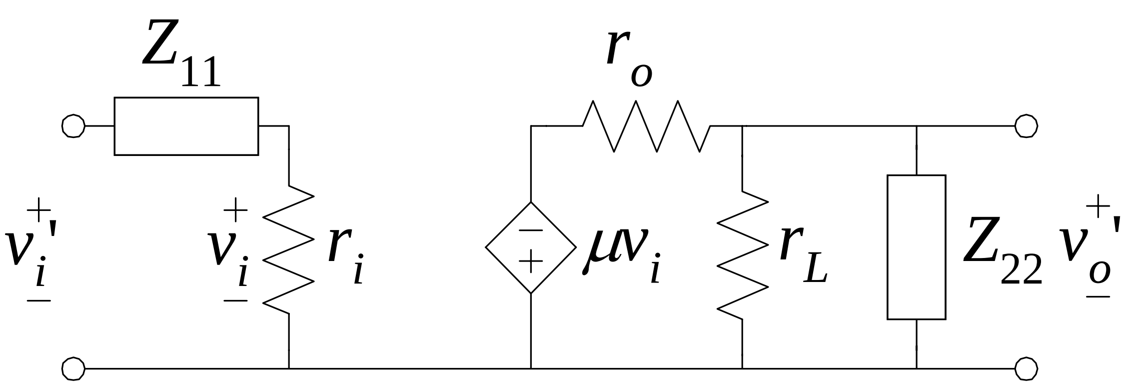


$$\beta = \frac{v_f}{v_o}$$



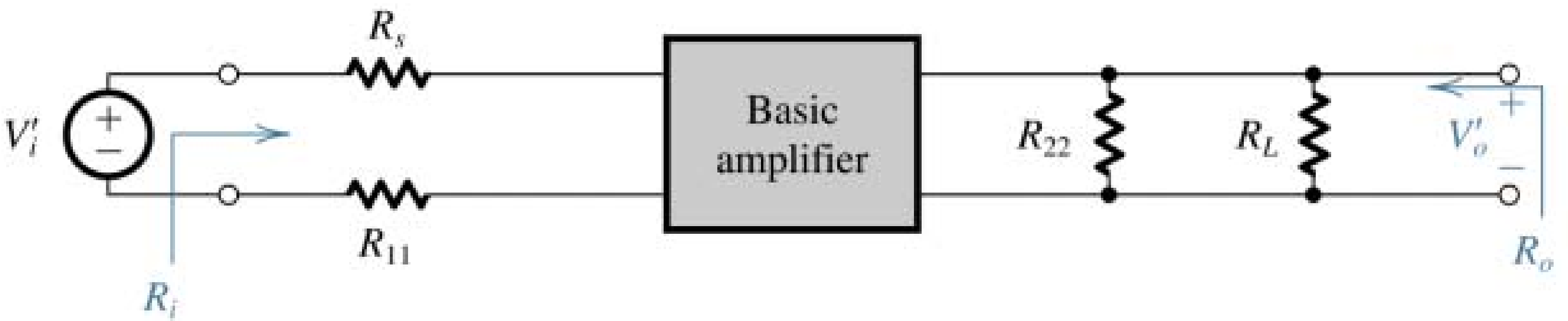
$$v_f = \frac{v_o\left(\dfrac{1}{sC_1}\right)}{\dfrac{1}{sC_1} + sL}$$

$$\beta = \frac{1}{1 + s^2 LC_1}$$

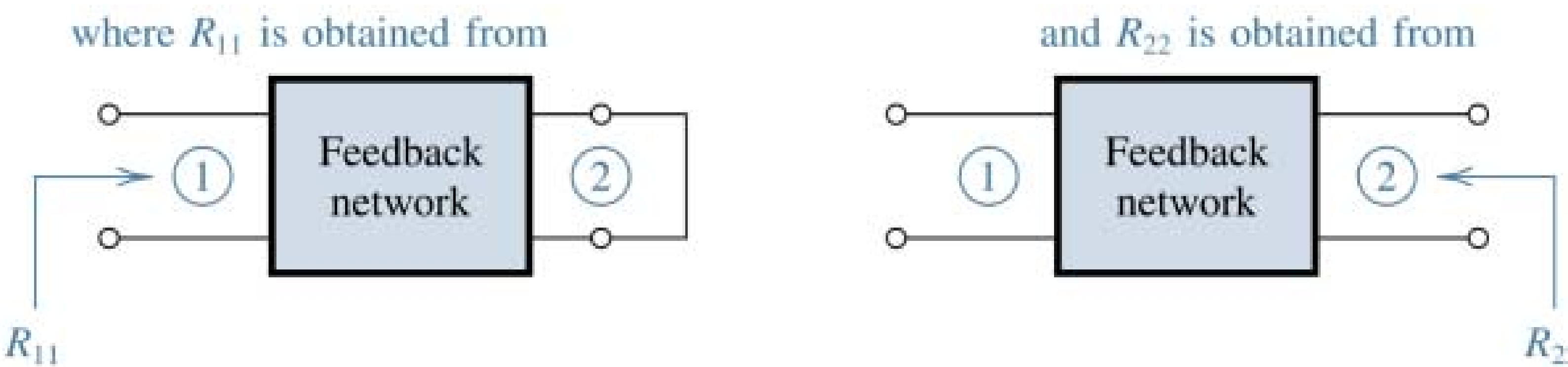


$$A = \frac{v_o'}{v_i'}$$

Calculando A y β para el caso S-P

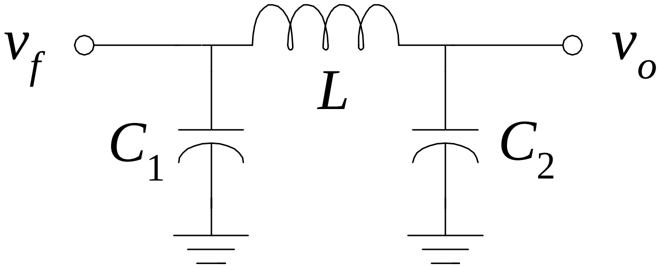


$$A = \frac{V_o'}{V_i'}$$



$$\beta = \left.\frac{V_f'}{V_o'}\right|_{I_1=0}$$

Oscilador Colpitts (cont.)

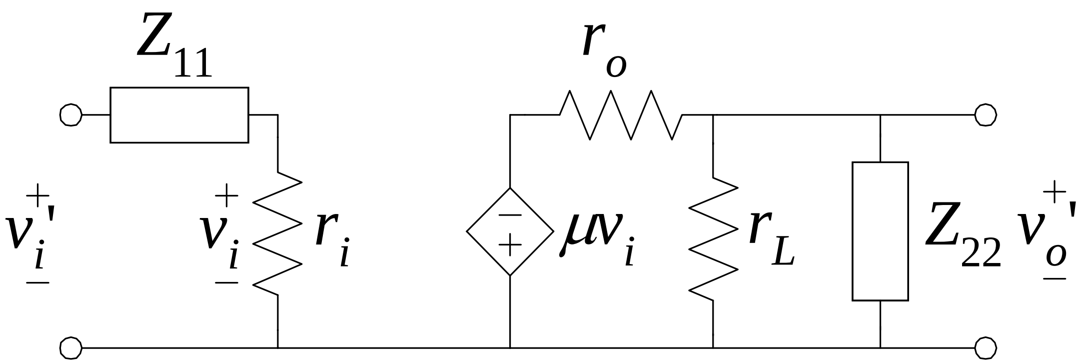


$$Z_{11} = \frac{1}{sC_1} \parallel sL = \frac{sL}{1 + s^2 LC_1}$$

$$Z_{22} = \frac{1}{sC_2} \parallel (sL + \frac{1}{sC_1}) = \frac{1 + s^2 LC_1}{s[1 + s^2 LC_{eq}]}$$

donde $C_{eq} = \dfrac{C_1 C_2}{C_1 + C_2}$

Oscilador Colpitts (cont.)



$$\text{si } |Z_{11}(\omega_0)| << r_i,\ v_i' \approx v_i$$

$$v_o' = \frac{-\mu v_i'(r_L \parallel Z_{22})}{r_o + (r_L \parallel Z_{22})}$$

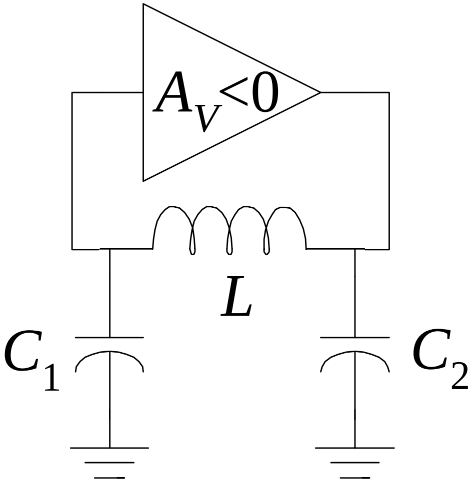
$$A = \frac{-\mu(r_L \parallel Z_{22})}{r_o + (r_L \parallel Z_{22})} \quad \text{donde} \quad Z_{22} = \frac{1 + s^2 LC_1}{s[1 + s^2 LC_{eq}]} \qquad \beta = \frac{1}{1 + s^2 LC_1}$$

criterio de Barkhausen $A(j\omega_0)\beta(j\omega_0) = 1$

$$Z_{22} \to \infty \text{ cuando } \omega = \frac{1}{\sqrt{LC_{eq}}} = \omega_0 \qquad \text{luego} \quad A(j\omega_0) = \frac{-\mu r_L}{r_o + r_L} = A_V$$

$$\beta(j\omega_0) = \frac{1}{1 - \omega_0^2 LC_1} = \frac{-C_2}{C_1} \qquad \text{por lo tanto } |A_V| \geq \frac{C_1}{C_2}$$

Oscilador Colpitts, Resumen

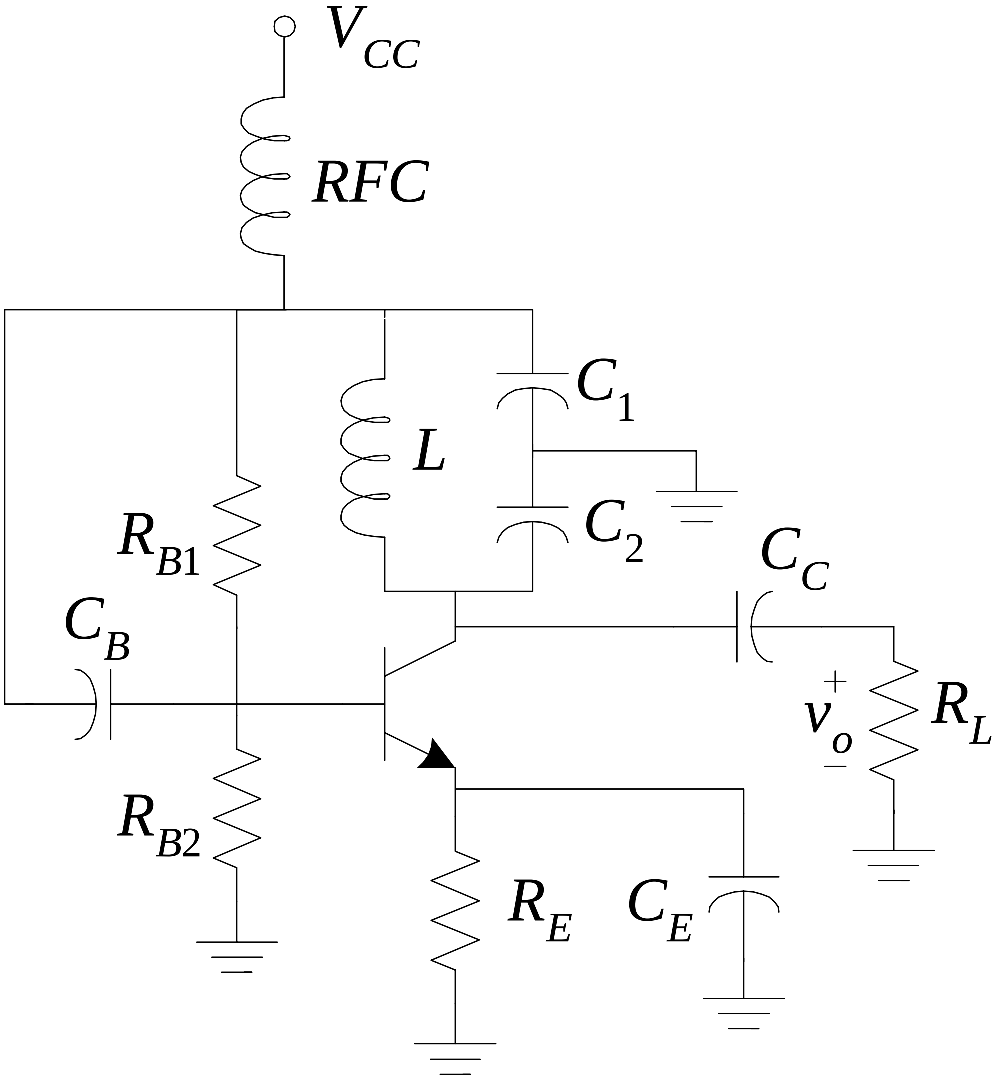


$$\omega_0 = \frac{1}{\sqrt{LC_{eq}}} \qquad \text{donde} \quad C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$$

$$|A_V| \geq \frac{C_1}{C_2}$$

$$r_i >> \frac{C_2}{C_1}\sqrt{\frac{L}{C_{eq}}}$$

Oscilador Colpitts con BJT



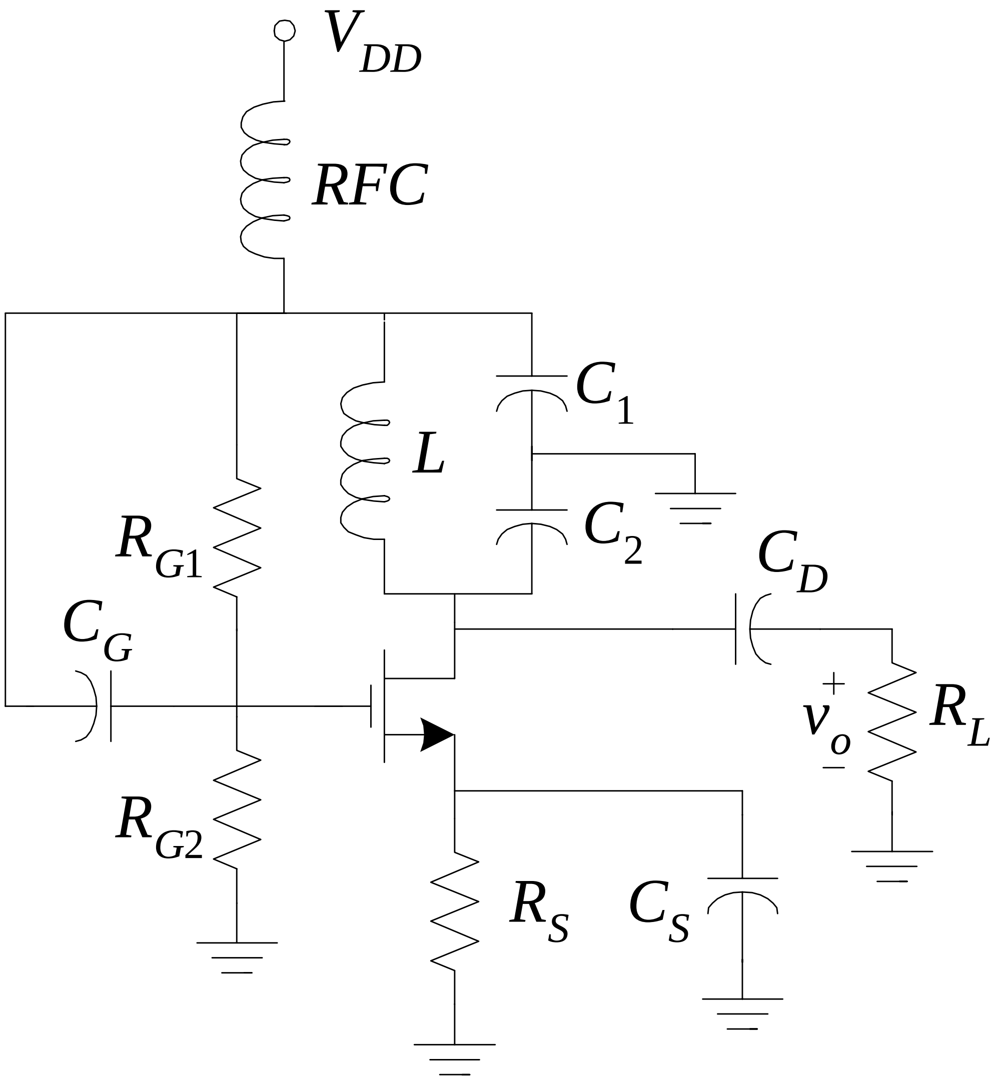
$$\omega_0 = \frac{1}{\sqrt{LC_{eq}}}$$

donde $C_{eq} = \dfrac{C_1 C_2}{C_1 + C_2}$

$$g_m (R_L \| r_o) \geq \frac{C_1}{C_2}$$

$$r_\pi \| R_{B2} >> \frac{C_2}{C_1} \sqrt{\frac{L}{C_{eq}}}$$

Oscilador Colpitts con FET

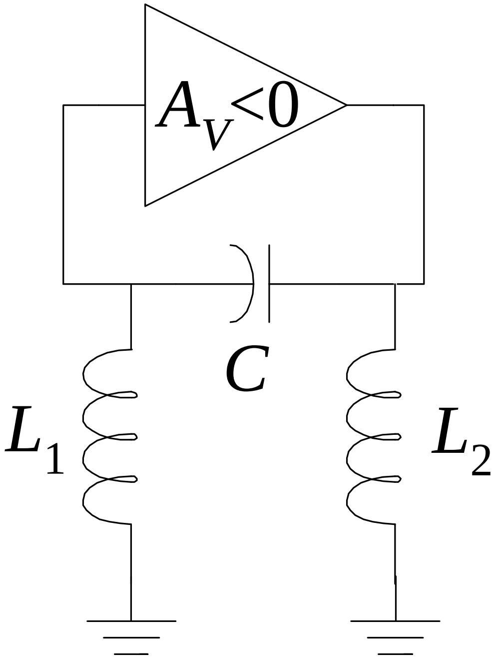


$$\omega_0 = \frac{1}{\sqrt{LC_{eq}}}$$

donde $C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$

$$g_m (R_L \parallel r_o) \geq \frac{C_1}{C_2}$$

Oscilador Hartley



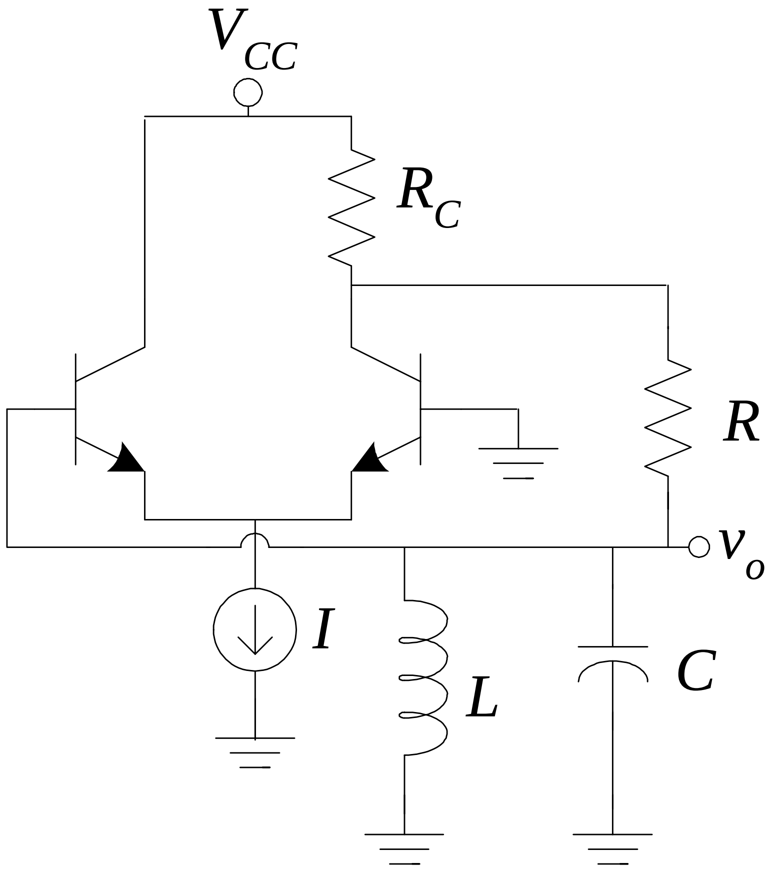
Se puede demostrar que

$$\omega_0 = \frac{1}{\sqrt{L_{eq}C}} \qquad \text{donde} \qquad L_{eq} = L_1 + L_2$$

$$|A_V| \geq \frac{L_2}{L_1}$$

$$r_i >> \frac{L_1}{L_{eq} - L_1}\sqrt{\frac{L_{eq}}{C}}$$

Problema



Para el oscilador mostrado:

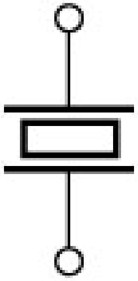
a) Deduce una fórmula para calcular la frecuencia de oscilación

b) ¿Cuál es el mínimo valor de I para sostener la oscilación?

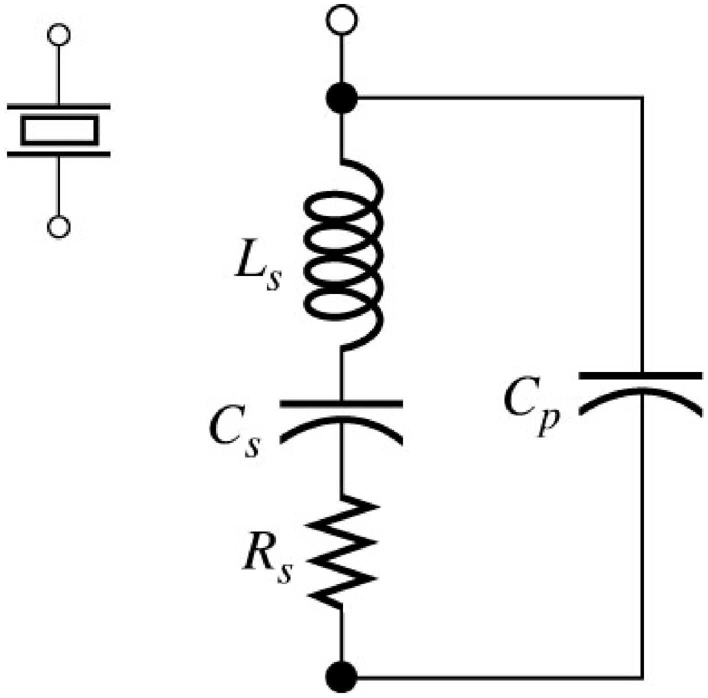
Cristales de Quarzo

Efecto piezoeléctrico

Símbolo



Modelo del Cristal



L_s: Masa del Cristal

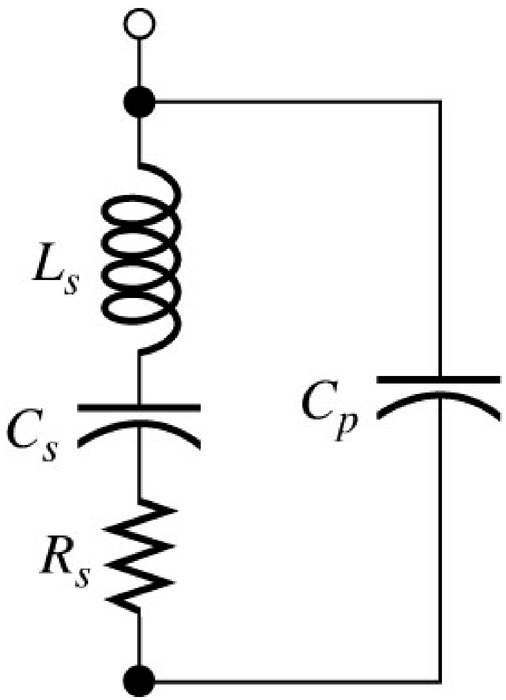
C_s: Viscocidad (coeficiente de amortiguamiento)

R_s: Rigidez (fricción mecánica, recíproco de la elasticidad)

C_p: Capacitancia electrostática

L_s, C_s, R_s, C_p dependen del material, de las dimensiones, de la orientación de los cortes, etc.

Modelo del Cristal (cont.)



$$Z_{XTAL} = [R_s + sL_s + 1/sC_s] \| 1/sC_p$$

Si R_s = 0... (alta Q)

$$Z_{XTAL} = [sL_s + 1/sC_s] \| 1/sC_p$$

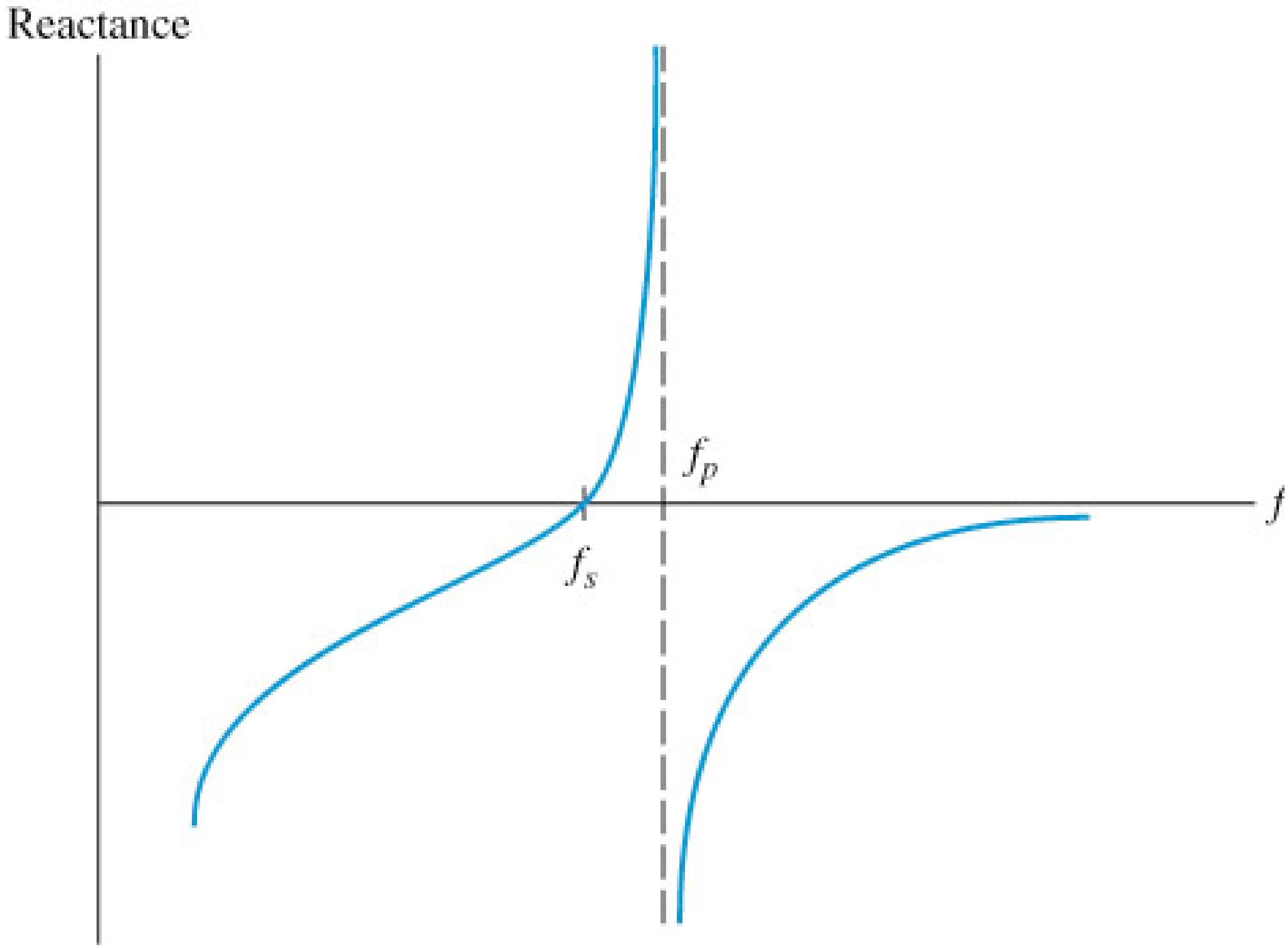
$$Z_{XTAL} = \frac{1}{sC_p} \frac{s^2 + \frac{1}{L_sC_s}}{s^2 + \frac{C_p + C_s}{L_sC_sC_p}}$$

$$\omega_s = \frac{1}{\sqrt{L_sC_s}} \qquad \omega_p = \frac{1}{\sqrt{L_s\left(\frac{C_sC_p}{C_s + C_p}\right)}} \qquad Z_{XTAL} = \frac{-j}{\omega C_p} \frac{\omega^2 - \omega_s^2}{\omega^2 - \omega_p^2}$$

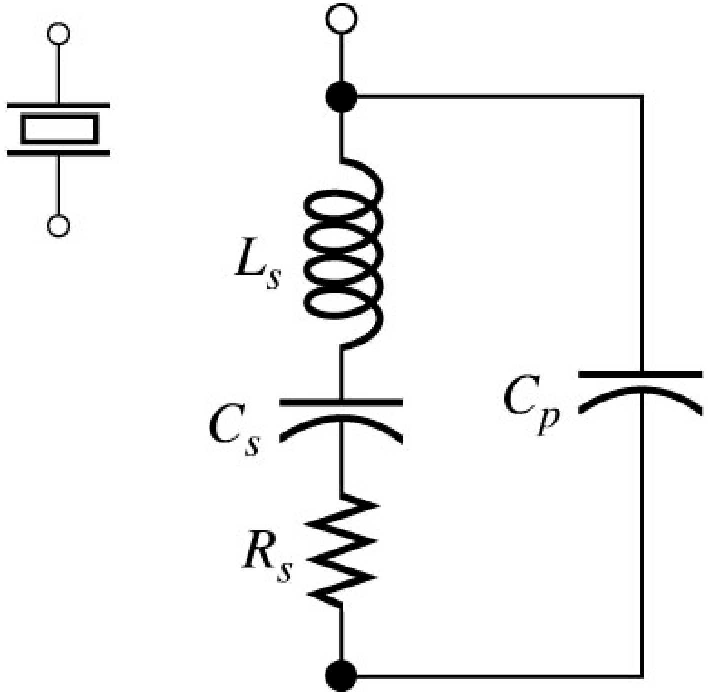
Modelo del Cristal (cont.)

$$C_p >> C_s$$

$$\omega_s \approx \omega_p$$



Ejemplo de un Cristal de Cuarzo



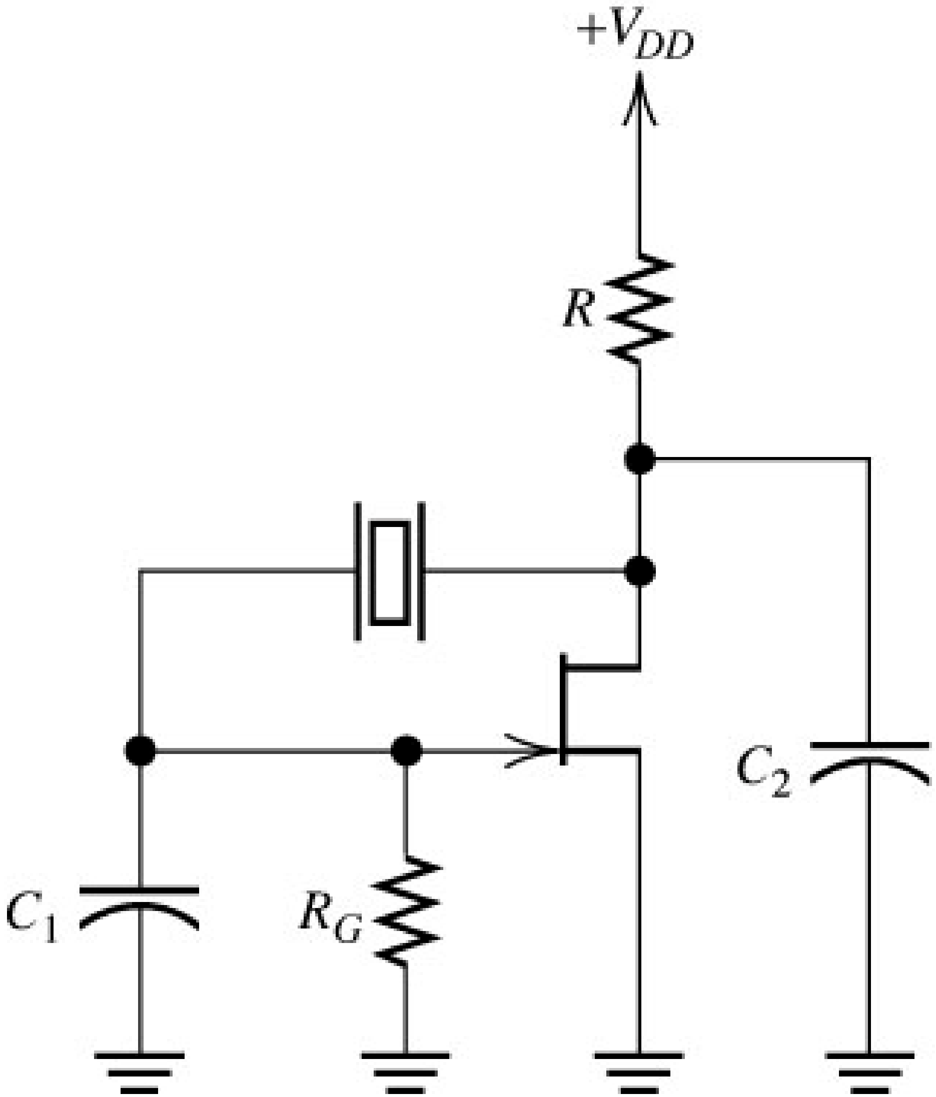
R_s	$15\ \Omega$
C_s	25×10^{-15} F
L_s	10.132118 mH
C_p	6×10^{-12} F
f_s	10.00000 MHz
f_p	10.02100 MHz
Q	42440

Cristales comerciales: 80KHz < f_s < 200MHz

Oscilador Pierce = Colpitts con Cristal

$$\omega_0 = \frac{1}{\sqrt{L_s C_s}}$$

Load Capacitance: $C_1 + C_2$



Ejercicios de Tarea

Resolver problemas 12.21 y 12.23 del libro de texto