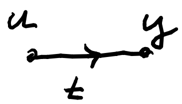
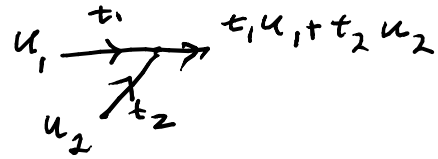
Note Title 10/15/2013

EE303H
10/15/13

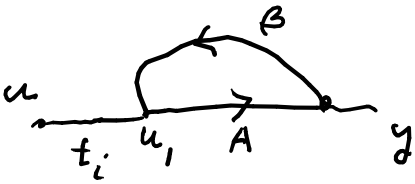
feedback, p. 805 Filters, p. 1261



$y = tu$

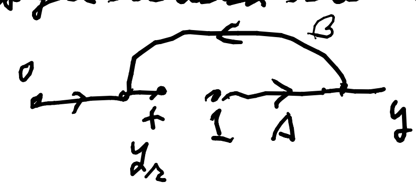


t ‖ transmittance



to get return ratio

$\Rightarrow$



y_r ‖ $A\beta$ = return ratio

$y = Au_1$

$u_1 = t_1 u + \beta y$

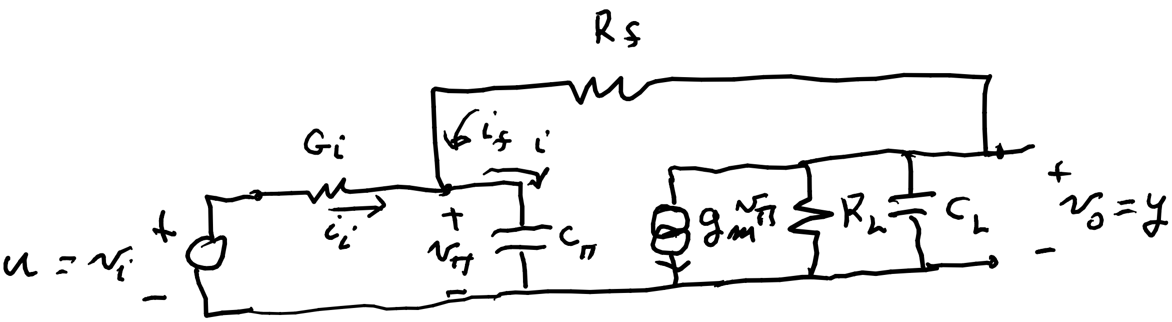
$y = A(t_1 u + \beta y)$

$(1 - A\beta)y = At_i u$

return difference $= 1 - y_r = 1 - A\beta$

$$\frac{y}{u} = \text{transfer function} = \frac{At_1}{1 - A\beta}$$

$1 - A\beta$ = return difference



$i = y_\pi v_\pi = \frac{1}{sC_\pi}$; $Ai = v_o$

$g_m \frac{i}{y_\pi} = -y_L v_o$, $y_L = G_L + sC_L$

G_L ‖ $1/R_L$

$i = i_f + i_i$

$= G_f(v_o - v_\pi) + G_i(v_i - v_\pi)$

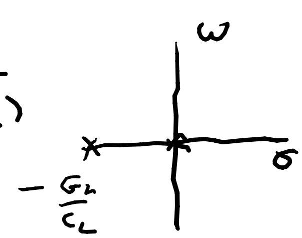
$= G_f v_o + G_i v_i - (G_i + G_f)v_\pi$

$= G_f v_o + G_i v_i - (G_i + G_f)(i/y_\pi)$

$\left(1 + (G_i + G_f)\frac{1}{y_\pi}\right) i = G_f v_o + G_i v_i$

$A = -g_m / y_L y_\pi$

$$= \frac{-g_m}{sC_\pi(G_L + sC_L)}$$



s-plane
$s = \sigma + j\omega$

$$i = \frac{y_\pi G_f v_o + y_\pi G_i v_i}{y_\pi + (G_i + G_f)} \Rightarrow v_o = -\frac{g_m}{y_L \cancel{y_\pi}}\left[\frac{\cancel{y_\pi} G_f v_o + \cancel{y_\pi} G_i v_i}{y_\pi + (G_i + G_f)}\right]$$

$$\left(1 + \frac{g_m G_f}{y_L\left[y_\pi + (G_i + G_f)\right]}\right) v_o = \frac{-g_m G_i}{\left[y_\pi + (G_i + G_f)\right] y_L} v_i$$

$$\frac{v_o}{v_i}(s) = \frac{-g_m G_i}{y_L y_\pi + y_L(G_i + G_f) + g_m G_f} = \frac{-g_m G_i}{(G_L + sC_L)sC_\pi + (sC_L + G_L)(G_i + G_f) + g_m G_f}$$

$$= \frac{-g_m G_i}{s^2 C_L C_\pi + s\left(G_L C_\pi + C_L(G_i + G_f)\right) + \left(G_L[G_i + G_f] + g_m G_f\right)}$$

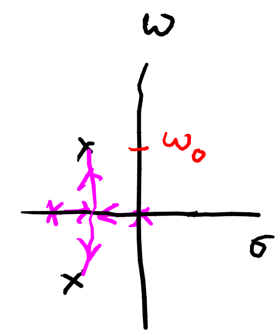
$$= \frac{-g_m G_i / C_L C_\pi}{s^2 + s\frac{1}{C_L C_\pi}\left(G_L C_\pi + C_L G_i + C_L G_f\right) + \frac{\left(G_L[G_i + G_f] + g_m G_f\right)}{C_L C_\pi}}$$

denominator, $D(s) = s^2 + \frac{\omega_0}{Q} s + \omega_0^2$

$$(s + s_1)(s + s_2)$$

$$s_{1,2} = -\frac{\omega_0}{2Q} \pm \frac{1}{2}\underbrace{\sqrt{\frac{\omega_0^2}{Q^2} - 4\omega_0^2}}$$

$\Rightarrow \omega_0\sqrt{1 - \frac{1}{4Q^2}}$ if imaginary



$$T(s) = \frac{v_o}{v_i}(s) = \frac{-\omega_0^2 A_0}{s^2 + \frac{\omega_0}{Q}s + \omega_0^2}$$

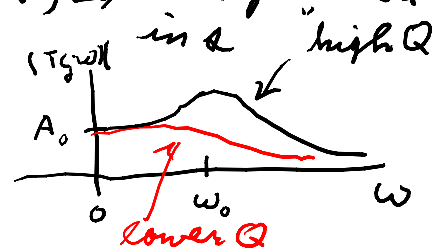
$T(s)\big|_{s=j\omega} \Rightarrow$ use for sinusoidal steady state

$$T(j\omega) = \frac{-\omega_0^2 A_0}{(-\omega^2 + \omega_0^2) + j\frac{\omega_0 \omega}{Q}}$$

$$|T(j\omega)|^2 = T(j\omega)T^*(j\omega) = T(j\omega)T(-j\omega) = T(s)T(-s)\big|_{s=j\omega}$$

$T(s)T(-s) = T(-s)T(s) \Rightarrow T(s)T(-s) \Rightarrow$ even function in s

here $$|T(j\omega)|^2 = \frac{(-\omega_0^2 A_0)^2}{(\omega_0^2 - \omega^2)^2 + \left(\frac{\omega_0^2 \omega^2}{Q^2}\right)}$$



Maximally flat $T(s)$, low pass

$$T(s) = \frac{1}{s^n + a_{n-1}s^{n-1} + \dots + a_1 s + a_0}$$

$$\frac{d|T(j\omega)|}{d\omega} = 0, \dots$$ as many of $$\frac{d(T(j\omega))^m}{d\omega^m} = 0$$ as possible (limited # m is only possible

look at $\frac{1}{|T(j\omega)|}$; $$\frac{d\,1/|T(j\omega)|}{d\omega} = 0 = -\frac{1}{|T(j\omega)|^2} \cdot d|T(j\omega)|$$

$\therefore$ use $\left|\frac{1}{T(j\omega)}\right| \Rightarrow \frac{1}{T(s)} = s^n + a_{n-1}s + \dots + a_0$

$$T(j\omega)T^*(j\omega) = T(j\omega)T(-j\omega) = |T(j\omega)|^2$$

$$\frac{d|T(j\omega)|^2}{d\omega} = 2|T(j\omega)|\frac{d|T(j\omega)|}{d\omega}$$ $\Rightarrow$ same set $= 0$ as setting $\frac{d|T(j\omega)|^2}{d\omega} = 0$

$$\frac{1}{|T(j\omega)|^2} = |s^n + a_{n-1}s^{n-1} + \dots a_0|^2\Big|_{s=j\omega}$$

$$= [(j\omega)^n + a_{n-1}(j\omega)^{n-1} \dots][(-j\omega)^n + a_{n-1}(-j\omega)^{n-1} + \dots + a_0]$$

even in ω (no j's present)

$$= a_0^2 + \dots + \alpha_{2n-2}\omega^{2n-2} + \omega^{2n} = a_0^2 + \omega^{2n}$$