Feedback and Oscillator

Thursday, April 27, 2017 1:52 PM

Consider transconductance feedback amplifier. (1) Find A_{gf}, R_{if} and R_{of} if open loop voltage gain is $A_v = 10^5$, $R_i = 10K$ $R_o = 5K$. feedback $\beta_2 = 0.9$. (11) If the bandwidth of the FB amplifier is 10KHz, find the open loop bandwidth (11) If FB amplifier gain variation is 1%. find the open loop gain variation.

$$A_{gf} = \frac{A_g}{1+\beta_2 A_g}$$

$$R_{if} = R_i(1+\beta_2 A_g)$$

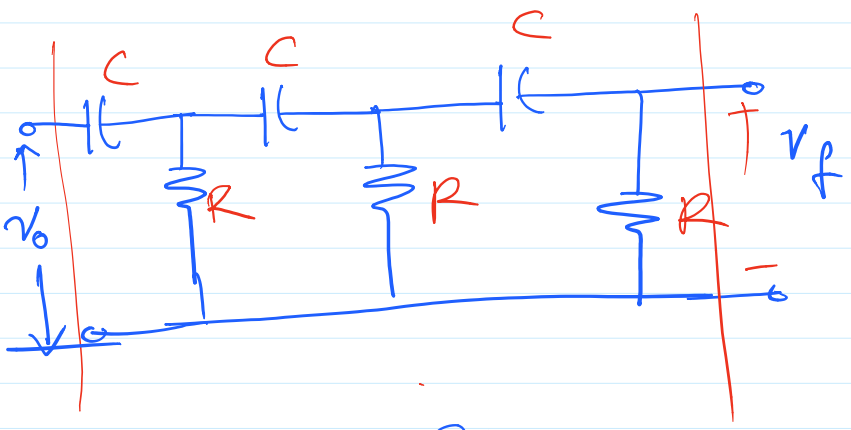
$$R_{of} = R_o(1+\beta_2 A_g)$$

$$A_g = \frac{i_o}{v_i} \qquad A_v = \frac{v_o}{v_i} = \frac{i_o R_o}{v_i} = A_g R_o$$

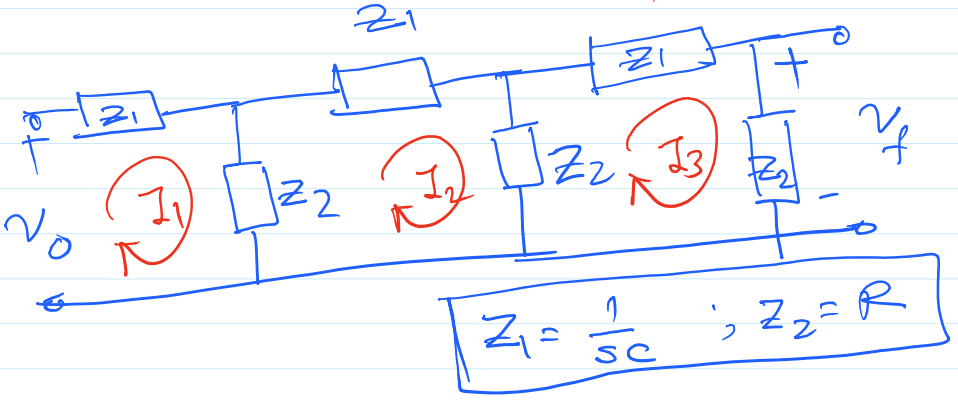
$$= \frac{A_v}{R_o} = \frac{10^5}{5K}$$

$$\# \quad f_{Hf} = f_H(1+\beta_2 A_g)$$

$$\# \quad \frac{dA_f}{A_f} = \frac{1}{(1+\beta_2 A_g)} \frac{dA}{A}$$



$$H(s) = \frac{V_f(s)}{V_o(s)} =$$



$$V_f = I_3 Z_2$$

$$-V_o + Z_1 I_1 + Z_2 (I_1 - I_2) = 0$$

$$Z_2 (I_2 - I_1) + Z_1 I_2 + Z_2 (I_2 - I_3) = 0$$

$$Z_2 (I_3 - I_2) + Z_1 I_3 + Z_2 I_3 = 0$$

$$\begin{bmatrix} (Z_1+Z_2) & -Z_2 & 0 \\ -Z_2 & (Z_1+2Z_2) & -Z_2 \\ 0 & -Z_2 & (Z_1+2Z_2) \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} V_o \\ 0 \\ 0 \end{bmatrix}$$

$$I_3 = \frac{\Delta_3}{\Delta}$$

$$\Delta_3 = \begin{vmatrix} (Z_1+Z_2) & -Z_2 & V_0 \\ -Z_2 & (Z_1+2Z_2) & 0 \\ 0 & -Z_2 & 0 \end{vmatrix} = V_0 (-Z_2)(-Z_2) = V_0 Z_2^2$$

$$\Delta = \begin{vmatrix} Z_1+Z_2 & -Z_2 & 0 \\ -Z_2 & (Z_1+2Z_2 & -Z_2 \\ 0 & -Z_2 & (Z_1+2Z_2 \\ (Z_1+Z_2) & -Z_2 & 0 \\ -Z_2 & (Z_1+2Z_2) & -Z_2 \end{vmatrix}$$

$$= (Z_1+Z_2)(Z_1+2Z_2)^2 - Z_2^2(Z_1+Z_2) - Z_2^2(Z_1+2Z_2)$$

$$= (Z_1+Z_2)\left[(Z_1+2Z_2)^2 - Z^2\right] - Z_2^2(Z_1+2Z_2)$$

$$= (Z_1+Z_2)\left[Z_1^2 + 4Z_1Z_2 + 4Z_2^2 - Z^2\right] - Z_2^2(Z_1+2Z_2)$$

$$= Z_1^3 + 4Z_1^2Z_2 + 3Z_1Z_2^2 + Z_1^2Z_2 + 4Z_1Z_2^2 + 3Z_2^3 - Z^2Z_1 - 2Z_2^3$$

$$+ z_1 z_2 + 4 z_1 z_2 + 2 z_2^2 - z_2 z_1 - 2 z_2^3$$

$$= z_1^3 + 5 z_1^2 z_2 + 6 z_1 z_2^2 + z_2^3$$

$$I_3 = \frac{\Delta_3}{\Delta} = \frac{V_0 z_2^2}{z_1 \cdots}$$

$$\therefore \frac{V_f}{V_0} = I_3 z_2 = \frac{z_2^3}{z_1^3 + 5 z_1^2 z_2 + 6 z_1 z_2^2 + z_2^3}$$

$$\frac{V_f(s)}{V_0(s)} = \frac{R^3}{\left(\frac{1}{sc}\right)^3 + 5\left(\frac{1}{sc}\right)^2 R + 6 \frac{1}{sc} R^2 + R^3}$$

$$= \frac{s^3 R^3 C^3}{1 + 5 sCR + 6 C^2 s^2 R^2 + C^3 R^3 s^3}$$