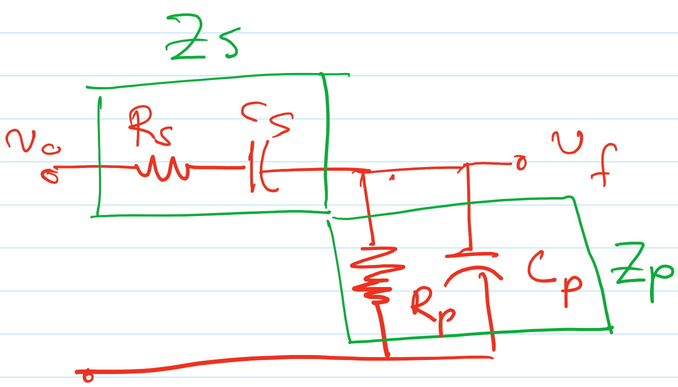
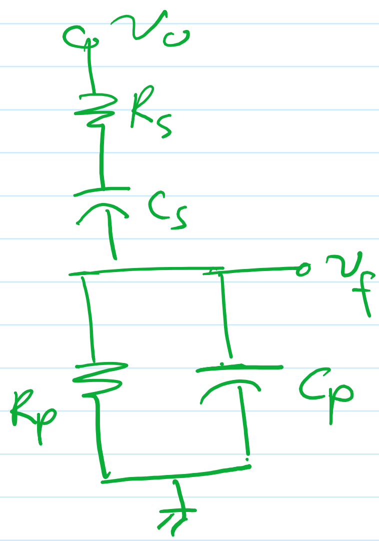
Oscilator

Wednesday, November 30, 2016 9:12 AM





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

$$\frac{v_f}{v_o} = T(s) = \frac{Z_p}{Z_p + Z_s}$$

$$Z_s = R_s + \frac{1}{sC_s} = \frac{1 + sR_sC_s}{sC_s}$$

$$Z_p = R_p \parallel \left(\frac{1}{sC_p}\right) = \frac{R_p \times \frac{1}{sC_p}}{R_p + \frac{1}{sC_p}}$$

$$= \frac{R_p}{1 + sC_pR_p}$$

$$Z_p + Z_s = \frac{R_p}{1 + sC_pR_p} + \frac{1 + sR_sC_s}{sC_s}$$

$$= \frac{R_p sC_s + (1 + sC_pR_p)(1 + sR_sC_s)}{(1 + sC_pR_p)\, sC_s}$$

$$T(s) = \frac{Z_p}{Z_p+Z_s} = \frac{\dfrac{R_p}{\cancel{1+sR_pC_p}}}{\dfrac{R_p s C_s + (1+sC_pR_p)(1+sR_sC_s)}{\cancel{(1+sC_pR_p)}\, s C_s}}$$

$$= \frac{sC_sR_p}{sR_pC_s + (1+sC_pR_p)(1+sR_sC_s)}$$

$R_p = R_s = R$

$C_s = C_p = C$

$$T(s) = \beta(s) = \frac{CR}{sCR + (1+sCR)^2}$$

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

$$\beta(s) = \frac{sCR}{1 + 3sCR + s^2C^2R^2}$$

$s = j\omega$

$$\beta(\omega) = \frac{j\omega CR}{1 + j3\omega CR - \omega^2C^2R^2}$$

$$= \frac{j\omega CR}{(1-\omega^2C^2R^2) + j\omega 3CR}$$

Loop gain $A\beta$

for oscillation $|A\beta| = 1$

Non inverting Amplifier gain

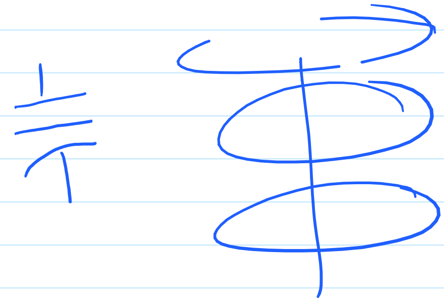
R_1 $\qquad j\omega CR$

$$A\beta(\omega) = \left(1+\frac{R_1}{R_2}\right)\frac{j\omega CR}{(1-\omega^2C^2R^2)+j\omega 3CR}$$

<u>Real part.</u> $\quad 1-\omega_0^2C^2R^2=0$

$$\omega_0 = \frac{1}{RC}$$

Frequency of oscillation is $f_0 = \dfrac{1}{2\pi RC}$



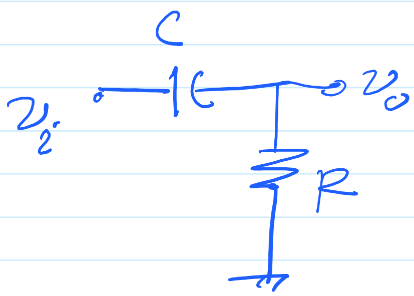
for oscillation

$$A\beta = \left(1+\frac{R_1}{R_2}\right)\frac{\cancel{j\omega CR}}{\cancel{j}3\cancel{\omega CR}} = 1$$

$$= \left(1+\frac{R_1}{R_2}\right)\frac{1}{3} = 1$$

$$\therefore \left(1+\frac{R_1}{R_2}\right) = 3$$

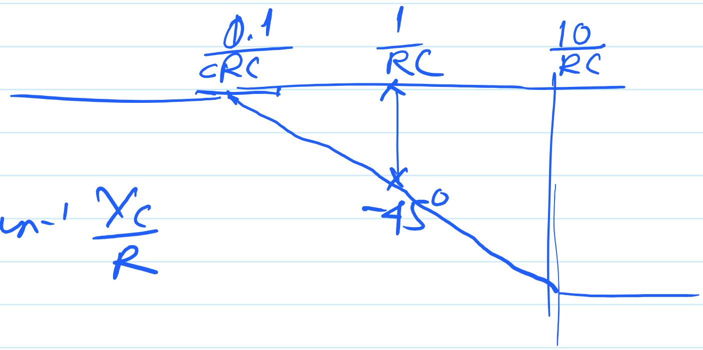
$$\boxed{A=3} \qquad \boxed{\frac{R_1}{R_2}=2}$$



$$\frac{R}{R+\frac{1}{sC}} = \frac{sRC}{1+sRC}$$

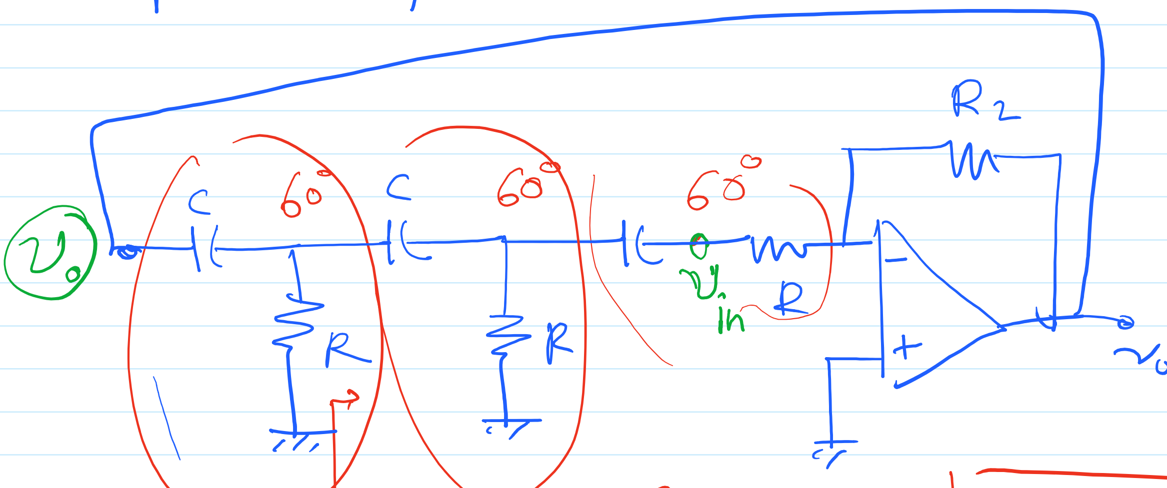
$$= \frac{j\omega RC}{1+j\omega RC}$$

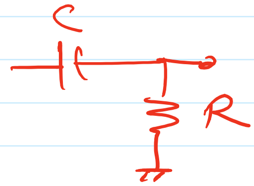
$$= \frac{\omega RC \angle 90^\circ}{\sqrt{1+(\omega RC)^2}\ \tan^{-1}\omega RC}$$



$R + jX_C \Rightarrow \tan^{-1}\frac{X_C}{R}$

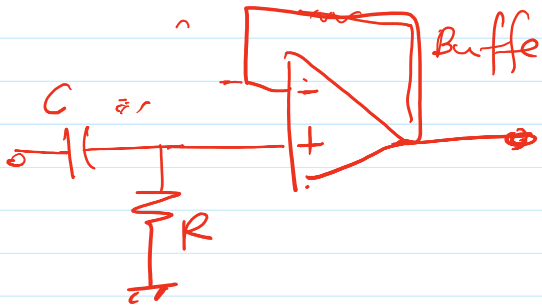
RC- phase-shift oscillater





$\boxed{\text{No Loading effect}}$

Buffer Amplifier

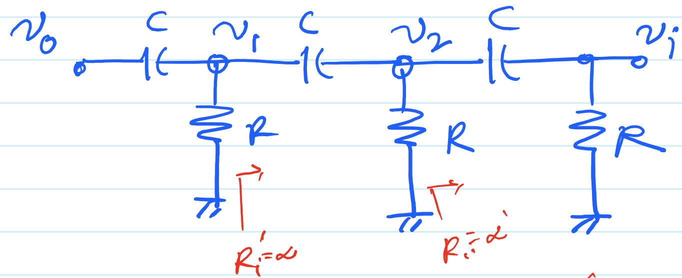


$$A = \left(1 + \frac{R_2}{R_1}\right)$$

$R_1 = \infty \quad A = 1$

$R_2 = 0$

$$\beta = \frac{v_i}{v_0}$$



$$\beta = \frac{v_i}{v_0} = \frac{v_1}{v_0} \cdot \frac{v_2}{v_1} \cdot \frac{v_i}{v_2} = \left(\frac{v_1}{v_0}\right)^3$$

$(a+b)(a+b)^2 = (a+b)(a^2+2ab+b^2)$

$(a+b)^3 = a^3 + 3ab^2 + 3a^2b + b^3$

$$\frac{v_1}{v_0} = \frac{R}{R + \frac{1}{sC}} = \frac{sRC}{1 + sRC}$$

$$\beta = \left(\frac{v_1}{v_0}\right)^3 = \frac{(sRC)^3}{(1 + sRC)^3}$$

$$\beta(s) = \frac{s^3R^3C^3}{1 + 3s^2R^2C^2 + 3RC\,s + s^3R^3C^3}$$

$s = j\omega$

$$\beta(\omega) = \frac{-jR^3C^3\omega^3}{1 - 3\omega^2R^2C^2 + j3\omega RC - j\omega^3R^3C^3}$$

$$= \frac{-jR^3C^3\omega^3}{(1-3\omega^2R^2C^2) + j\omega RC[3-\omega^2R^2C^2]}$$

Loop gain $$A\beta = -\frac{R_2}{R}\,\frac{-jR^3C^3\omega^3}{(1-3\omega^2R^2C^2)+j\omega RC[3-\omega^2R^2C^2]}$$

$$|A\beta| = 1 \Rightarrow \quad 1-3\omega_0^2R^2C^2 = 0$$

$$\omega_0^2 = \frac{1}{3R^2C^2}$$

$$\boxed{\omega_0 = \frac{1}{\sqrt{3}\,RC}}$$ frequency of oscillation

$$|A\beta| = 1 = \frac{R_2}{R}\cdot\frac{\omega_0^3R^3C^3}{\omega_0RC[3-\omega_0^2R^2C^2]} = \frac{\omega_0^2R^2C^2}{[3-\omega_0^2R^2C^2]}$$

$$= \frac{R_2}{R}\cdot\frac{1/3}{[3-1/3]} = \frac{1/3}{\frac{9-1}{3}} = \frac{1}{8}$$

$$\therefore \boxed{\frac{R_2}{R} = 8}$$

Considering the Loading effect:

$$\omega = \frac{1}{\sqrt{6}\,RC}$$

$$\frac{R_2}{R} = 29$$