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EE3110 Electronic Circuits

Oscillator

Name: _____ Student Number: _____ Date: _____

- Figure 1 is a phase-shift oscillator using 3 op-amp, A_1 , A_2 , A_3 . Determine the oscillator frequency and required amplifier gain if $R = 1k$ and $C = 0.1\mu F$. Hence, calculate the required value of R_2 .

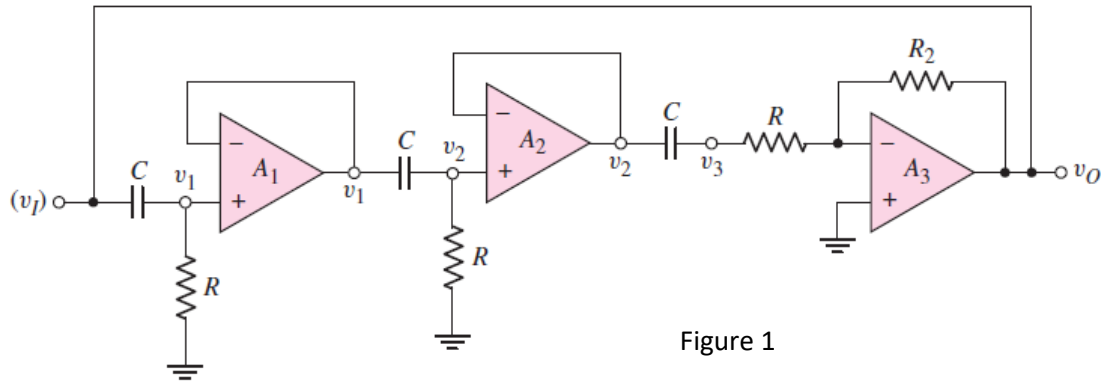


Figure 1

Hint: the criterion for the above circuit to oscillator is $A(j\omega)\beta(j\omega) = 1$, where $A(j\omega)\beta(j\omega)$ for the circuit is for the above circuit is

$$A(j\omega)\beta(j\omega) = -A_3 \times \frac{(j\omega RC)(\omega RC)^2}{(1 - 3\omega^2 R^2 C^2) + j\omega RC(3 - \omega^2 R^2 C^2)}$$

where A_3 is the gain between v_O/v_3 .

To satisfy the Barkhausen criterion,

$$1 - 3\omega^2 R^2 C^2 = 0 \Rightarrow \omega_0 = \frac{1}{\sqrt{3}RC}$$

$$\Rightarrow \omega_0 = \frac{1}{\sqrt{3}(1k)(0.1\mu F)} = 6934 \text{ rad/s} = 1104 \text{ Hz}$$

At this frequency,

$$A(j\omega_0)\beta(j\omega_0) = -A_3 \frac{(\omega_0 RC)^2}{(3 - \omega_0^2 R^2 C^2)} = 1$$

$$\Rightarrow A_3 = \frac{3\omega_0^2 C^2 R^2}{(\omega_0 RC)^2} = -8$$

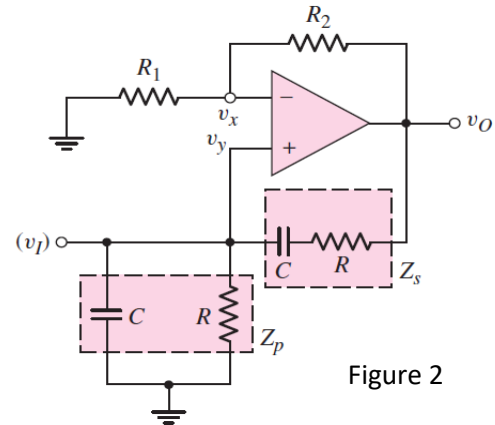
$$\Rightarrow R_2 = (-8)(-1k) = 8k$$

2. Figure 2 is a Wien-bridge oscillator using an op-amp. Assume $R=R_1 = 10k$. Determine C and R_2 to oscillator an 800Hz frequency.

Hint: the criterion for the circuit to oscillator is $A(j\omega)\beta(j\omega) = 1$, where $A(j\omega)\beta(j\omega)$ for the circuit is

$$A(j\omega)\beta(j\omega) = \frac{A}{3 + j\omega RC + (1/j\omega RC)}$$

where A is the gain between v_0/v_y .



To satisfy the Barkhausen criterion, at $\omega = \omega_0$

$$\textcircled{1} \quad j\omega_0 RC + \frac{1}{j\omega_0 RC} = 0 \Rightarrow \omega_0 = \frac{1}{RC}$$

$$\Rightarrow C = \frac{1}{\omega_0 R} = \frac{1}{(2\pi)(800)(10k)} = 19.8 \text{ nF}$$

$$\textcircled{2} \quad \frac{A}{3} = 1 \Rightarrow A = 3$$

$$\therefore A = \left(1 + \frac{R_2}{R_1}\right) \Rightarrow R_2 = (A - 1)R_1 = 20k$$