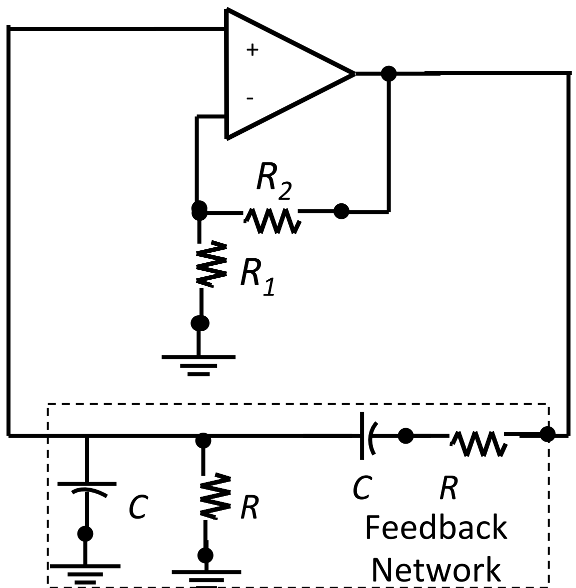
Wein Bridge Lab



- You are to build a Wein Bridge Oscillator.
- Design the circuit to yield of frequency of oscillation of ~340Hz.
- Choose values all resistors from your kit. Once you calculate its value, the capacitors will be supplied.
- Build the circuit in 3 stages:
  1. First, build the non-inverting amplifier to provide a gain that varies somewhere between 2.5 and 3.5.
  2. Use a potentiometer to vary the gain in place of R_2 such that the ratio of R_2/R_1 is somewhere between 1.5 and 2.5. Show that it attains the proper value of gain using the function generator and the oscilloscope.
  3. Once the gain is verified, build the feedback network, such that the 2 resistors are the same and the 2 capacitors are the same.
  4. Do not connect the feedback network to the circuit and how that its transfer function meet the needs of the circuit; that is it has a peak at the oscillation frequency.
  5. Connect the feedback network to the amplifier and show the following cases:
     a) Gain is too low
     b) Gain is adequate
     c) Gain is too high

Analysis of an Oscillator

$$\beta = \frac{(R \parallel C)_{parallel}}{(R \parallel C)_{parallel} + (R + C)_{series}}$$

$$(R \parallel C)_{parallel} = \frac{1}{\frac{1}{R} + j\omega C} = \frac{R}{1 + j\omega RC}$$

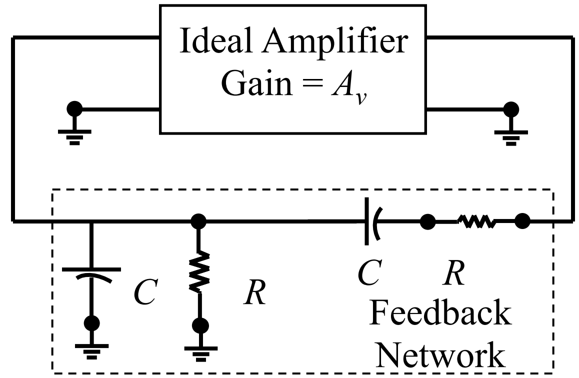
$$(R + C)_{series} = R + \frac{1}{j\omega C} = \frac{j\omega RC + 1}{j\omega C}$$

$$\beta(j\omega) = \frac{\frac{R}{1 + j\omega RC}}{\frac{R}{1 + j\omega RC} + \frac{j\omega RC + 1}{j\omega C}}$$

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

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

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



Barkhausen Criterion:

$$A_v \beta(j\omega) = 1$$

$$\frac{A_v \omega CR}{j[(\omega RC)^2 - 1] + 3\omega CR} = 1$$

$$3\omega CR - A_v \omega CR + j[(\omega RC)^2 - 1] = 0$$

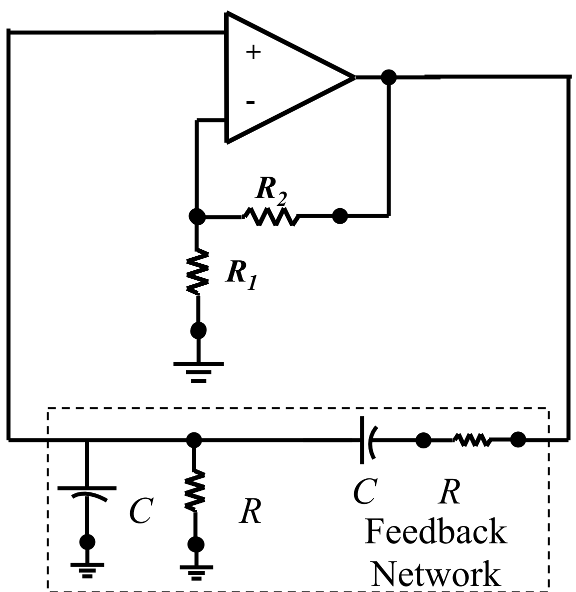
This yields:

$$A_{v\min} = 3$$

$$f = \frac{1}{2\pi RC}$$

Wien Bridge Oscillator

- A non-inverting Amplifier with gain determined by R_1 and R_2 and the RC feedback network



For the non - inverting amplifier

$$v_{in} = v_f = \frac{R_1}{R_1 + R_2} v_o$$

$$\therefore A_{noninverting} = \frac{R_1 + R_2}{R_1} = 1 + \frac{R_2}{R_1}$$

$$A_{v\min} = 3 = 1 + \frac{R_2}{R_1}$$

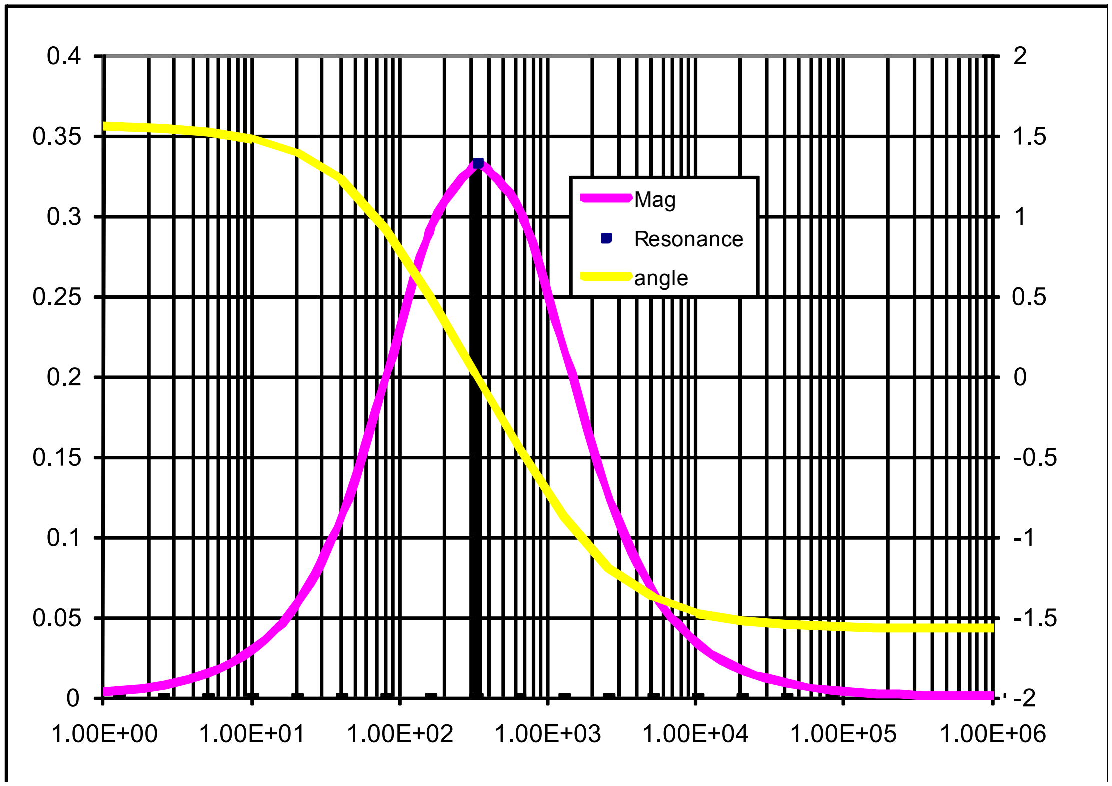
$R_2 \geq 2R_1$ for Oscillations

If $R_2 > 2R_1$ then the amplitude of the oscillations will increase and clipping will occur.

Frequency Response

$$\frac{v_f}{v_o} = \frac{j\omega CR}{1-(\omega RC)^2 + 3j\omega CR} = \frac{\omega CR}{\sqrt{[1-(\omega RC)^2]^2 + (3\omega CR)^2}} \angle \frac{\pi}{2} - \tan^{-1}(\frac{3\omega CR}{1-(\omega RC)^2}$$

$$\frac{v_f}{v_o}|_{\omega=0} = 0\angle\frac{\pi}{2}; \frac{v_f}{v_o}|_{\omega\to\infty} \to \frac{j\omega CR}{-(\omega RC)^2} = 0\angle-\frac{\pi}{2}; \frac{v_f}{v_o}|_{\omega=\frac{1}{RC}} = \frac{j1}{+3j1} = \frac{1}{3}\angle 0$$



r	c	f	wmax
1.00E+04	4.70E-08	338.63	2127.66