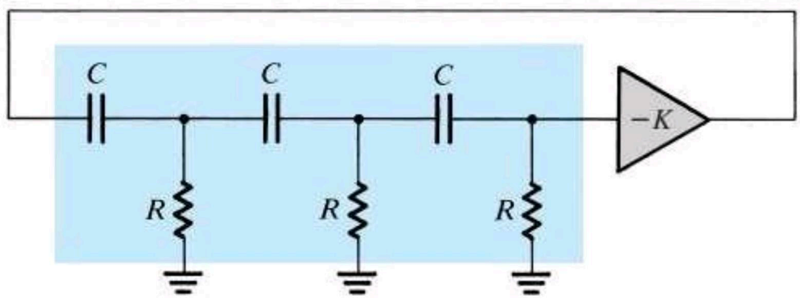
EXPERIMENT .NO.7
DATE:--/--/--

RC PHASE SHIFT OSCILLATOR USING OP-AMPS

AIM

To design and setup an RC Phase shift Oscillator using op-amp for a frequency of oscillation= $1kHz$

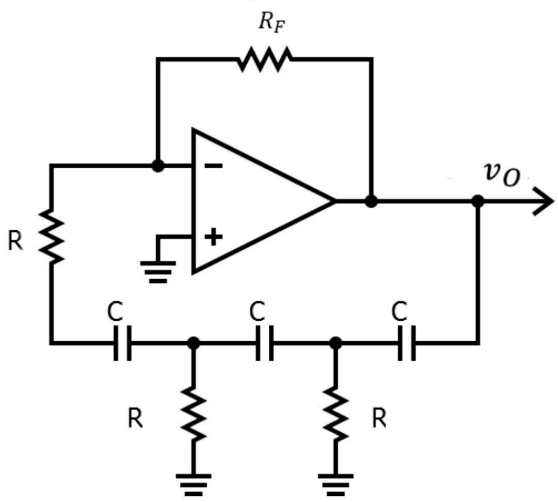
THEORY



The basic structure of a phase shift oscillator consists of a negative gain amplifier($-K$) with a 3-section RC ladder network in the feedback.

The circuit will oscillate at the frequency for which the total phase shift of the RC network is 180°. Only at this frequency will the total phase shift around the loop be 0° or 360°

The reason for using a three-section RC network is that three is the minimum number of sections (i.e., lowest order) that is capable of producing a 180° phase shift at a finite frequency.



The above circuit shows an RC Phase shift oscillator using an operational amplifier. It Consists of an op-amp as the amplifier stage and 3 cascaded RC networks as the feedback circuit.

The op amp is used in the inverting mode ⇒ provides $180°$ phase shift

Additional $180°$ phase shift required for oscillation is provided by the cascaded RC networks. At some specific frequency f_0, when the phase shift of the cascaded RC networks is exactly $180°$ & the gain of the amplifier is sufficiently large, the circuit will oscillate at that frequency.

The frequency of oscillation f_0 is given by, $f_0 = \frac{1}{2\pi RC\sqrt{6}} \cong \frac{0.065}{RC}$

At this frequency, the gain, A_v must be at least 29. *i.e.*, $\left|\frac{R_F}{R}\right| = 29$ or $R_F = 29R$

i.e., this circuit will produce a sinusoidal waveform of frequency f_0 if the gain is 29 & the total phase shift around the circuit is exactly $360°$

One important feature of an RC Oscillator is its frequency stability. *i.e.*, it is able to provide a constant frequency sine wave output under varying load conditions.

However, RC Oscillators are restricted to low frequency (e.g.: audio frequency) applications because of their bandwidth limitations to produce the desired phase shift at high frequencies.

DESIGN

The attenuation β of the three section RC feedback network is, $\beta = 1/29$

To meet the greater than unity loop gain requirement, the closed loop voltage gain of op-amp must be greater than 29.

Desired frequency of oscillations = $1kHz$

We have, $f_0 = \frac{1}{2\pi RC\sqrt{6}} \cong \frac{0.065}{RC}$

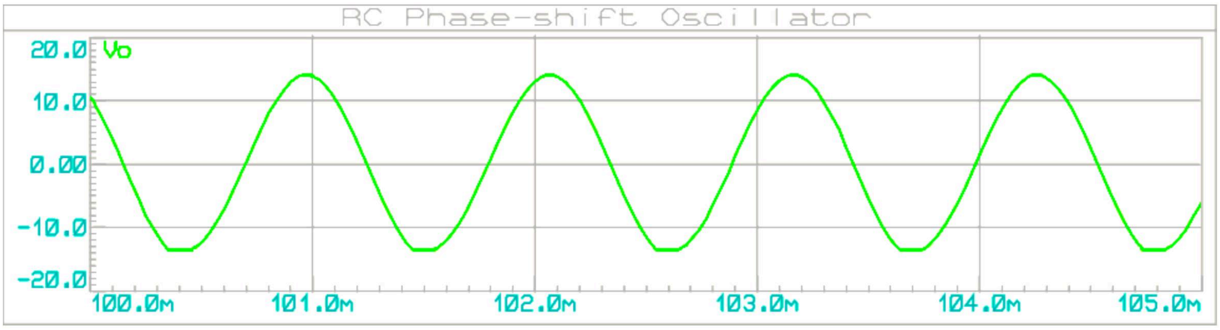
Choose $C = 0.01uF$; $\Rightarrow R = \frac{0.065}{0.01uF \times 1kHz} = 6.5k$; Choose $6.8k$ Std.

$\Rightarrow R_F = 29R = 197.2k$; Use $220k$ pot. (Or $150k$ Resistor in series with a $100k$ pot.)

PROCEDURE

- Setup the circuit and provide supply voltages to the op-amp
- Adjust the $220k$ pot until a stable sinusoidal waveform appears at the output of the op-amp
- Observe the waveforms at the output of the op-amp v_O and note down its frequency

Expected Waveforms: RC-Phase shift oscillator



OBSERVATIONS

RESULTS

An RC Phase shift Oscillator using op-amp was designed and setup for a frequency of oscillation= $1kHz$

- Observed frequency of oscillations = ______