6. SINE WAVE GENERATOR USING OPERATIONAL AMPLIFIER

6.1 OBJECTIVE

Design a sine wave oscillator using operational amplifier

1. RC phase shift oscillator
2. Wien bridge oscillator

6.2 HARDWARE REQUIRED

S.No	Equipment/Component name	Specifications/Value	Quantity
1	IC 741	Refer data sheet in appendix	1
2	Cathode Ray Oscilloscope	(0 – 20MHz) 1	1
3	Resistors	330 Ω	1
		1.5K Ω	4
		15K Ω	1
		1M Ω	1
		4.7K Ω	1
		18K Ω	1
		10K Ω	2
		15K Ω	1
		18K Ω	1
4	Capacitors	0.1µf	2
		.01µf	2
5	Regulated power supply	15 V	1

6.3.1 RC phase shift oscillator

The feedback network consists of three identical RC sections. Each section produces a phase shift of 60º Therefore, the net phase shift of the feedback is 180 º the amplifier stage introduces a phase shift of 180 º Therefore, the total phase shift between the input and output is 360 º or 0 º. When the circuit is energized, by switching on the supply, the circuit starts oscillating. The oscillations will be maintained if the loop gain is at least equal to unity.

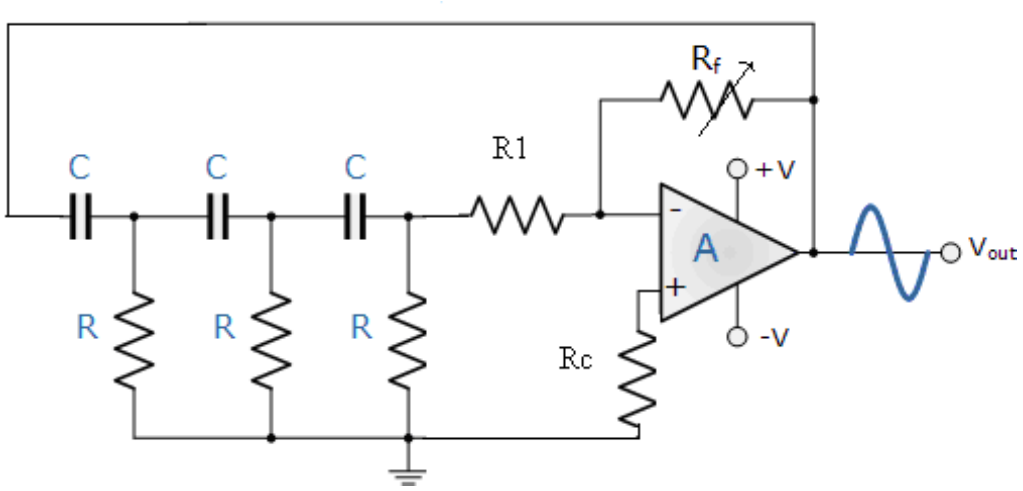
Feedback fraction of the RC phase shift network

$\beta=1/29$

The frequency of oscillation

$f_0=1/2\ \pi RC\sqrt{6}$.

Circuit diagram



C=0.1µF, R=1.5KΩ, R 1 =15KΩ, R_F=1MΩ pot

Design:

$f_0=1/2\ \pi RC\sqrt{6}$

$R_f \geq 29R_1$

$R_1 \geq 10R$

Choose C =0.1µF

f_0 = 500 Hz

$$R = \frac{1}{\sqrt{6}x2\pi f_0 C} = \frac{1}{\sqrt{6}x2\pi x500x0.1x10^{-6}}$$

R = 1.3 KΩ

Choose R = 1.5KΩ

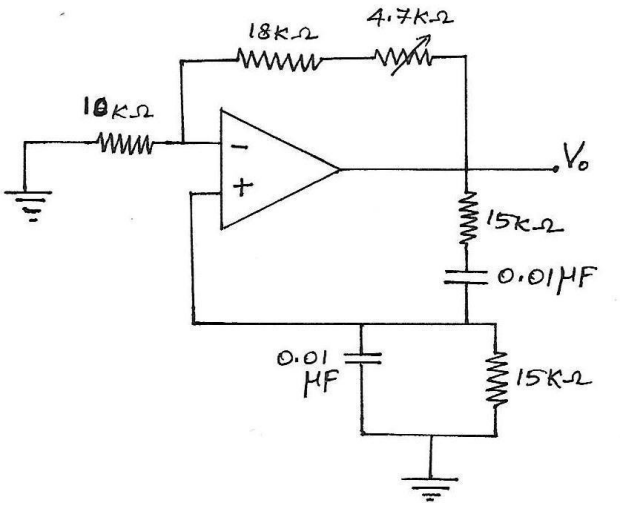
$R_1 \geq 15K\Omega$ (to prevent loading)

Therefore, $R_1 = 10R = 15K\Omega$

$R_f = 29R1 = 29x15K\Omega = 435K\Omega$ (Use 1MΩpot)

6.3.2 Wien Bridge Oscillator

It is commonly used in audio frequency oscillator. The feedback signal is connected in the input terminal so that the output amplifier is working as a non-inverting amplifier. The Wien bridge circuit is connected between amplifier input terminal and output terminal. The bridge has a series R network, in one arm and a parallel RC network in the adjoining arm. In the remaining two arms of the bridge, resistor R1 and Rf are connected. the phase angle criterion for oscillation is that the total phase shift around the circuit must be zero. This condition occurs when bridge is balanced. At resonance frequency of oscillation is exactly the resonance frequency of balanced Wien bridge and is given by $f_0 = 1/ (2\pi fC)$.assuming that the resistors are input impedance value and capacitance are equal to the value in the reactive stage of Wien bridge. At this frequency, the gain required for sustained.



Design

Given, f_o = 1KHz;

Assume C = 0.0015μF

$f_o = 1/(2\pi RC)$,

R = 100KΩ

$R_f = 2R = 200K\Omega$

Design Constraints

- The loading effect of the amplifier on the feedback network has an effect on the frequency of oscillations and can cause the oscillator frequency to be up to 25% higher than calculated. Then the feedback network should be driven from a high impedance output source and fed into a low impedance load such as a common emitter transistor amplifier but better still is to use an Operational Amplifier as it satisfies these conditions perfectly.
- The voltage gain of the Wien bridge oscillator circuit must be equal to or greater than three "Gain = 3″ for oscillations to start.
- Due to the open-loop gain limitations of operational amplifiers, frequencies above 1MHz are unachievable without the use of special high frequency op-amps.

6.3 PRE-LAB

1. In an op-amp based RC phase shift oscillator, what is the minimum gain that should be maintained. Why?
2. State Barkhausen criterion for oscillation
3. Write the formula to calculate frequency of oscillation for RC &Wien bridge oscillator
4. What are the applications of oscillators?
5. In RC phase shift oscillator using, the value of capacitor is 0.01μF and the Frequency of oscillation is 35 KHz. the voltage gain of the amplifier Should be 30.calculate the value of R of RC feedback Network?

6.4 POST-LAB

1. What are the merits and Demerits of Wien bridge oscillator?

2. Why do we need three RC networks for a phase shift oscillator?

3. Explain the main difference between an amplifier and an oscillator.

4. In as RC phase shift oscillator, if R1 = R2 = R3 = 200kΩ and C1 = C2 = C3 = 100pF. Find the frequency of oscillation.

5. Mention the advantages and disadvantages of negative feedback.

Result: