Wien bridge Oscillator

Aim :- To construct Wien bridge oscillator using operational amplifier 741. To measure the frequency of oscillation and to compare it to that of theoretical value.

Apparatus :- Operational amplifier 741, CRO, two variable capacitors (C_1,C_2), three variable non-inductive resistors (R_1, R_2 and R$_3$)and one fixed resistor, two power supplies and connecting terminals.

Formula :- Frequency of oscillation

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

Where $\qquad\qquad\qquad\qquad$ $R_1 = R_2 = R = $ Resistances (Ω)

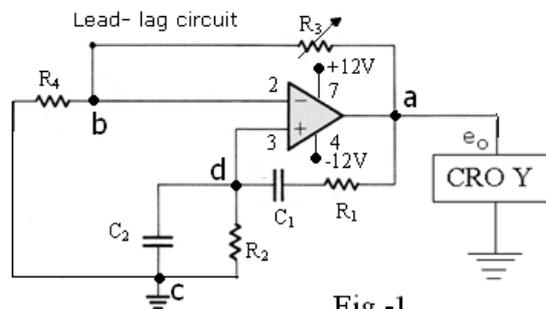and $\qquad\qquad\qquad\qquad$ $C_1 = C_2 = C = $ Capacitances (µF)
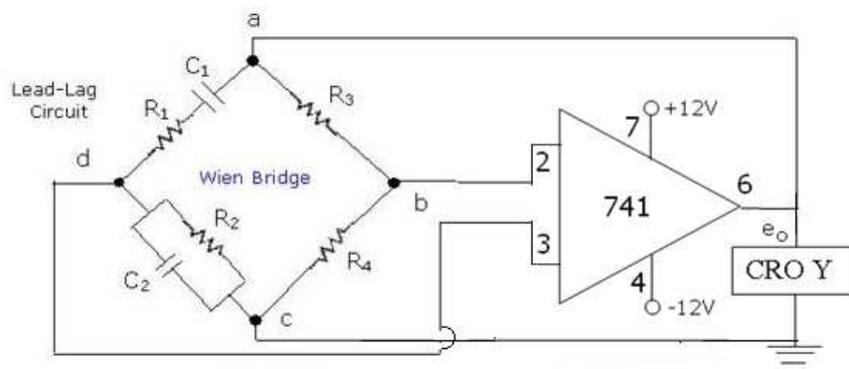

Fig -1

OR

Fig-2

Description :- Fig-1 or Fig-2 is the circuit of the Wien bridge oscillator (as these two circuits are same). A resistor R_4 is connected to the inverting terminal (2) of the operational amplifier from the ground. Similarly a parallel combination of a resistance R_2 and a capacitor C_2 is connected to the non-inverting terminal (3) of the operational amplifier from the ground. The output terminal (6) of the amplifier is fed back to inverting terminal (2) through a variable resistor R_3. A series combination of a resistance R_1 and a capacitor C_1 is connected between non-inverting terminal (3) and the out put of operational amplifier. To observe the out put wave form, the out put terminal (6) is connected to CRO Y- Plates phase terminal and the other terminal of CRO is grounded. The terminals (7) and (4) of the op. amp. are connected to +12 V and -12 V of the D.C. power supplies separately.

Theory :-An oscillator consists of an amplifier and a feedback network.
1) 'Active device' i.e. Op Amp is used as an amplifier.
2) Passive components such as R-C or L-C combinations are used as feed back net work.

To start the oscillation with the constant amplitude, positive feedback is not the only sufficient condition. Oscillator circuit must satisfy the following two conditions known as **Barkhausen** conditions:

i. The first condition is that the magnitude of the loop gain (Aβ) = 1
   A = Amplifier gain and β = Feedback gain.
ii. The second condition is that the phase shift around the loop must be 360° or 0°.

The feedback signal does not produce any phase shift. This is the "basic principle of a Wien bridge oscillator".

Lead-Lag circuit :- The given circuit shows the RC combination used in Wien bridge oscillator. This circuit is also known as lead-lag circuit. Here, resistor R_1 and capacitor C_1 are connected in the series while resistor R_2 and capacitor C_2 are connected in parallel.

Working of lead-lag circuit :- At high frequencies, the reactance of capacitor C_1 and C_2 approaches zero. This causes C_1 and C_2 appears short. Here, capacitor C_2 shorts the resistor R_2. Hence, the output voltage Vo will be zero since output is taken across R_2 and C_2 combination. So, at high frequencies, circuit acts as a **'lag circuit'**.

At low frequencies, both capacitors act as open because capacitor offers very high reactance. Again output voltage will be zero because the input signal is dropped across the R_1 and C_1 combination. Here, the circuit acts like a **'lead circuit'**.

But at one particular frequency between the two extremes, the output voltage reaches to the maximum value. <u>At this frequency only, resistance value becomes equal to capacitive reactance and gives maximum output.</u> Hence, this particular frequency is known as <u>resonant frequency or oscillating frequency.</u>

The maximum output would be produced if **R = Xc**.

$$R = X_c = \frac{1}{2\pi f C}$$

If $R_1 = R_2 = R$ and $C_1 = C_2 = C$

Then the resonant frequency

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

Due to limitations of the op-amp, frequencies above 1MHz are not achievable.

The basic version of Wien bridge has four arms. The two arms are purely resistive and other two arms are frequency sensitive arms. These two arms are nothing but the lead-lag circuit. The series combination of R_1 and C_1 is connected between terminal a and d. The parallel combination of R_2 and C_2 is connected between terminal d and c . So the two circuits (Fig.1 and Fig.2) are same except in shape.

Here, bridge does not provide phase shift at oscillating frequency as one arm consists of lead circuit and other arm consists of lag circuit. There is no need to introduce phase shift by the operational amplifier. Therefore, non inverting amplifier is used.

<u>Procedure</u> :- Connect the circuit is as shown in the Fig-1. Keep the resistance and capacitor values $R_1 = R_2 = R$ and $C_1 = C_2 = C$ and switch on the power. Adjust the voltage sensitivity band switch and time – base band switch such that at least two or more complete sine waves are observed on the screen of CRO. Also adjust the resistance R_3 value till the wave formed on the CRO screen is stationary. Note R and C values in the table and measure the peak to peak

horizontal length (l) of one sine wave. Multiply this value with the corresponding time-base (t) value. This product (l x t) gives the time period (T) of the generated sine wave. The reciprocal of time period gives the experimental frequency of the sine wave. On substitution of Rand C values in the above equation, it gives theoretical frequency. The theoretical and experimental frequencies are equal. The experiment is repeated by changing the value of R or C.

Precautions :- 1. Check the continuity of the connecting terminals before connecting them.

2. Keep the band switches of the C.R.O. and adjust the value of R_3 such that steady wave forms are observed on the screen.

3. Observe the out put sine wave on the screen of CRO and measure the horizontal length accurately.

Results :- It is found that the experimental frequency and theoretical frequency are equal.

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Table

S.No.	Theoretical frequency			Measurement of out put frequency			
	$R_1 = R_2 = R$ (Ω)	$C_1 = C_2 = C$ (μF)	$f = \dfrac{1}{2\pi RC}$ (Hz)	Peak to peak Horizontal length (l) (Divisions)	Time base (t) Sec/div	Period T=(l x t) Sec	Frequency $f = \frac{1}{T}$ Hz

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