Phase Shift Oscillator using OPAMP

Objectives:

To construct and determine the resonant frequency of
(i) A phase shift oscillator

Overview:

The main principle of oscillator is positive feedback. Block diagram of oscillator is shown in Figure 1.

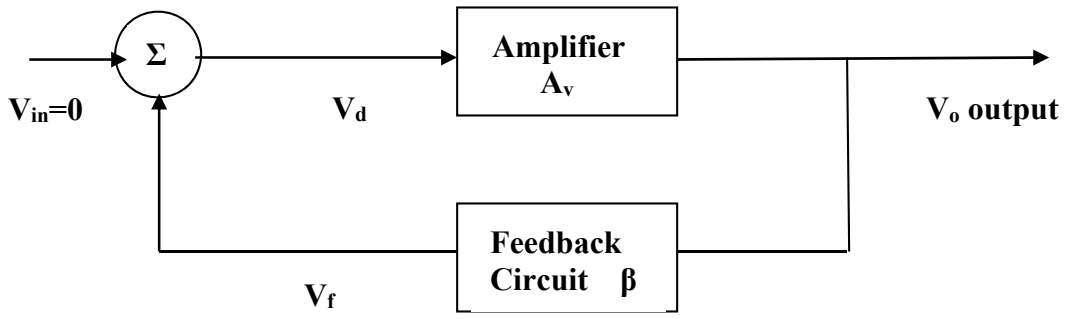

Figure.1

In the block diagram, $V_d = V_f + V_{in}$

$$V_o = A_v V_d \text{ and } V_f = \beta V_o$$

Using these relationships, following equation can be obtained:

$$\frac{V_o}{V_{in}} = \frac{A_V}{1 - A_V \beta}$$

.

When $A_V\beta = 1$, $A_{fb} = \infty = \frac{V_o}{V_{in}}$, This will happen only when $V_{in} = 0$. That is we get a signal at output without any input. The condition $A_V\beta = 1$ is known as Barkhausen condition. This condition expressed in polar form as follows. $A_V\beta = 1 \angle 0° \; or \; 360°$

Barkhausen condition gives two requirements for oscillation.

1) The magnitude of the loop gain must be equal to 1.
2) The total phase shift of the loop gain must be equal to $0° \; or \; 360°$.

Phase shift Oscillator: Figure.2 gives the circuit diagram for a phase shift oscillator, which consists of an op-amp as the amplifying stage and three RC cascaded networks as the feedback circuit. The opamp used in this oscillator is in the inverting mode, output is 180° is phase shifted. To feedback the output to input, additional 180° degree phase shift is achieved by RC network.

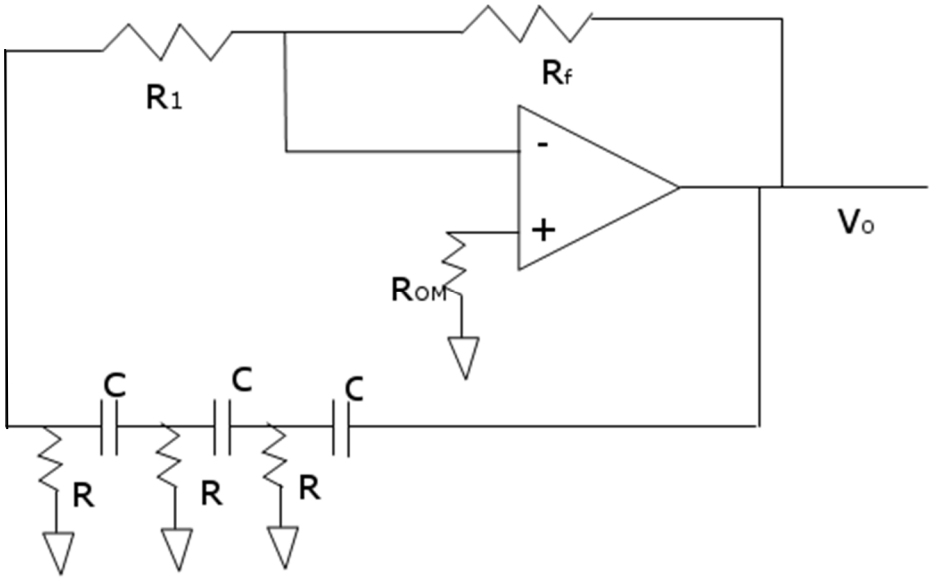

Figure.2

The frequency of oscillation is given by, $\boldsymbol{f = \frac{1}{2\pi\sqrt{6}RC}}$ and at this frequency gain must be *at least* 29. That is $\left|\frac{R_F}{R_1}\right| = \mathbf{29}$.

Feedback circuit with RC network gives 180 degree phase shift but decreases the output voltage by a factor of 29. That is β=1/29. For the oscillations Avβ = 1. Therefore, gain should be at least 29.

Procedure: Choose R_f = 100 KΩ, R = 2 KΩ, C = 0.1 uF, R=1 KΩ and construct a phase shift oscillator. Determine the oscillating frequency using oscilloscope and compare with calculated oscillation frequency.

Experimentally determine the minimum gain required to sustain oscillations by varying the gain in the circuit. Use Lissajous figures with X-Y mode of the oscilloscope to estimate oscillating frequency. Try to make the circuit for some other oscillating frequency by choosing components appropriately.