CHAPTER 6 (OSCILLATORS)
PHASE SHIFT OSCILLATORS

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Course Homepage

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REMAINING PORTIONS

- Phase Shift Oscillator
- LC Oscillators
- Astable Multivibrators
- Square Wave Generators
- Triangular Wave Generators
- 555 Timer

Phase Shift Oscillators Introduction

- At low frequencies (around 100 KhZ or less) combination of resistors are usually employed to determine frequency of oscillation
- Phase shift oscillator is a sinusoidal feedback oscillator
- Employs 3 resistors and 3 capacitors to determine the frequency of Oscillation

Circuit Diagram of Phase Shift Oscillator

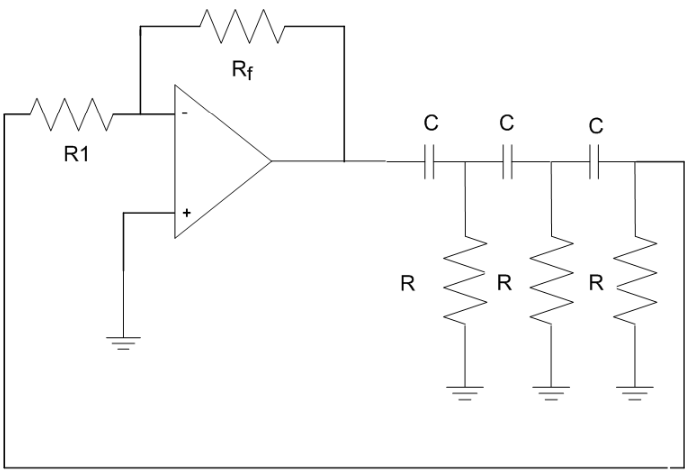
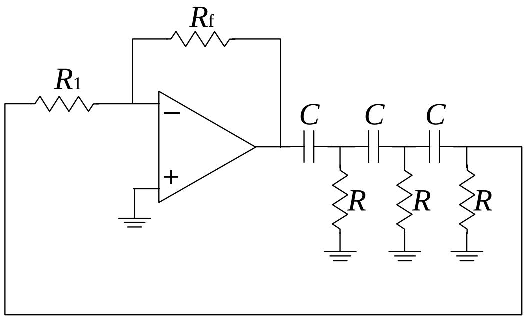


Fig. Phase Shift Oscillator

RC Phase-Shift Oscillator



- Using an inverting amplifier
- The additional 180º phase shift is provided by an RC phase-shift network

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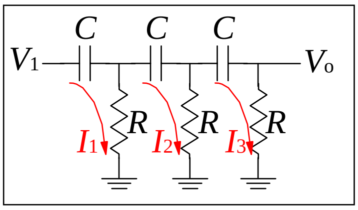
Applying KVL to the phase-shift network, we have

$$\begin{aligned} V_1 &= I_1(R - jX_C) - I_2R \\ 0 &= -I_1R + I_2(2R - jX_C) - I_3R \\ 0 &= -I_2R + I_3(2R - jX_C) \end{aligned}$$



Solving for I_3, we get

$$I_3 = \frac{\begin{vmatrix} R - jX_C & -R & V_1 \\ -R & 2R - jX_C & 0 \\ 0 & -R & 0 \end{vmatrix}}{\begin{vmatrix} R - jX_C & -R & 0 \\ -R & 2R - jX_C & -R \\ 0 & -R & 2R - jX_C \end{vmatrix}}$$

Or $$I_3 = \frac{V_1R^2}{(R - jX_C)[(2R - jX_C)^2 - R^2] - R^2(2R - jX_C)}$$

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The output voltage,

$$V_o = I_3 R = \frac{V_1 R^3}{(R - jX_C)[(2R - jX_C)^2 - R^2] - R^2(2R - jX_C)}$$

Hence the transfer function of the phase-shift network is given by,

$$\beta = \frac{V_o}{V_1} = \frac{R^3}{(R^3 - 5RX_C^2) + j(X_C^3 - 6R^2 X_C)}$$

For 180º phase shift, the imaginary part = 0, i.e.,

$$X_C^3 - 6R^2 X_C = 0 \quad \text{or} \quad X_C = 0 \text{ (Rejected)}$$

$$\Rightarrow \mathrm{X}_\mathrm{C}^2 = 6R^2$$

$$\omega = \frac{1}{\sqrt{6}RC}$$

and,

$$\beta = -\frac{1}{29}$$

Note: The –ve sign meas the phase inversion from the voltage

PHASE SHIFT OSCILLATORS USING BJT

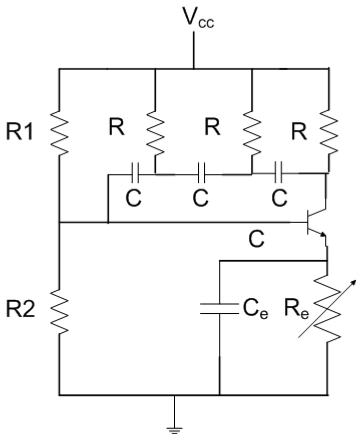


Fig.1 Phase shift Oscillator using BJT

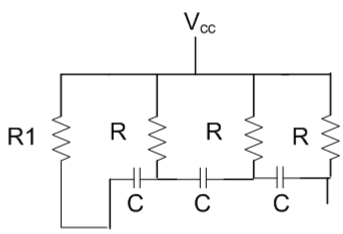
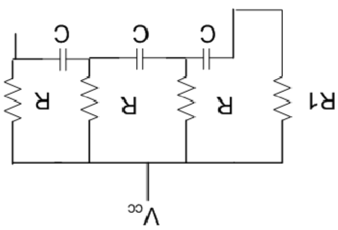


Fig.2 Dissecting the upper half



Rotating fig. 2 by180 degrees

Approximate Equivalent Circuit

Derive i4/i1=-1/29