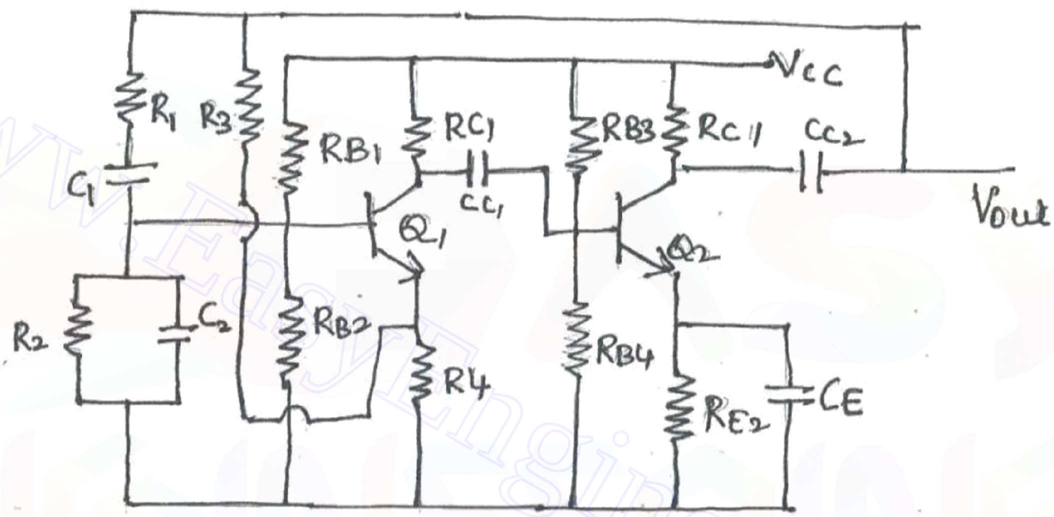
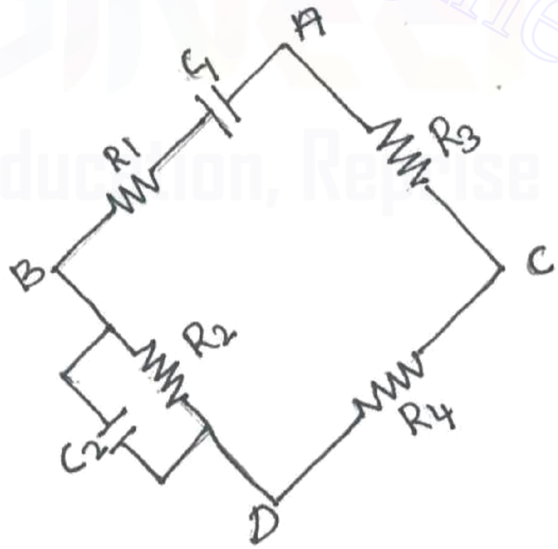
Wein Bridge Oscillator :-

→ It is an audio frequency Oscillator. It is the only one Oscillator involves both positive and negative feedback Negative feedback provides stability and positive feedback provides Oscillation.





The bridge circuit consists of two arms the resistive arm R_3 & R_4 and reactive arms R_1C_1 and R_2C_2. The resistive arm consisting of R_4 introduces negative

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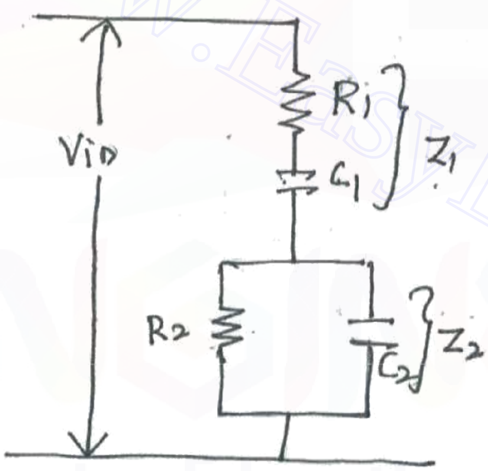
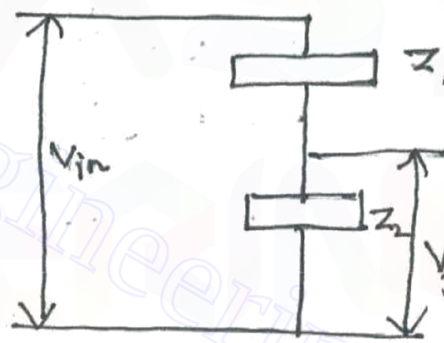
feedback to the circuit of transistor Q. It improves bias stability. Since arm ACD contains only resistance the feedback is the provided by the arm is not sensitine to changes in frequency. The amount of feedback is determined only by the voltage divider $R_3 R_4$. The reactive arm contains two RC networks out of which one is and other is in series.





$$Z_1 = R_1 + \frac{1}{j\omega C_1} = \frac{R_1 j\omega C_1 + 1}{j\omega C_1}, \quad Z_2 = R_2 \,||\, j\omega C_2 = \frac{R_2 / j\omega C_2}{R_2 + \frac{1}{j\omega C_2}}$$

$$= \frac{R_2}{1 + j\omega C_2 R_2}$$

$$I = \frac{V_{in}}{Z_1 + Z_2}, \quad V_f = I \cdot Z_2 = \frac{V_{in} Z_2}{Z_1 + Z_2}$$

$\beta = \frac{V_f}{V_o}$ Here the output V_o is fed to the input $\therefore V_o = V_{in}$

$$\beta = \frac{Z_2}{Z_1 + Z_2} \rightarrow (3)$$ substituting Z_1, Z_2 in (3)

$$\beta = \frac{\frac{R_2}{1+j\omega R_2 C_2}}{\frac{1+j\omega R_1 C_1}{j\omega C_1} + \frac{R_2}{1+j\omega R_2 C_2}} = \frac{R_2 j\omega C_1}{(1+j\omega R_1 C_1)(1+j\omega R_2 C_2) + R_2 j\omega C_1}$$

$$= \frac{j\omega R_2 C_1}{1 + j\omega R_2 C_2 + j\omega R_1 C_1 + j^2\omega^2 R_1 C_1 R_2 C_2 + j\omega R_2 C_1}$$

$$= \frac{j\omega R_2 C_1}{1 + j\omega R_2 C_2 + j\omega R_1 C_1 - \omega^2 R_1 C_1 R_2 C_2 + j\omega R_2 C_1}$$

$$\beta = \frac{j\omega R_2 C_1}{1 + j\omega (R_2 C_2 + R_1 C_1 + R_2 C_1) - \omega^2 R_1 R_2 C_1 C_2}$$

$$= \frac{j\omega R_2 C_1}{(1 - \omega^2 R_1 R_2 C_1 C_2) + j\omega (R_1 C_1 + R_2 C_2 + R_2 C_1)} \rightarrow (4)$$

multiplying by its conjugate

$$\beta = \frac{j\omega R_2 C_1 [(1 - \omega^2 R_1 R_2 C_1 C_2) - j\omega (R_1 C_1 + R_2 C_2 + R_2 C_1)]}{(1 - \omega^2 R_1 R_2 C_1 C_2)^2 + \omega^2 (R_1 C_1 + R_2 C_2 + R_C C_1)^2} \rightarrow (5)$$

$$\beta = \frac{j\omega R_2 C_1 (1 - \omega^2 R_1 C_1 R_2 C_2) + \omega^2 R_2 C_1 (R_1 C_1 + R_2 C_2 + R_2 C_1)}{(1 - \omega^2 R_1 C_1 R_2 C_2)^2 + \omega^2 (R_1 C_1 + R_2 C_2 + R_2 C_1)^2} \rightarrow ($$

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To have zero phase shift of the feedback network, its imaginary part must be zero. Equating the imaginary part of (6) to be zero, we get

$$\omega R_2 C_1 \left[1 - \omega^2 R_1 C_1 R_2 C_2\right] = 0$$

As $\omega \neq 0, R_2 \neq 0, C \neq 0$

$$1 - \omega^2 R_1 C_1 R_2 C_2 = 0$$

$$\omega^2 = \frac{1}{R_1 R_2 C_1 C_2} \Rightarrow \omega = \frac{1}{\sqrt{R_1 R_2 C_1 C_2}}$$

$$f = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}} \rightarrow (7)$$

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

$$f = \frac{1}{2\pi RC} \rightarrow (8)$$

If $R_1 = R_2 = R$, $C_1 = C_2 = C$ in eqn (6)

$$\beta = \frac{\omega^2 RC(3RC) + j\omega RC(1 - \omega^2 R^2 C^2)}{(1 - \omega^2 R^2 C^2)^2 + \omega^2 (3RC)^2} \rightarrow (9)$$

Substituting $\omega = \frac{1}{RC}$

$$\beta = \frac{\frac{3R^2C^2}{R^2C^2} + j\frac{RC}{RC}\left(1 - \frac{R^2C^2}{R^2C^2}\right)}{\left(1 - \frac{R^2C^2}{R^2C^2}\right) + \frac{1}{R^2C^2}(3RC)^2} = \frac{3}{9} = 1/3$$

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For Sustained Oscillations

$|A\beta| \geq 1 \quad \therefore |A(1/3)| \geq 1 \quad = A \geq 3$

Advantages :-

→ Good stability, By replacing R_2 with a thermistor, the amplitude stability of Oscillator Output Voltage can be increased.

→ Overall gain is high because of two transistors employed in the circuit.

→ Frequency of Oscillation can be changed varying R and C

→ Good sine wave output. It does not require inductors.

Disadvantages :-

→ Circuit requires two transistors and large number of components

→ It can't generate very high frequencies.

Frequency Stability of an Oscillator :-

The ability of an Oscillator to maintain a constant frequency of Oscillation is called frequency stability

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1) operating point of the active devices
2) Inter element capacitances
3) Variations in power supply
4) Temperature variation
5) Output and
6) Mechanical vibrations.