PARALLEL RESONANT CIRCUITS

- Consider the parallel resonant circuit shown in the Fig. 4.8
- The total current is

$$I_T = I_R + I_L + I_C = V_m\left(\frac{1}{R} + \frac{1}{j\omega L} + j\omega C\right) = V_m\left(\frac{1}{R} - j\left(\frac{1}{\omega L} - \omega C\right)\right)$$

$$= \boldsymbol{V_m(G - jB)}$$

- Where G = conductance and B= susceptance
- At resonance, $\boldsymbol{B = 0}$
- Thus the total current at resonance is

$$\boldsymbol{I_T = V_m G = \frac{V_m}{R}}$$

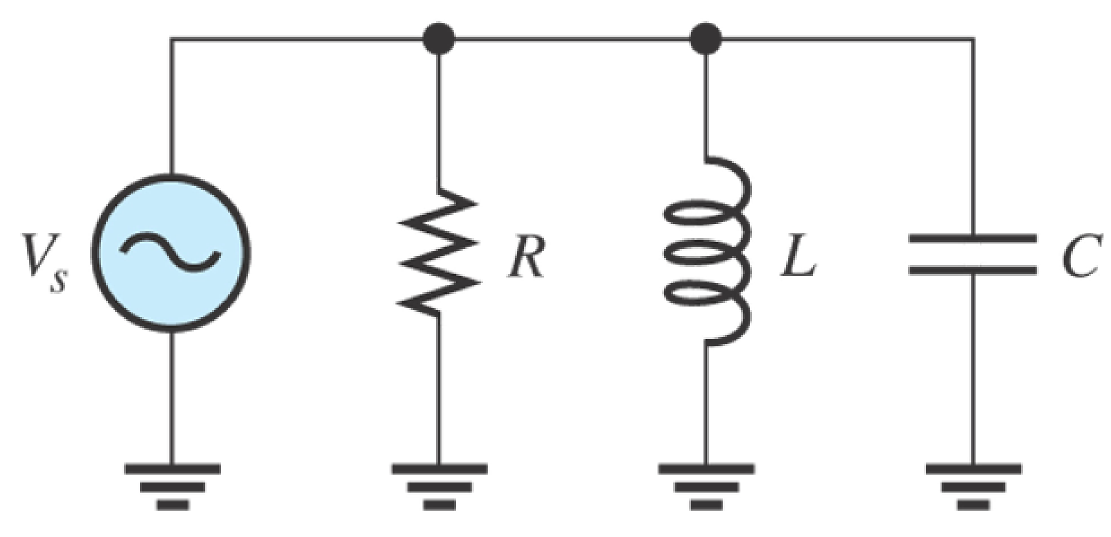


Fig. 4.8: Parallel resonant circuit

PARALLEL RESONANCE

- For a parallel RLC circuit , the resonant frequency is given by

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

- At resonance
  i. Current is minimum
  ii. Impedance is maximum
- Fig. 4.9 shows the current variation with frequency. Fig. 4.10 shows the impedance variation with frequency

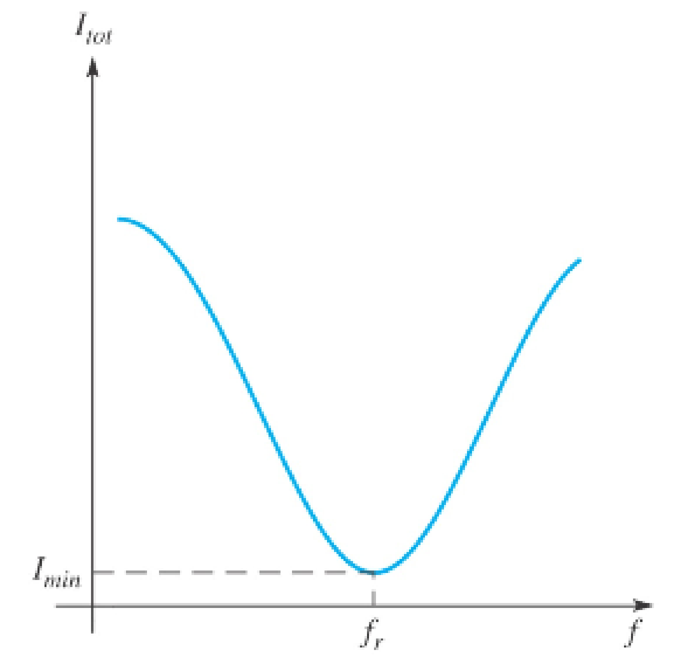


Fig. 4.9: Current vs frequency

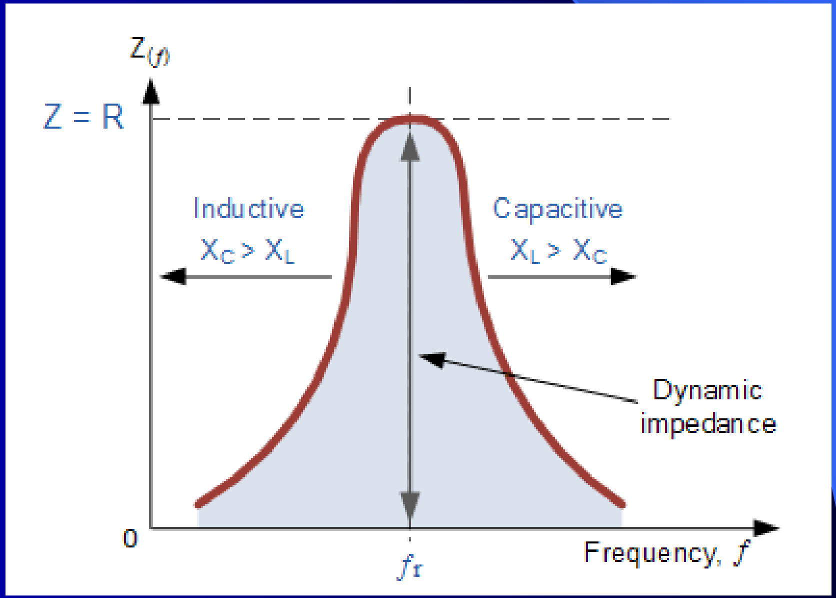


Fig. 4.10: Impedance vs frequency

- Fig. 4.11 shows the variation of the output voltage of the parallel resonant circuit with frequency

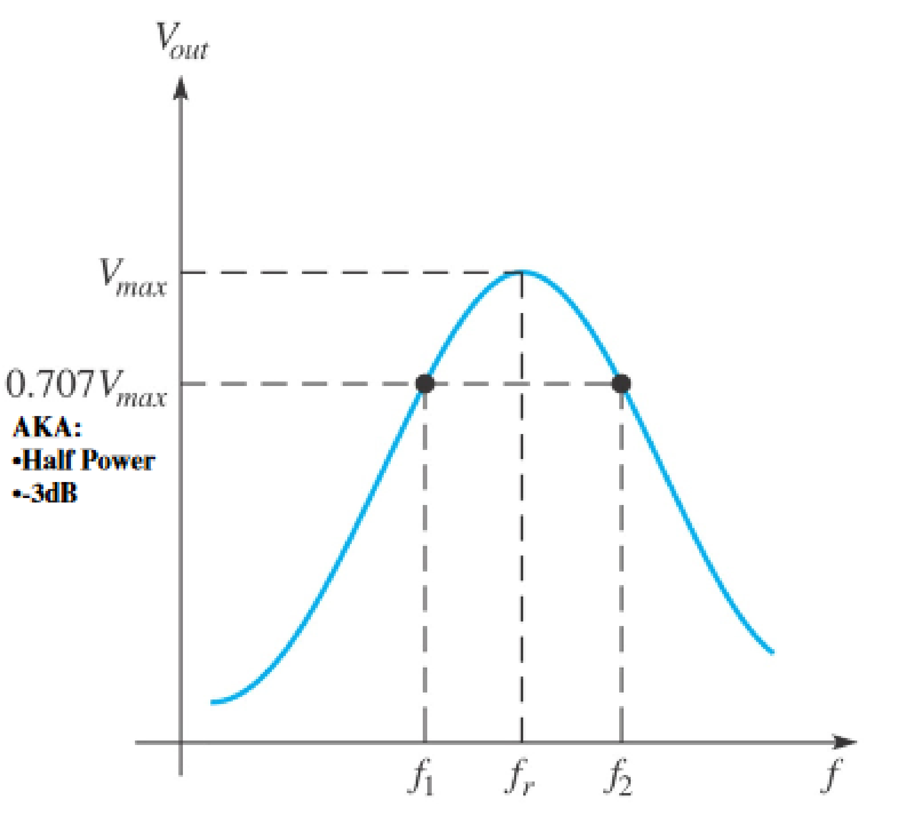


Fig. 4.11: Voltage versus frequency

PARALLEL RESONANCE

- The quality factor of the parallel resonant circuit is

$$Q = 2\pi f_r RC = \frac{R}{X_L}$$

- The bandwidth of the parallel resonant circuit is

$$BW = \frac{1}{2\pi RC}$$

- Using Q, we can write the bandwidth as:

$$\boldsymbol{BW = \frac{f_r}{Q}}$$

EXAMPLE 4.2:

- A parallel resonance network consisting of a resistor of 60Ω, a capacitor of 120uF and an inductor of 200mH is connected across a sinusoidal supply voltage which has a constant output of 100 volts at all frequencies. Calculate, the resonant frequency, the quality factor and the bandwidth of the circuit and the circuit current at resonance.

- Solution:

Resonant frequency, f_r

$$f_r = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{0.2 \text{ x } 120 \text{ x } 10^{-6}}} = 32.5\ Hz$$

Quality factor

$$Q = \frac{R}{X_L} = \frac{R}{2\pi f L} = \frac{60}{40.8} = 1.47$$

Bandwidth

$$BW = \frac{f_r}{Q} = \frac{32.5}{1.47} = 22\ Hz$$

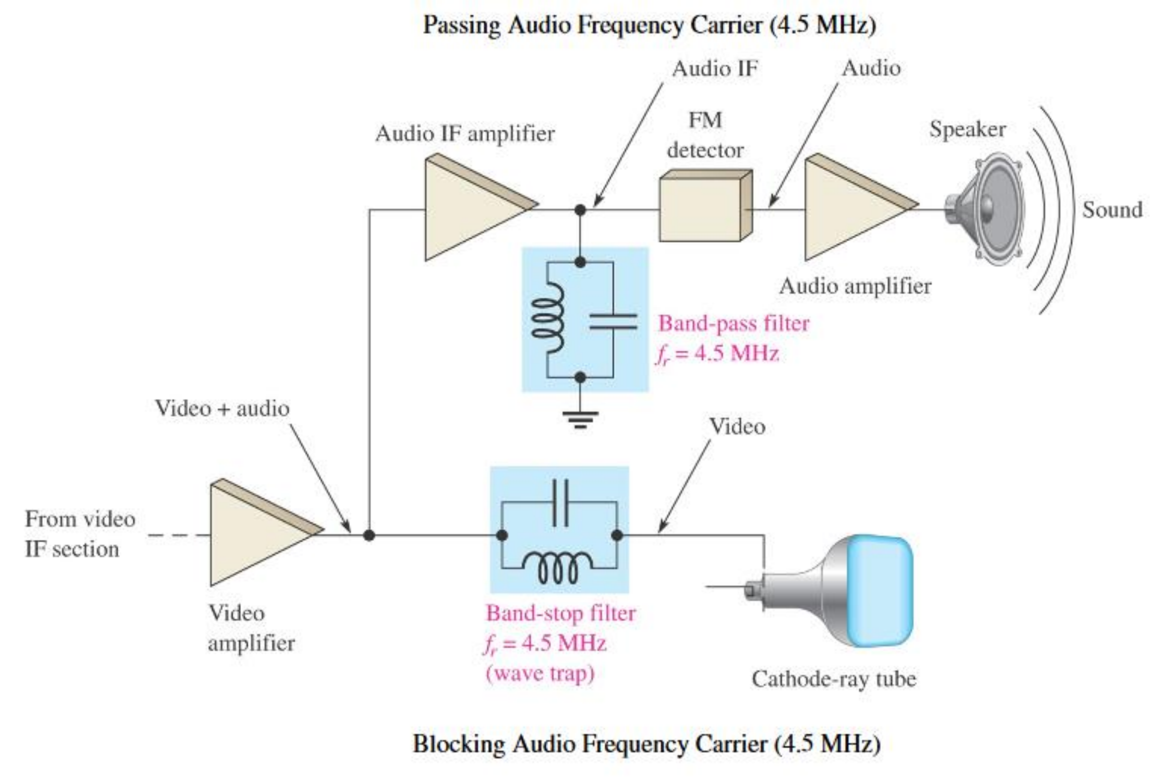
Circuit current at Resonance, I_T

At resonance the dynamic impedance of the circuit is equal to R

$$I_T = I_R = \frac{V}{R} = \frac{100}{60} = 1.67\ A$$

APPLICATION OF RESONANT CIRCUITS

1. Parallel resonant circuits can be used as bandpass filters in RF receivers
2. Parallel resonant circuits can be used as oscillators in RF receivers



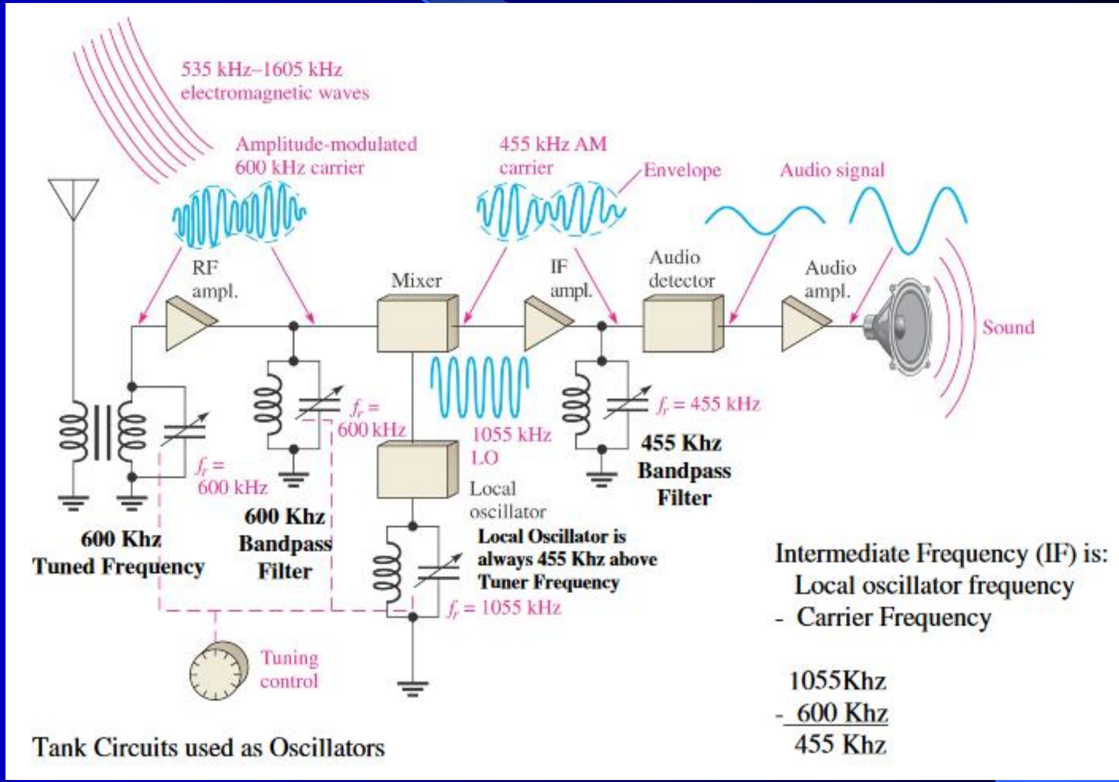


Fig. 4.12: Resonant circuit used as bandpass filter

Fig. 4.13: Resonant circuit used as oscillator