## PARALLEL RESONANT CIRCUITS

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

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

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

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

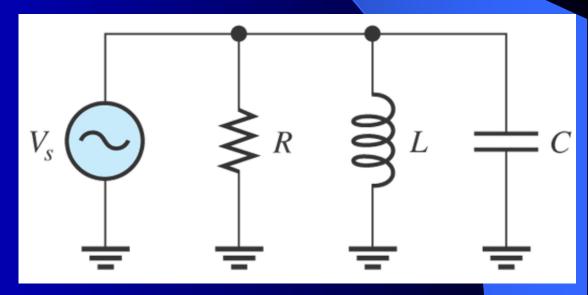


Fig. 4.8: Parallel resonant circuit

## 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

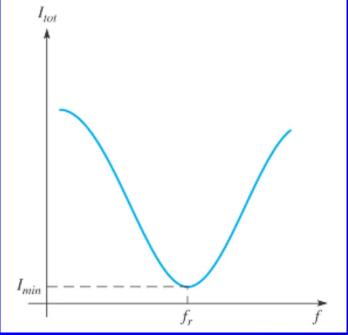


Fig. 4.9: Current vs frequency

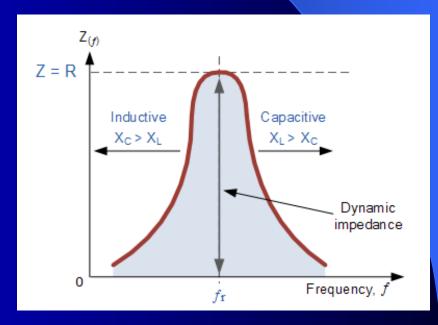


Fig. 4.10: Impedance vs frequency

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

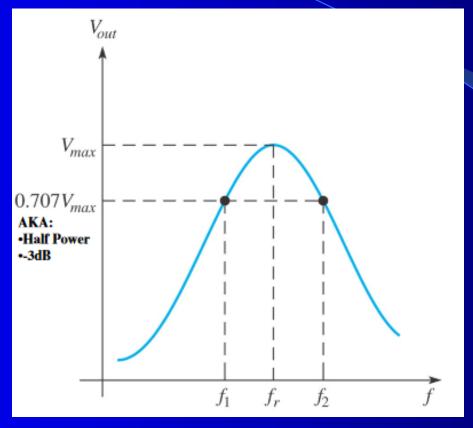


Fig. 4.11: Voltage versus frequency

# 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:

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

### **EXAMPLE 4.2:**

A parallel resonance network consisting of a resistor of  $60\Omega$ , 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<sub>r</sub>

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

Quality factor

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

Bandwidth

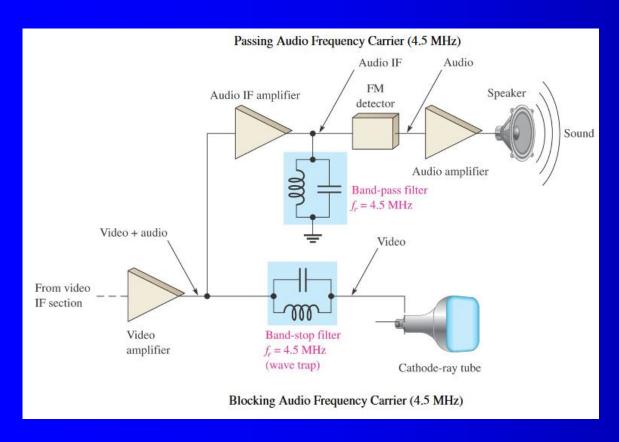
$$BW = \frac{f_r}{Q} = \frac{32.5}{1.47} = 22 \, Hz$$

Circuit current at Resonance, I<sub>T</sub>
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



535 kHz-1605 kHz electromagnetic waves Amplitude-modulated 455 kHz AM Envelope Audio signal Audio Mixer detector Sound E = 455 kHz600 kHz 455 Khz Bandpass Filter 600 Khz Local Oscillator is 600 Khz Bandpass Intermediate Frequency (IF) is: always 455 Khz above **Tuned Frequency** Filter **Tuner Frequency** Local oscillator frequency - Carrier Frequency Tuning 1055Khz - 600 Khz 455 Khz Tank Circuits used as Oscillators

Fig. 4.12: Resonant circuit used as bandpass filter

Fig. 4.13: Resonant circuit used as oscillator