Tuned Amplifier

Amplifier
- DC amplifier (from zero to about 10Hz)
- Audio amplifier (20 Hz to 20KHz)
- Radio ,, (a few KHz to hundred of MHz)

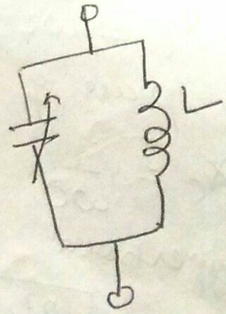
* Some times selection of a desired freq. or a narrow band of frequencies for amplification is our need, such as in radio/ TV the receiver is required to pick up and amplify the desired radio freq. while rejecting all other.

Amplifier, amplifying a signal of specific freq. or narrow band of frequencies is known as tunned Amplifier.

* Employed for amplification of high or radio freq. signals and can't used for amplification of audio-freq. signals, because :-

① Tunned amp^r select & amplifies a single freq. while AF are mixtures of frequencies in the freq. range of (20 Hz – 20 KHz)

② for amplification of Low freq. signals large valued, inductor & capacitors are required $f_r = \frac{1}{2\pi\sqrt{LC}}$



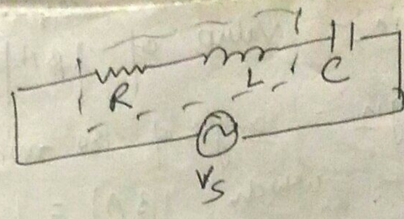
~~Tuned~~ The centre of this freq. band is the resonant freq. of the tuned Ckt.

Resonant L-C circuit as a load provides high impedance and so the tuned transistor amplifier can provide high gain because gain of a transistor amplifier depends on the value of its load impedance.

only Narrow band of frequencies around the resonant freq. f_r would be amplified well while other frequencies would be discriminated

Resonant ckt :-

① series resonant ckt :-



$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$= \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

① when $X_L = X_C$

② $Z = R$ ③ Current flowing through the ckt is maximum and inphase with the applied voltage. $I = V/R$.

④ $V_C = V_L$ but opposite in phase ⑥ power expended = VI watts.

⑤ power factor = 1

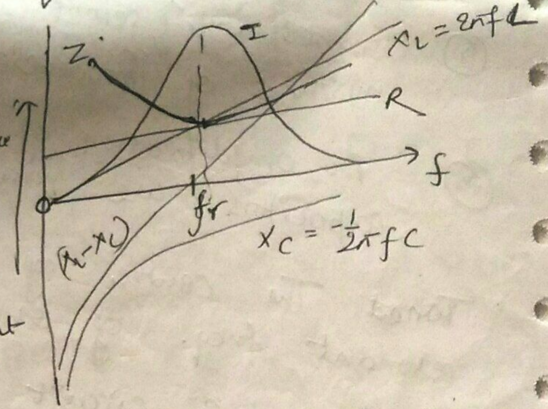
The ckt is said to be in resonance and the freq. at which it occurs is known as resonant freq.

$$\omega L = \frac{1}{\omega C} \Rightarrow \omega^2 = \frac{1}{LC} = (2\pi f)^2 = \frac{1}{LC} \Rightarrow 2\pi f = \frac{1}{\sqrt{LC}}$$

$$\boxed{f = \frac{1}{2\pi\sqrt{LC}}}$$

since voltage is max. So it is called voltage resonance.

The series resonance is called an acceptor circuit because such a circuit accepts currents at one particular freq. but rejects current of other frequencies.



$X_L = \omega L$ so represented by straight line passing through the origin.

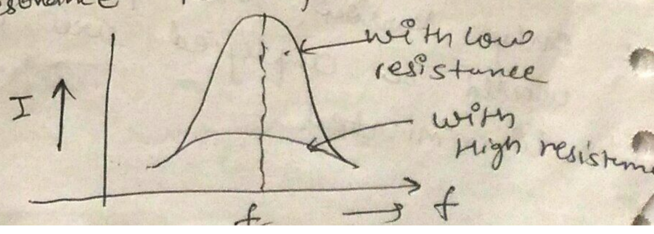
$X_C = \frac{1}{\omega C}$ represented by reactangular hyperbola.

$Z = \sqrt{R^2 + (X_L - X_C)^2}$ is minimum at reasonent freq (f_r)

* At freq. lower than resonant freq. fr the impedance Z is large and capacitive as $X_C > X_L$ & power factor is leading

* At higher freq. than fr Z is again large but inductive $X_L > X_C$ and power factor is lagging. At resonance Power factor = 1

Resonance curve :-



Selectivity and B.W. :- * Low resistance circuit the resonance curve is sharply peaked and such a circuit is said to be sharply - resonant or highly selective.

* High resistance ckt have flat resonance curve and is said to have poor selectivity.

Actual power $P = I^2R = \left(\frac{I_{max}}{\sqrt{2}}\right)^2 R = \frac{I_{max}^2}{2} R = \frac{1}{2} P_{max}$

$P = \frac{1}{2} \times$ Power i/p at resonance

At half power points :-

(1) current $\frac{I_{max}}{\sqrt{2}}$ (2) Impedance $= \sqrt{2}R = \sqrt{2} Z_{min}$

(3) $P_1 = P_2 = \frac{P_{max}}{2}$ (4) Phase angle $\phi = \pm 45^\circ$ or $\frac{\pi}{4}$ radians

Quality factor :- defined by :-

(I) It may be given as the voltage magnification that the circuit produces at resonance.

supply voltage $V = I_{max} R$, voltage across inductance or capacitance $= I_{max} X_L = I_{max} X_C$

voltage magnification $= \frac{I_{max} X_L}{I_{max} R} = \frac{X_L}{R} = \frac{\omega L}{R} = \frac{1}{\omega RC}$

$Q = \frac{\omega L}{R} = \frac{2\pi f_r L}{R} = \frac{2\pi L}{R} \frac{1}{2\pi \sqrt{LC}} = \frac{1}{R}\sqrt{\frac{L}{C}}$

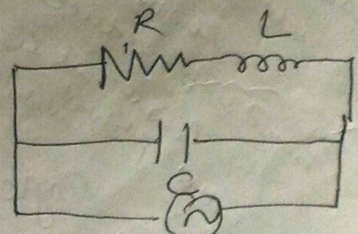
(II) Q - factor of a coil is a measure of its efficiency of energy storage when it carriers a.c.

$Q = 2\pi \times \frac{\text{max energy stored}}{\text{Energy dissipation per cycle}} = \frac{2\pi \frac{1}{2} L I_{max}^2}{\frac{I_{max}^2}{2} R / f_r}$

$= \frac{2\pi L \times f_r}{R} = \frac{\omega L}{R}$

(III) higher value of Q - factor means - higher voltage magnification & high selectivity. $Q = \frac{\text{Resonant freq}}{\text{BW}}$.

Parallel or current Resonance :-

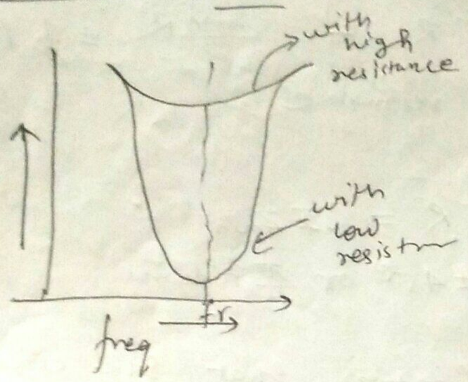


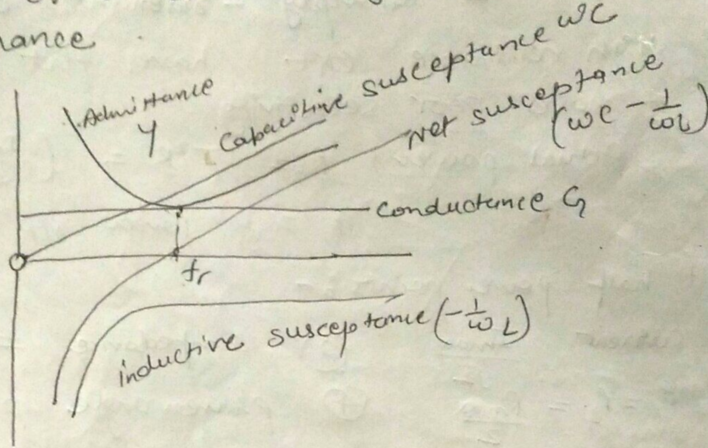
$f_r = \frac{1}{2\pi \sqrt{LC}}$

effective impedance $= \frac{L}{RC}$

when impedance is purely resistive, maximum in magnitude $= L/RC$
This ckt is also known as rejector ckt, because at resonent freq. the line current is minimum or it almost rejects it.
* Also called current resonance

||el Resonance :-





freq. lower than resonant freq the inductive susceptance is more than capacitive susceptance. therefore line current lags behind the applied voltage.

for freq > resonance freq. capacitive susceptance is large so current leads the voltage.

~~BW~~ Quality factor :- $Q = \frac{X_L}{R} = \frac{2\pi f_r L}{R}$

higher the value of Q, the more selective is the tuned ckt.

Advantages of Tunned ckt :- ① High selectivity
② Small collector voltage
③ Small power

Tunned Amplifier
- Large signal ← amplification of large signal At RF ~ uses class B & C operation (Class A can't be due to low efficiency)
- small signal - Amplification of small signal at R.f. uses class A
  - Single tunned → one ||el tuned ckt
  - Double tuned
    - L two inductively coupled tunned ckt.
    - L over come potential instability.

Disadvantage:- for high selectivity → high Q factor → Low BW
so Tunned amp' reduce the B.W. This is called potential instability