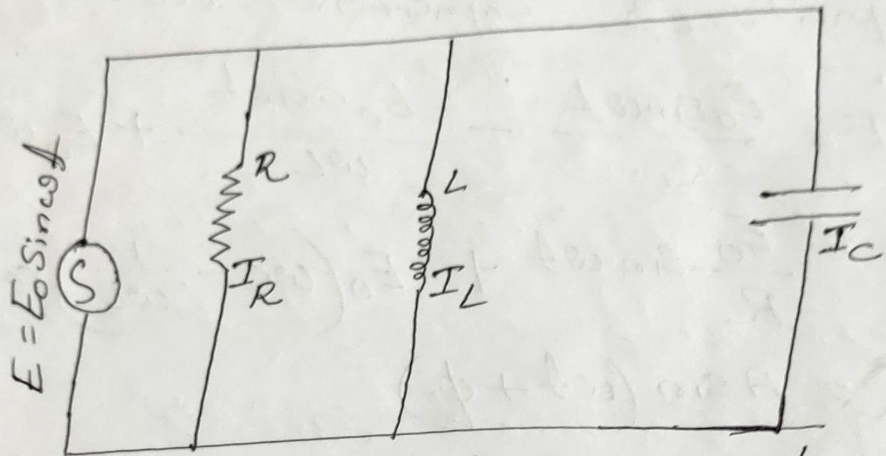
B.Sc. part II
Current Electricity

Q

Discuss analytically a parallel resonant circuit.



An alternating emf $E_0 \sin\omega t$ has been applied in parallel combination of R, L, C as shown in above fig.
where R = resister, L = Inductor & C = Capacitor

Total intantaneous current at any instant,

$$I = I_L + I_C + I_R$$

Now,

$$I_R = \frac{E}{R} = \frac{E_0 \sin\omega t}{R}$$

$$I_L = \frac{E_0}{\omega L} \sin\left(\omega t - \frac{\pi}{2}\right)$$

$$= \frac{-E_0}{\omega L} \cos\omega t$$

as emf leads the current in an inductor & ωL is inductive reactance.

$$I_c = \frac{E_0}{1/\omega C}\left[\sin\left(\omega t + \frac{\pi}{2}\right)\right]$$

$$= E_0 \omega C \cos\omega t$$

as. emf lags behind the current in capaciter & capacitative reactance $= \frac{1}{\omega C}$

Hence $I = \frac{E_0 \sin\omega t}{R} - \frac{E_0 \cos\omega t}{\omega L} + E_0 \omega C \cos\omega t$

$$= \frac{E_0}{R}\sin\omega t + E_0\left(\omega C - \frac{1}{\omega L}\right)\cos\omega t$$

$$= A\sin(\omega t + \phi)$$

where $\frac{E_0}{R} = A\cos\phi$ & $E_0\left(\omega C - \frac{1}{\omega L}\right) = A\sin\phi$

i.e $A^2 = E_0^2\left[\frac{1}{R^2} + \left(\omega C - \frac{1}{\omega L}\right)^2\right]$

or, $A = E_0\left[\frac{1}{R^2} + \left(\omega C - \frac{1}{\omega L}\right)^2\right]^{1/2}$

& $\phi = \tan^{-1}\left[R\left(\omega C - \frac{1}{\omega L}\right)\right]$

i.e $I = E_0\left[\frac{1}{R^2} + \left(\omega C - \frac{1}{\omega L}\right)^2\right]^{\frac{1}{2}} \sin(\omega t + \phi)$

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

clearly that in this circuit I_L and I_c differ in phase by π.

$\therefore$ Total current in circuit is

$I_L - I_c$ or $I_c - I_L$.

at a particular frequency

$I_c = I_L$,

i.e $\frac{E}{\omega L} = E\omega C$, $\Rightarrow \omega^2 = \frac{E}{LCE}$

$\Rightarrow \omega = \frac{1}{\sqrt{LC}}$

= Resonant frequency

Under this condition, the closed circuit containing Inductance and capacitance oscillates with its natural frequency & requires no further supply of energy, from any external source. At this frequency impedance is maximum.

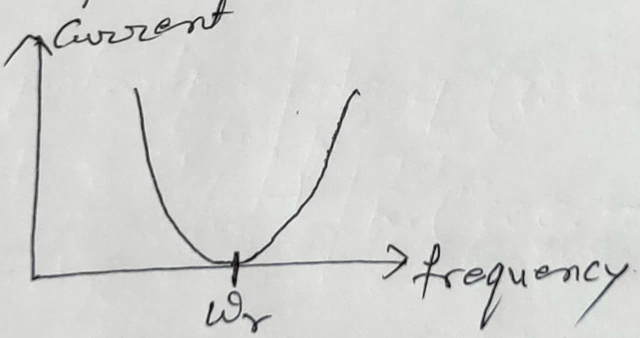


fig. ②

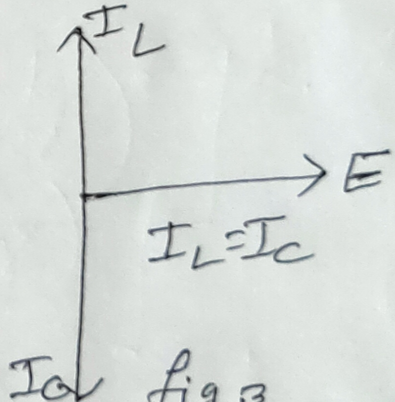


fig 3.

In actual practice, the circuit always some resistance & oscillation can be sutained. only by supply of energy from some external source.

The parallel resonant circuit is of valuable importance in wireless transmitting circuits. This circuit is also known as rectifier circuit because when used as filter, it rejects the current at a particular frequency, supply current is minimum but oscillating current is maximum.

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