Conducting loop rotated in a magnetic field at constant angular frequency `omega` a sinusoidal voltage(emf) is induced in the loop

`v = v\_{0}(sinomegat)text( )omega =2pif`

this creates alternating current

AC in India = 50hz

Time for one cycle is called time period

`I\_{av} = 2/pi i\_{0} = 0.637i\_{0}`

`V\_{av} = 2/piv\_{0} = 0.637v\_{0}`

Here `i\_{0}` and `v\_{0}` are maximum current and voltage

The average value over half the cycle is represented here

`i\_{rms} = i\_{0}/sqrt(2) = 0.707i\_{0}`

`v\_{rms} = v\_{0}/sqrt(2) = 0.707v\_{0}`

this rms values are called virtual value and is given by AC instruments

AC is represented by

&image&

phasors

graphical construction of current and voltage are rotating vectors called phasors

&image&

ωt

I0

I0cosωt

I0sinωt

ω

`theta = omegat`

Resister in ACcircuit

`v\_{R} = iR = i\_{0}rsinomegat`

`v\_{0} = i\_{0}R`

`v\_{R} = v\_{0}sinomegat`

capacitor in Ac circuit

`q = CV\_{c} = CV\_{0}sinomegat`

`I = (dq)/(dt) = CV\_{0}omegacosomegt`

`I = i\_{0}sin(omegat + pi/2)`

`V\_{0} = i\_{0}/(omegaC)`

So `1/(omegaC)` is effective AC resistance or capacitive reactance(`X\_{c}`)

`X\_{c} = 1/(omegaC)`

&image&

I0

I0sinωt

ωt

V0cosωt

V0

Current phasor is ahead of voltage phasor by 90 deg

Inductor in AC circuit

`V\_{L}` potential difference between inductor terminates because current varies with time giving rise to a self-induced emf

`V\_{L} = -(induced emf) = -(-L(di)/(dt))`

`V\_{L} = L(di)/(dt) = Li\_{0}omegacosomegat = V\_{0}sin(omegat + pi/2)`

`V\_{0} = i\_{0}omegaL`

`omegaL = X\_{L}`

`V\_{0} = i\_{0}X\_{L}`

(`X\_{L}`) effective AC resistance or inductive reactance

&image&

V0

I0

ωt

Voltage phasor is ahead of current by `90 deg`

In DC `omega = 0`

So `X\_{L} = 0text( )X\_{c} = infty`

Phasor algebra

Phasor `A = a + jb`

Where a is x component and b is y component

`abs(A) = sqrt(a^2 +b^2)`

`tantheta = b/a`

`theta` is the angle between A and positive x axis, `j = sqrt(-1)`

Series L – R circuit

&image&

V

θ

VL

VR

Taking current along positive x direction, so

`V = V\_{R} + jV\_{L}`

` = iR + j(ix\_{L}) = iz`

`Z = R + jX\_{L}` = impedence

(Same role as ohmic resistance in DC circuit)

`abs(z) = sqrt(R^2 + (omegaL)^2)`

`tantheta = V\_{L}/V\_{R} = X\_{L}/R = (omegaL)/R`

Series C\_R circuit

&image&

VR

θ

V

VC

taking current along +ve x direction

`V = V\_{R} –jV\_{C} = iR – jX\_{c} = iZ`

`Z = R – j(1/(omegaC))`

`abs(z) = sqrt(R^2 + (1/(omegaC))^2)`

`tantheta = V\_{C}/V\_{L} = 1/(omegaRC)`

L-C-Rcircuit

Takng current along positive x axis

&image&

VL -Vc VL 

VL

θ

VR

Vc

VR

`V = V\_{R} + j(V\_{L} – V\_{R}) = iZ`

`Z = R + j(X\_{L} – X\_{R})`

`abs(Z) = sqrt(R^2 + (omegaL – (1(omegaC))^2)`

`tantheta = (V\_{L} – V\_{C})/V\_{R} = (omegaL –(omegaC))/R`

case 1: resonance frequency

when `X\_{L} = X\_{C}`

`omega =1/(sqrt(LC))text( )abs(z) = R`

`text(frequency) = 1/(2pisqrt(LC))`

at resonance

`abs(Z) = abs(Z\_{min}) text( )i\_{rms} = max`

maximum potential difference across inductor or capacitor

case 2: `X\_{L} > X\_{C}`

voltage leads current by angle phi

`tanphi = (X\_{L} – X\_{C})/R text( ) i\_{0} = v\_{0}/abs(R)`

`V =V\_{0}sinomegat text( ) i = i\_{0}sin(omegat - phi)`

case 3: `X\_{C} > X\_{L}`

current leads voltage by angle `phi`

`tanphi = (X\_{C} – X\_{L})/R text( )i\_{0} = v\_{0}/abs(R)`

`V =V\_{0}sinomegat text( )i = i\_{0}sin(omegat + phi)`

`i\_{0} =V\_{0}/abs(Z) , i\_{rms} = V\_{rms}/abs(Z) text( but )i ne V/abs(Z)`

peak value = `sqrt(2)` times rms value

voltage magnification = `text(potential difference across inductor or capcitor)/text(applied emf) = (i\_{rms}omegL)/i\_{rms}R = (omegaL)/R`

power in AC circuit

`P = VI` in DC

`P\_{text(one cycle)} = v\_{rms} i\_{rms}cosphi = i\_{rms}^2R`

`Cosphi` = power factor

`Phi rightarrow` voltage leading the current by an angle `phi`

Power factor of 0.5 lagging means, current lags the voltage by 60 `deg`

Apparent power = `v\_{rms} xx i\_{rms}`

True power = apparent power `xx` power factor

`phi` = 90 power = 0, current is then stated wattles such case arise when resistance in circuit Is zero

`cosphi = R/Z = R/(sqrt(R^2 + (omegaL)^2)) approx R/(omegaL)`

`I\_{AC} < I\_{DC}`

Steady state `rightarrow text( )omegaL = 0 text( )1/(omegaC) = infty`

Mass `leftrightarrow` inductance(L)

Displacement `leftrightarrow` charge(q)

Velocity `leftrightarrow` current

Force constant (k) `leftrightarrow 1/(text(capacitance))`

`U = 1/2kx^2 + 1/2mv^2`

`U = q^2/(2C) + 1/2Li^2`

`A = A\_{0}e^((-bt)/(2m)) `

Efficiency(n) = `P\_{out}/P\_{in} = (V\_{s}I\_{s})/(V\_{p}I\_{p})`

Quality factor(Q) = `1/R sqrt(L/C)`