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

v = v\_{0}(sinomegat) 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

V0

I0

ωt

Voltage phasor is ahead of current by 90 deg

In DC omega = 0

So `X\_{L} = 0` `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 duirection

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

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)) abs(z) = R

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

at resonance

abs(Z) = abs(Z\_{min}) 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 i\_{0} = v\_{0}/abs(R)

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

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

current leads voltage by angle phi

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

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

i\_{0} =V\_{0}/abs(Z) , i\_{rms} = V\_{rms}/abs(Z) 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 resitance in circuit Is zero

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

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

Steady state `rightarrow` omegaL = 0 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)