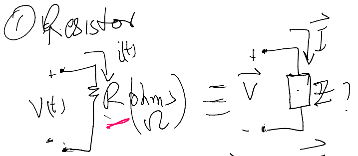
Impedance of R,L,C

Monday, March 15, 2021 11:42 AM

① Resistor

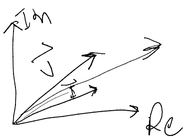


$v(t) = R\, i(t)$ ⟺ $\vec{V} = R\vec{I}$; $Z = R$

$\vec{V} = Z\vec{I}$

KVL, KCL,
- Nodal, Mesh,
- Superposition,
- Source transformation
- Thevenin's, Norton

in phase



Impedance:

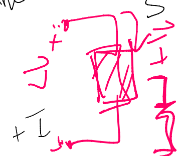
$Z \overset{def}{=} \frac{\vec{V}}{\vec{I}}$ (Ohms, Ω) $= R + jX$

R: Resistance Ω ; X: Reactance Ω

Admittance:

$Y \overset{def}{=} \frac{\vec{I}}{\vec{V}} = \frac{1}{Z}$ (Seimens, S) $= G + jB$

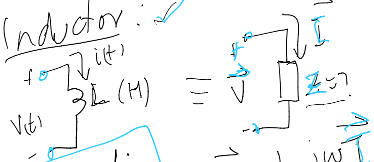
G: Conductance S ; B: susceptance S



$\vec{V} = 10\angle 10^\circ$

$\vec{I} = 5\angle 10^\circ$

Inductor:



$v(t) = L\frac{di}{dt}$ ⟹ $\vec{V} = Lj\omega\vec{I}$

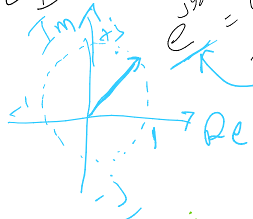
$\vec{V} = j\omega L\vec{I}$

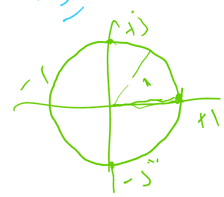
$Z = \frac{\vec{V}}{\vec{I}} = +j\omega L$ (Ω)

$j = 1\angle 90^\circ$

$e^{j90^\circ} = \cos 90^\circ + j\sin 90^\circ = j$

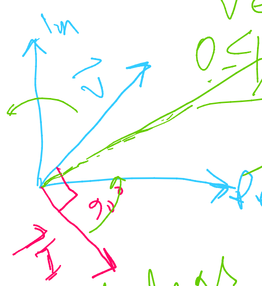
circle of unity radius





$\vec{V}e^{j\omega t}$

$0 \le \phi \le 180^\circ$



current leads the voltage by -90°

270°

-90°

current lags the voltage by 90°

$Z = 2\angle 30^\circ$ inductive

90°

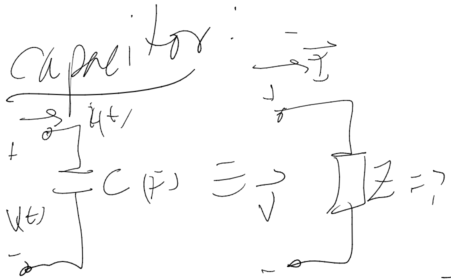
$\phi_v - \phi_i$ = +ve ang

= +jve

$10 + 10j$

$10\angle 45^\circ$ or 90°

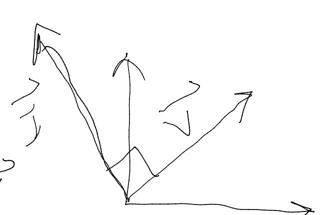
Capacitor:



$i(t) = C\frac{dv}{dt}$ ≡ $\vec{I} = Cj\omega\vec{V}$

$\vec{I} = j\omega C\vec{V}$

$Z = \frac{\vec{V}}{\vec{I}} = \frac{1}{j\omega C} = \frac{-j}{\omega C}$



$\phi_Z = -90^\circ$

capacitive