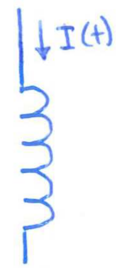
Inductors

$$\boxed{V_L = L\frac{dI}{dt}}$$

equation



symbol

$L = [H] = [\text{henry}]$

$[H] = \left[\frac{kg\ m^2}{amp^2\ s^2}\right]$

units

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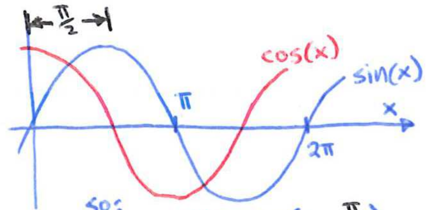
if $I(t) = I_p \sin(\omega t - \phi_I)$

then: $V_L = L\frac{d}{dt}\left(I_p \sin(\omega t - \phi_I)\right)$

$= \omega L I_p \cos(\omega t - \phi_I)$ — $\cos(x) = \sin(x + \frac{\pi}{2})$

$$\boxed{V_L = \omega L I_p \sin\left(\omega t - \phi_I + \frac{\pi}{2}\right)}$$

in time domain V_L lags the current by 90°

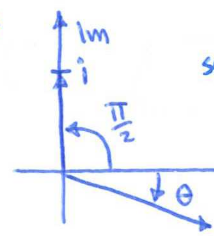


move to complex plane: — $e^{i\theta} = \cos\theta + i\sin\theta$

$V_L = \text{Im}\left(\omega L I_p e^{i(\omega t - \phi_I + \frac{\pi}{2})}\right)$ — $x^{m+n} = x^m x^n$

$= \text{Im}\left(\omega L I_p e^{i\omega t} e^{-i\phi_I} e^{i\frac{\pi}{2}}\right)$ — $e^{i\frac{\pi}{2}} = i$

$= \text{Im}\left(i\omega L I_p e^{-i\phi_I} e^{i\omega t}\right)$ — phasors



so: $e^{i\frac{\pi}{2}} = i$

$e^{i\theta} = \cos\theta + i\sin\theta$

so: $\text{Re}(e^{i\theta}) = \cos\theta$

$\text{Im}(e^{i\theta}) = \sin\theta$

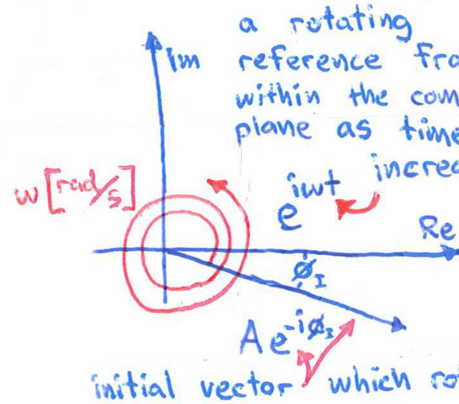
move to phasor reference frame:

$\text{Im}\left(\tilde{V}_L e^{i\omega t}\right) = \text{Im}\left(i\omega L \tilde{I} e^{i\omega t}\right)$

rotating reference frame

where: $\tilde{V}_L = V_{L,p} e^{-i\phi_V}$ & $\tilde{I} = I_p e^{-i\phi_I}$

Phasors:



seperate phasor part:

$\tilde{V}_L = i\omega L \tilde{I}$

$\boxed{\tilde{V}_L = Z_L \tilde{I}}$ where $\boxed{Z_L = i\omega L}$

in phase domain — Z_L is Imaginary and is +90° to the real axis