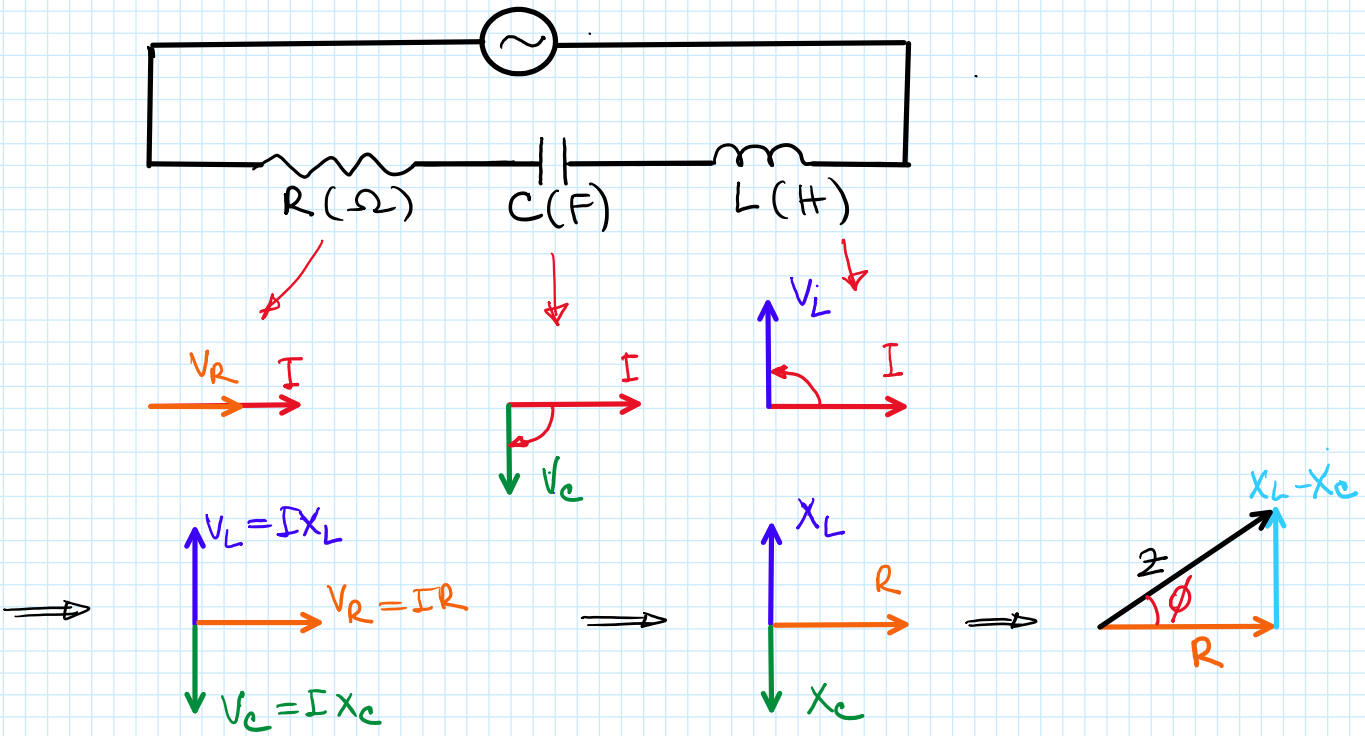
March 12

Friday, March 8, 2024 12:44 PM

AC Circuits

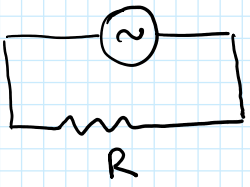
→ we explore steady state Ac circuits that involve inductors, capacitors, and resistors.



$$Z = R + j(X_L - X_C)$$ impedance (Ω)

Φ - phase angle

Resistor (only)



$$Z = R\ (\Omega)$$

→ resistance does not change with f.

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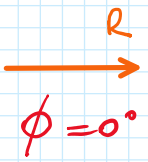
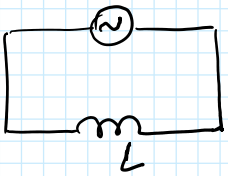


$V_R = (I \angle 0°)R = IR \angle 0°$

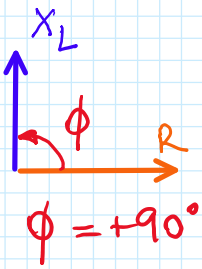
Inductors (only)



$Z_L = j(X_L) = j(\omega L) = j(2\pi f L)$

$X_L = \omega L$ inductive reactance (Ω)

L - inductance (H)



$X_L = 2\pi f L$

→ as f increases, X_L increases

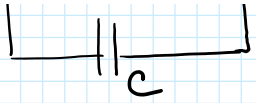
→ at extremely low frequencies $X_L \to 0$ (inductor behaves like a short) and at high frequencies, the inductor behaves like an open, $X_L \to \infty$

$V_L = (I \angle 0°)(X_L \angle 90°) = IX_L \angle 90°$

ELI - E leads I in L (inductors)
VIL - V leads I in L (inductors)

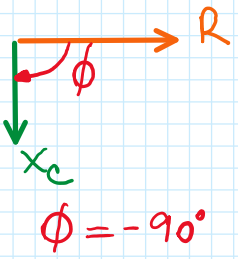
Capacitors (only)

$Z = -j(X_C) = -j(\frac{1}{\omega C}) = -j(\frac{1}{2\pi f C})$



$X_C = \frac{1}{\omega C}$ capacitive reactance (Ω)

C - capacitance (F)



→ as f increases, X_C decreases

→ at extremely low frequencies $X_C \rightarrow \infty$ (the capacitor behaves like an open) and at high frequencies, the capacitor behaves like a short, $X_C \rightarrow 0$

$$V_C = (I \angle 0°)(X_C \angle -90°) = IX_C \angle -90°$$

ICE - I leads E in C (capacitors)

CIV - I leads V in C (capacitors)

Circuit Phase Angle

→ circuit angle is the angle between the generator voltage and generator current. We normally use the current phase angle as the reference. Assume that the source current has a phase angle of zero.

→ phase angle is positive if the voltage leads the current (the circuit has more inductive reactance than capacitive reactance).

→ phase angle is negative if the voltage lags the current (the circuit has more capacitive reactance than inductive reactance).

ELI the ICE man and CIVIL