AC Circuits

→ Resistance (R), Inductance and Capacitance

→ Addition of current and voltage requires phase difference

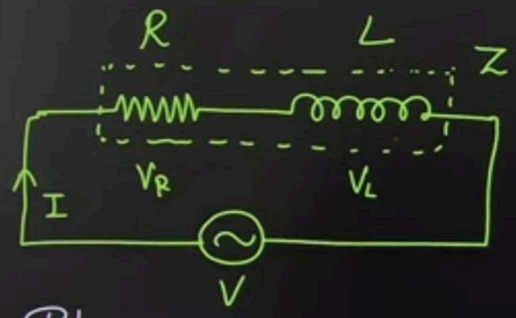
→ Phase angle (ϕ)

nature of circuit [Resistive, inductive, capacitive]

circuit impedance

power consumed.

RL Series Circuit



Ohms law

I = rms

V = rms

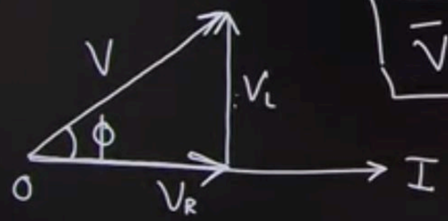
$$V = IZ$$

$$V_R = IR$$

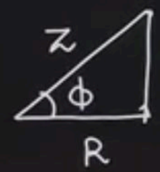
$$V_L = IX_L$$

Inductance $\begin{cases} V_L \text{ leads } I \text{ by } \pi/2 \\ I \text{ lags } V_L \text{ by } \pi/2 \end{cases}$

Phasor diagram



$$\boxed{\bar{V} = \bar{V}_R + \vec{V}_L}$$



$$X_L = \omega L$$

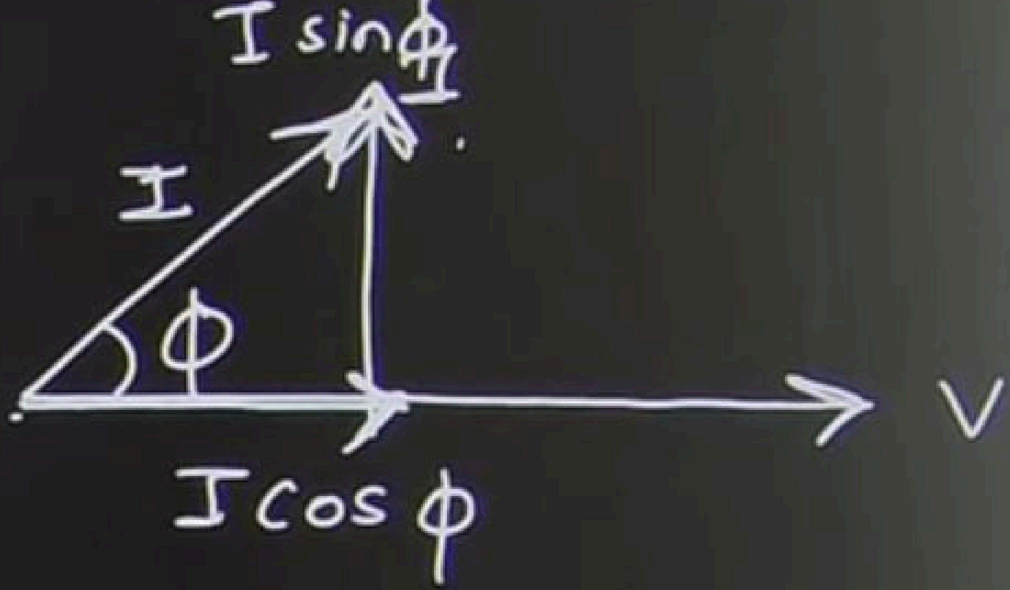
$$Z = \sqrt{R^2 + X_L^2}$$

$$\bar{Z} = (R + jX_L)$$

$$\phi = \tan^{-1}\left(\frac{V_L}{V_R}\right) \qquad \phi = \tan^{-1}\left(\frac{X_L}{R}\right)$$

$$\bar{Z} = (Z \angle \phi)$$

power factor $\cos\phi = \frac{R}{Z}$ [lagging]



Active power (consumable) $= V \times I\cos\phi$

ωL

Reactive power $= V \times I\sin\phi$

✓ Apparent power $= V \times I$.

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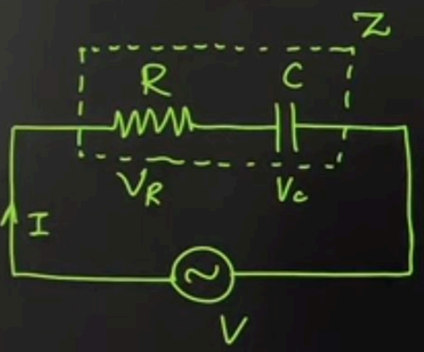
R- C Series Circuit



By ohm's law.

$V = IZ$

$V_R = IR \qquad X_C = \frac{1}{\omega C}$.

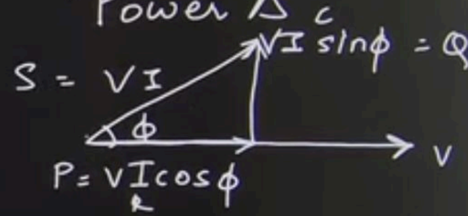
$V_c = IX_c$.

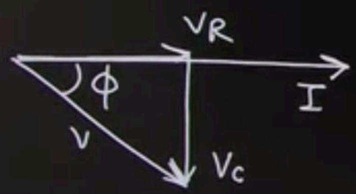
I leads voltage.

Power factor

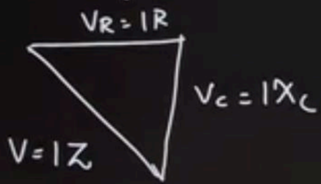
$\cos\phi = \frac{R}{Z}$ (leading)

Power Δ

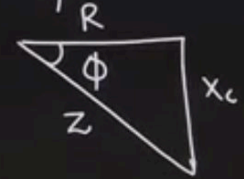




Voltage Δ.



Impedance Δ



Active power $P = VI\cos\phi$ (kW)

Reactive power $Q = VI\sin\phi$ (kVAR)

Apparent power $S = VI$ kVA.

$\bar{V} = \bar{V_R} + \bar{V_c}$

$\phi = \tan^{-1}\left(\frac{V_c}{V_R}\right)$

$Z = \sqrt{R^2 + X_c^2}$

$\phi = \tan^{-1}\left(X_c/R\right)$

$\bar{Z} = (R - jX_c)\,\Omega$

$\bar{Z} = (Z \angle -\phi)$

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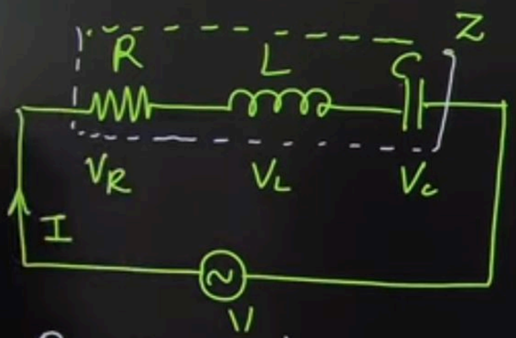
026 880

R-L-C Series Circuit



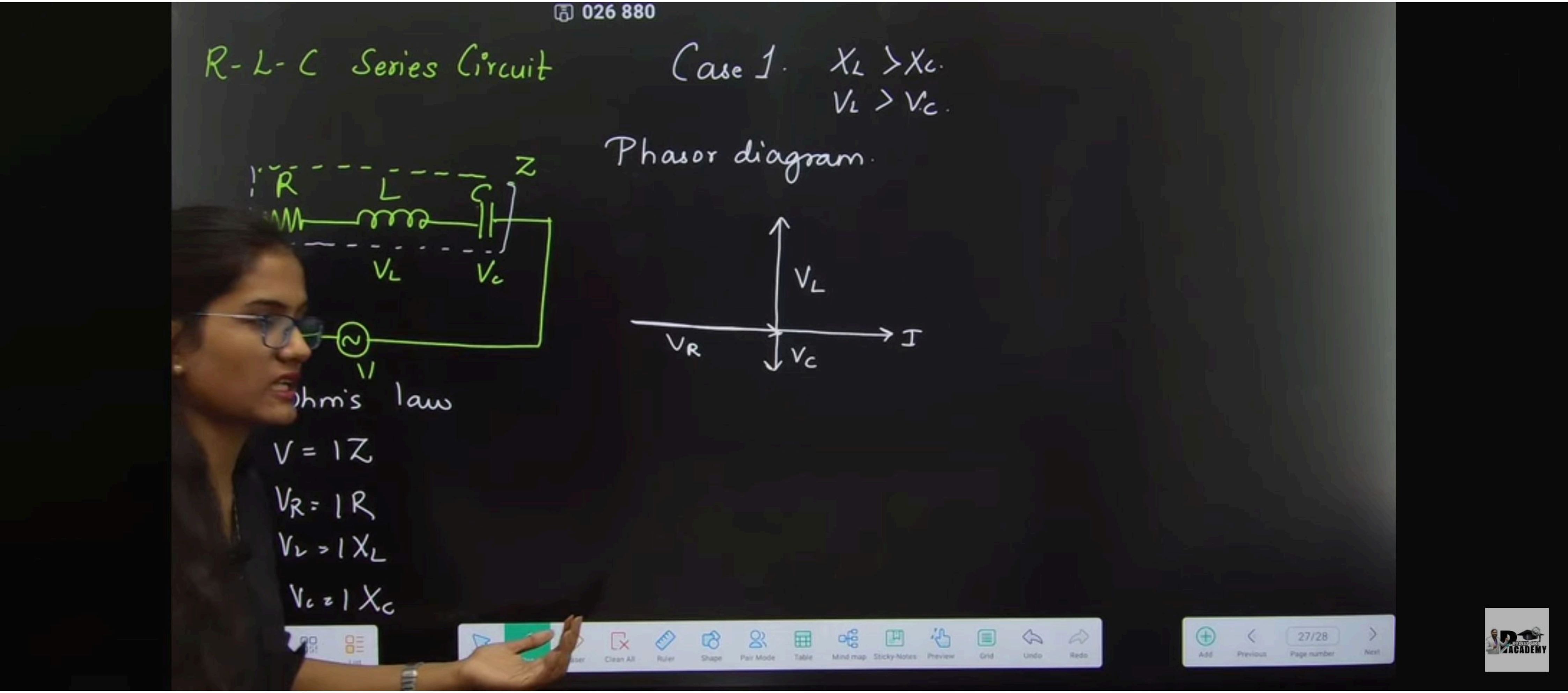
By Ohm's law

$$V = IZ$$

$$V_R = IR$$

$$V_L = IX_L$$

$$V_c = IX_c$$


026 880
R-L-C Series Circuit
Case 1. XL > Xc.
VL > Vc.
Phasor diagram.
Z
R
L
C
VL
Vc
V
VL
VR
I
Vc
Ohm's law
V = IZ
VR = IR
VL = IXL
Vc = IXc
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ACADEMY

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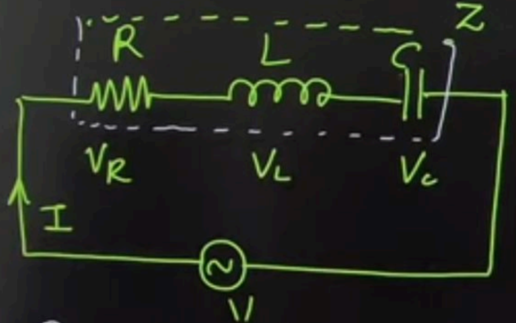
R-L-C Series Circuit



By Ohm's law

$V = IZ$

$V_R = IR$

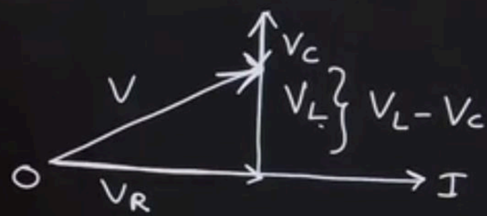
$V_L = IX_L$

$V_c = IX_c$

Case 1. $X_L > X_c$.

$V_L > V_c$.

Phasor diagram.



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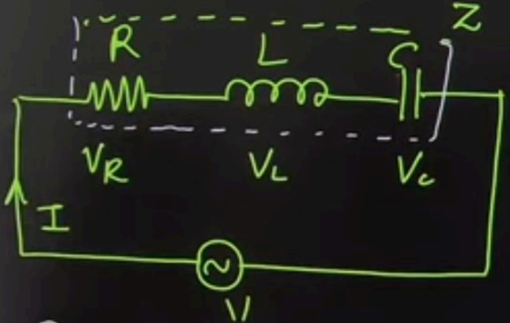
R-L-C Series Circuit

Case 1. Inductance > Capacitance

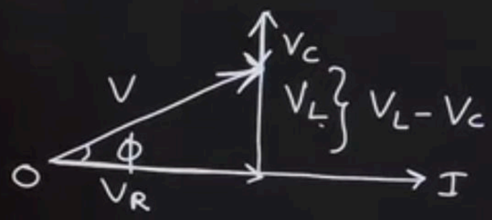
$X_L > X_C$

$V_L > V_C$

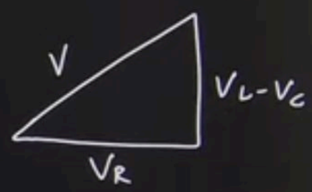
lagging → Power factor $\cos\phi = \frac{R}{Z}$



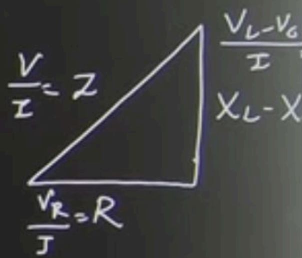
Phasor diagram.



Voltage Δ



Impedance Δ



By Ohm's law

$V = IZ$

$V_R = IR$

$V_L = IX_L$

$V_C = IX_C$

$\bar{V} = \bar{V}_R + \bar{V}_L + \bar{V}_C$

$\phi = \tan^{-1}\left(\frac{V_L - V_C}{V_R}\right)$

$Z = \sqrt{R^2 + (X_L - X_C)^2}$

$\bar{Z} = R + j(X_L - X_C)\ \Omega$

$\bar{Z} = (Z \angle \phi)$

$X_L = \omega L$

$X_C = \frac{1}{\omega C}$ $\omega = 2\pi$

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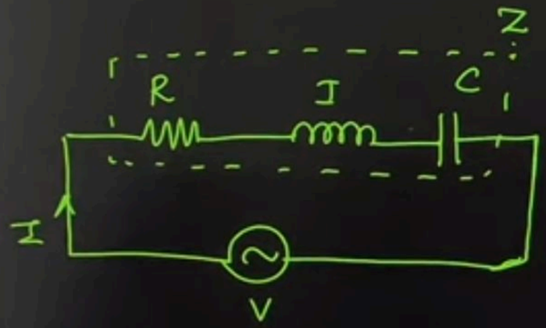
R-L-C- Series Circuit.

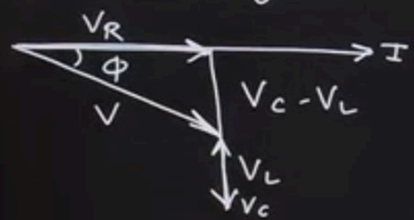


Case 2: $X_C > X_L$

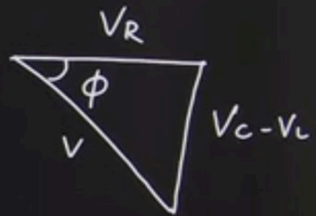
$V_C > V_L$

Power factor $\cos\phi = \frac{R}{Z}$ leading.

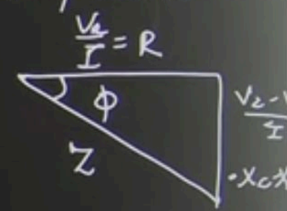
Phasor diagram.



Voltage Δ



Impedance Δ



By ohm's law.

$V_R = IR$

$V_L = IX_L$

$V_C = IX_C$

$V = IZ$.

$\bar{V} = \bar{V}_R + \bar{V}_L + \bar{V}_C$

$\phi = \tan^{-1}\left(\frac{V_C - V_L}{V_R}\right)$

$\phi = \tan^{-1}\left(\frac{X_C - X_L}{R}\right)$

$Z = \sqrt{R^2 + (X_C - X_L)^2}$

$\bar{Z} = R - j(X_C - X_L)\,\Omega$

$\bar{Z} = (z, \angle\phi)$

$X_C = \frac{1}{\omega C}$

$X_L = \omega L$.