جامعة الفرات الاوسط التقنية / المعهد التقني- سماوة
قسم التقنيات الكهربائية

المحاضرة الحادية عشر

اسم المادة / دوائر كهربائية

المرحلة الدراسية / الاولى

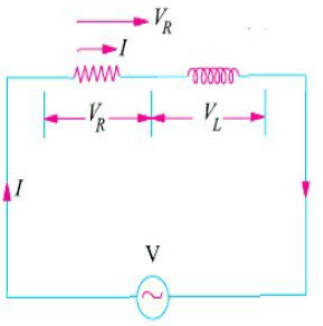
العام الدراسي / 2022 – 2023

استاذ المادة : بشائر مكي جبر

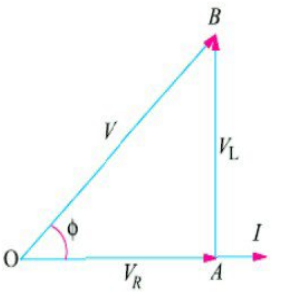
Series AC circuit:

1. AC through Resistance and Inductance:

A pure resistance R and inductance L are shown in figure(a) is connected in series.



Figure(a)



Figure(b)

Let V=r.m.s. value of the applied voltage; I=r.m.s. value of the resultant current.

$$V_R = IR \quad voltage\ drop\ across\ R(in\ phase\ with\ I)$$

$$V_L = I \times X_L \quad voltage\ drop\ across\ inductance\ (lag\ of\ I\ by\ 90)$$

The applied voltage V is:

$$V = \sqrt{V_R^2 + V_L^2} \qquad or\ V = I \times Z$$

$$where\ Z\ is\ the\ impedance\ of\ the\ circuit$$

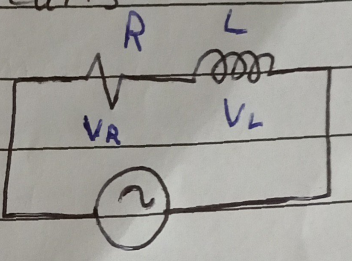
$$Z = \sqrt{R^2 + X_L^2}$$

From figure(b) it is clear that the applied voltage V leads the current I by an angle φ such that:

$$\tan\varphi = \frac{V_L}{V_R} = \frac{X_L}{R}$$

Series AC circuits

1. R_L series circuits



$|V_R| = IR$

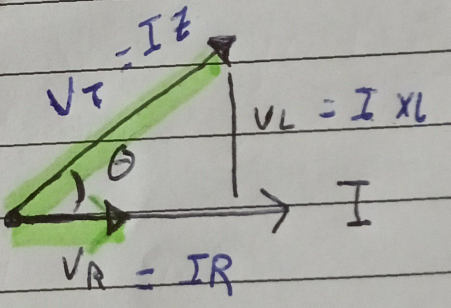
$|V_L| = I X_L$

Amplitude

$V_T = \sqrt{V_R^2 + V_L^2}$

$= \sqrt{(IR)^2 + (IX_L)^2}$

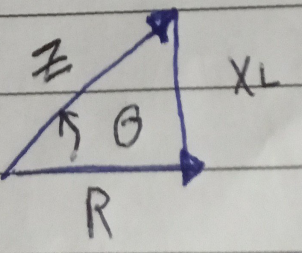
$= I\sqrt{R^2 + X_L^2} = IZ$



Amplitud valu for impedance

$\theta = \tan^{-1} V_L / V_R$

$= \tan^{-1} X_L / R$



$P.F = \frac{R}{Z}$

$0 < \theta < 90°$

$p(t) = V(t) \cdot i(t)$ متوسط القدرة

$= V_m \sin(\omega t + \theta) \cdot I_m \sin \omega t$

$$P_{av} = \frac{1}{2\pi} \int_0^{2\pi} p(t)\, dt = IV \cos\theta$$

$$= I^2 R$$

التاريخ / /

الموضوع :

Sol. for ex 24.1

$X_L = 2\pi f L = \omega L = 2 \times 3.14 \times 60 \times 0.06$
$= 4\,\Omega$

$V_{r.m.s} = V_m/\sqrt{2} = 141/\sqrt{2}$
$\simeq 100V$

$Z = \sqrt{R^2 + X_L^2} = \sqrt{(3)^2 + (4)^2} = 5\,\Omega$

$I_{r.m.s} = V/Z = 100/5 = 20A$

$\theta = \tan^{-1} X_L/R$
$= \tan^{-1} 4/3 = 53.1^\circ$

$I = 100\angle 0 / 4\angle 53.1 = 20\angle -53.1$

2) $I_{r.m.s} = I_m/\sqrt{2}$
$I_m = 20 \times \sqrt{2} = 28.28$

and $i(t) = 28.28 \sin(\omega t - 53.1)$

الموضوع :

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$V_R = IR = 20\angle -53.1 * 3 = 60\angle -53.1\ V$

$V_L = I X_L =$

$= (20\angle 90 - 53.1) \times 4$

$= 80\angle 36.9$

Example-24: A 60Hz sinusoidal voltage V = 141sinωt is applied to a series R-L circuit. The value of the resistance and the inductance are 3Ω and 0.0106H respectively.

i. Write the expression for the instantaneous current in the circuit.
ii. Compute the r.m.s. value and the phase of the voltage across the resistance and the inductance.

Solution:

$V_m = 141$ V; $V = 141/\sqrt{2} = 100\,V \quad \therefore\ V = 100 + j0$

$X_L = 2\pi \times 60 \times 0.0106 = 4\,\Omega.\ Z = 3 + j\,4 = 5\angle 53.1°$

(*i*) $I = V/Z = 100\angle 0°/5\angle 53.1° = 20\angle -53.1°$

Since angle is minus, the current lags behind the voltage by 53.1

(*ii*) $I_m = \sqrt{2} \times 20 = 28.28;\quad \therefore\ i = 28.28 \sin(\omega t - 53.1°)$

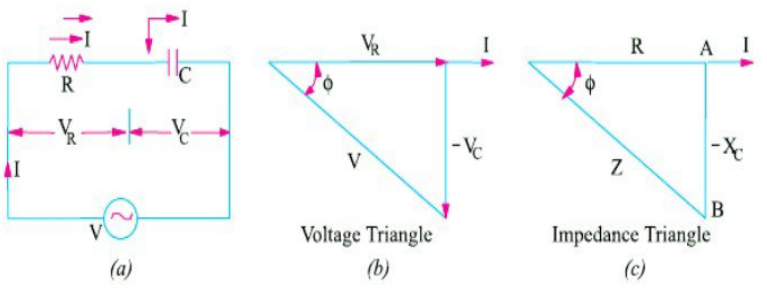
(*iii*) $V_R = IR = 20\angle -53.1° \times 3 = 60\angle -53.1°$ volt.

$V_L = jIX_L = 1\angle 90° \times 20\angle -53.1° \times 4 = 80\angle 36.9°$

2. AC through Resistance and Capacitance:

The circuit is shown in figure(a). Here V_R = I.R = drop across R in phase with I. $V_C = I.X_C$ = drop across capacitor lagging I by 90°.

Ac capacitive reactance X_C is taken negative; V_C is shown along negative direction of Y-axis in the voltage triangle figure(b).



$$V = \sqrt{V_R^2 + (-V_C)^2} \qquad or\ V = I \times Z$$

where Z is the impedance of the circuit

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

From figure(b) it is clear that the current I leads the applied voltage V by an angle φ such that:

$$\tan\varphi = \frac{-V_C}{V_R} = \frac{-X_L}{R}$$

Example-25: A pure resistance of 50Ω is in series with a pure capacitance of 100μf. The series combination is connected across 100v ; 50Hz supply. Find:

a) The impedance.
b) Current.
c) Phase angle.
d) Voltage across resistor and capacitor.

Solution:

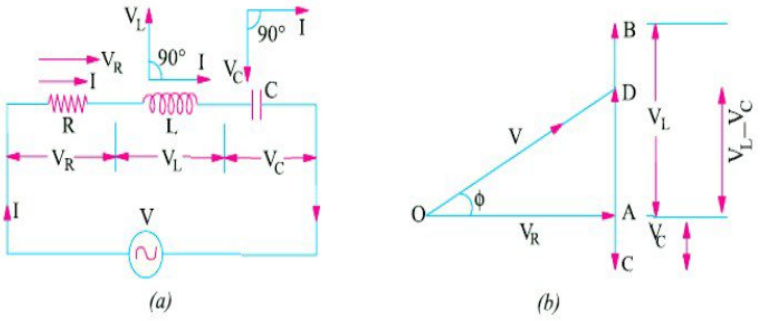
(*a*) $Z = \sqrt{50^2 + 32^2} = 59.4\ \Omega$ (*b*) $I = V/Z = 100/59.4 = 1.684$ A

(*c*) p.f. $= R/Z = 50 = 59.4 = 0.842$ (lead) (*d*) $\phi = \cos^{-1}(0.842) = 32°36'$

(*e*) $V_R = IR = 50 \times 1.684 = 84.2$ V $V_C = IX_C = 32 \times 1.684 = 53.9$ V

3. Resistance; Inductance and capacitance in series:

The three are shown in figure(b) joined in series across an AC supply of r.m.s. voltage V



Let $V_R = I.R$ = *voltage drop across R* *In phase with I*

$V_L = I.X_L$

$V_C = I.X_C$ = voltage drop across C Lagging by 90°

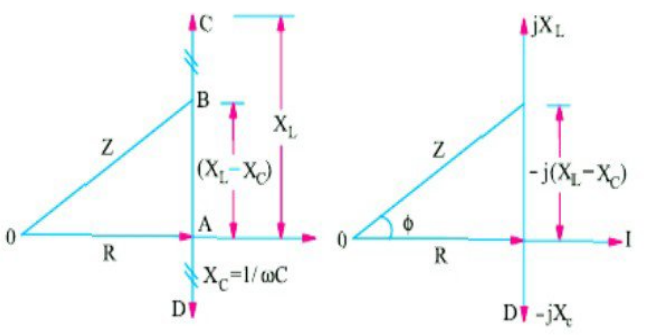
In the voltage triangle of figure(b):

$$V = \sqrt{V_R^2 + (V_L - V_C)^2} \quad ; \quad V = Z \times I$$

Where Z is the impedance of the circuit $Z = \sqrt{R^2 + (X_L - X_C)^2}$

Phase angle φ is given by:

$\tan\varphi = \frac{(X_L - X_C)}{R}$



Example-26: A resistance of 20Ω an inductance of 0.2H and a capcitance of 100μf are connected in series across 220V; 50Hz mains. Detemine:

a. Impedance.
b. Current.
c. Voltage across R; L; and C.

Solution:

Solution. $X_C = 0.2 \times 314 = 63\ \Omega$, $C = 10\ \mu F = 100 \times 10^{-6} = 10^{-4}$ farad

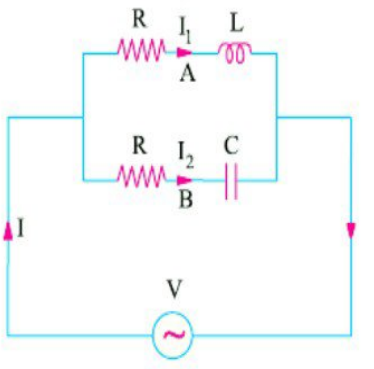
$X_C = \frac{1}{\omega C} = \frac{1}{314 \times 10^{-4}} = 32\ \Omega$, $X = 63 - 32 = \mathbf{31\ \Omega}$ *(inductive)*

(*a*) $Z = \sqrt{(20^2 + 31)^2} = \mathbf{37\ \Omega}$ (*b*) $I = 220/37 = \mathbf{6\ A}$ **(approx)**

(*c*) $V_R = I \times R = 6 \times 20 = \mathbf{120\ V}$; $V_L = 6 \times 63 = \mathbf{278\ V}$, $V_C = 6 \times 32 = \mathbf{192\ V}$

AC parallel circuit:

Consider the circuits shown in figure below. Here two branch A and B have been joined in parallel across an r.m.s supply of V volts. The voltage across two parallel branches A and B is the same. But currents through them are different.



For branch A

$$Z_1 = \sqrt{(R_1^2 + X_L^2)} \ : \ I_1 = \frac{V}{Z_1}$$