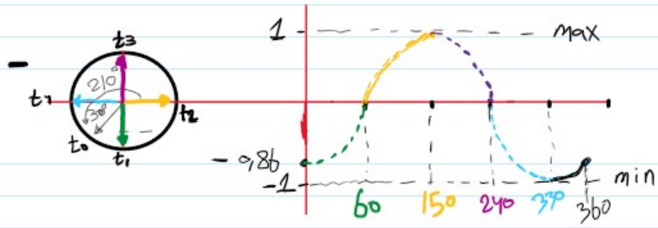
LECTURE 1&2

Wednesday, October 12, 2022 10:16 PM

1 Draw the sin and cos wave From Vector:



$t_0 \Rightarrow \cos(210) = \boxed{-0,86}$

$t_1 \Rightarrow$ After $60^\circ \Rightarrow \cos(270) = \boxed{0}$

$t_2 \Rightarrow$ After $150 \Rightarrow \cos(0) = \boxed{1}$ max

$t_3 \Rightarrow$ After $240 \Rightarrow \cos(90) = \boxed{0}$

$t_4 \Rightarrow$ After $330 \Rightarrow \cos(180) = \boxed{-1}$ min

$t_5 \Rightarrow$ After $360 \Rightarrow \cos(330) = \boxed{-0,86}$

لإكمال دورة كاملة

لو طلب X-axis بال time

$t_1 \Rightarrow$ 1

$t_2 \Rightarrow$ 1

$t_3 \Rightarrow$ 1

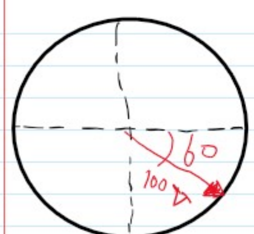
$t_4 \Rightarrow \frac{330}{360} \times T_0$

$t_5 \Rightarrow$ 1

After 150

البديل وال الاصلي

2 Vector and Rotating vector:



Vector $\vec{V} = 100\, e^{j60}$

small $\vec{v} = \vec{V}\, e^{j\omega t} \Rightarrow \vec{v} = |\vec{V}|\, e^{j(\omega t + \phi)}$

Rotating vector

* complex number

$5e^{j\phi} = 5\angle\phi = 5\,[\cos\phi + j\sin\phi]$

3 How to write numirical expression:

* عند كتابة ال expression والذي يكون على صورة :

$$\begin{cases} A(t) = A_{max} \cos(\omega t \pm \varnothing) \\ B(t) = A_{max} \sin(\omega t \pm \varnothing) \end{cases}$$

① $\omega \Rightarrow 2\pi F = \frac{2\pi}{T_0}$

② shift $\begin{cases} \text{to left } (+) \\ \text{to Right } (-) \end{cases}$

③ $\varnothing \begin{cases} \cos \Rightarrow \cos^{-1}\left(\frac{A(0)}{A_{max}}\right) \\ \sin \Rightarrow \sin^{-1}\left(\frac{A(0)}{A_{max}}\right) \end{cases}$

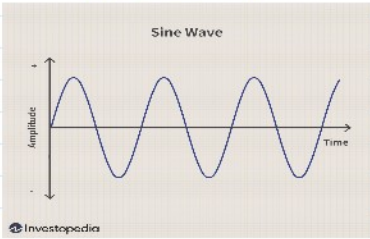
ملحوظة هامة:

١- عند الكتابة بالـ cos ⇐ ننظر لأقرب قمة إلى أين مزاحة

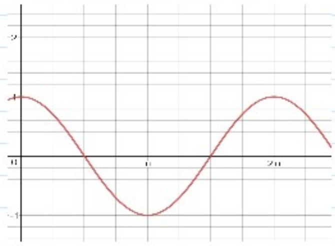
٢- // // // sin ⇐ ننظر إلى نقطة التقاطع مع الـ x-axis من الأقرب إلى أقرب قمة

التوضيح في ex

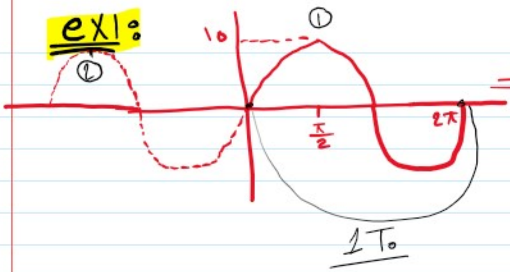
Sin wave



Cos wave



ex1:



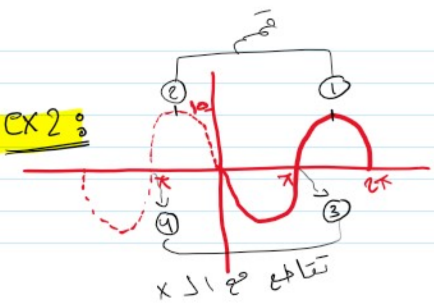
$\Rightarrow 10\cos\left(t - \frac{\pi}{2}\right) = 10\sin(t)$

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

اقرب قمة وهي ① مزاحة لليمين إذاً ⊖

مقدار الازاحة $\frac{\pi}{2}$

ex2:



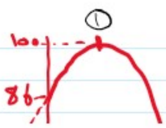
$\Rightarrow 10\sin(1t + \pi) \Rightarrow \underbrace{10\sin\left(t + \frac{\pi}{2}\right)}_{\text{② قمة}}$

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

عند الكتابة بالـ sin ننظر للنقطة التي تقطع الـ x مع اقرب قمة وهي ④ ومزاحة لليسار إذاً ⊕

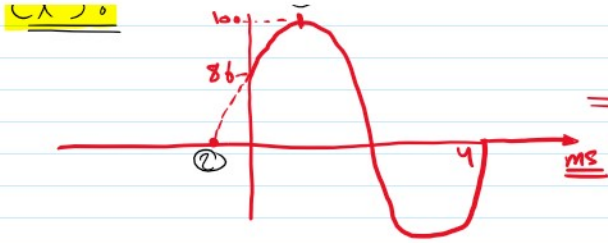
مقدار الازاحة π

ex3:



$\Rightarrow$ ① $= 100\cos(500\pi t - 30)$

Ex 3 :



$\Longrightarrow$ ① $= 100\cos(500\pi t - 30)$
② $= 100\sin(500\pi t + 60)$

$\boxed{\cos^{-1}\left(\frac{86}{100}\right) = 30 \quad \sin^{-1}\left(\frac{86}{100}\right) = 60}$

$\boxed{\omega = \frac{2\pi}{4\times10^{-3}} = 500\pi}$

Capacitor

1- $Z = \frac{1}{j\omega C} = \frac{1}{\omega C}\angle{-90}$

2- $\bar{V} = \frac{I}{j\omega C}$

3- I lead V by 90°

Inductor:

1- $Z = j\omega L = \omega L\angle 90$

2- $\bar{V} = I j\omega L$

3- I lage $\bar{V}$ by 90°

$Z = \frac{\bar{V}}{\bar{I}}$

Resister

1- $R = Z$

2- $V = ZI = RI$

3- $I, \bar{V}$ in phase

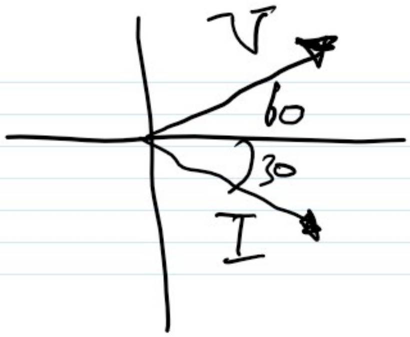
$\boxed{\phi_v - \phi_i}$

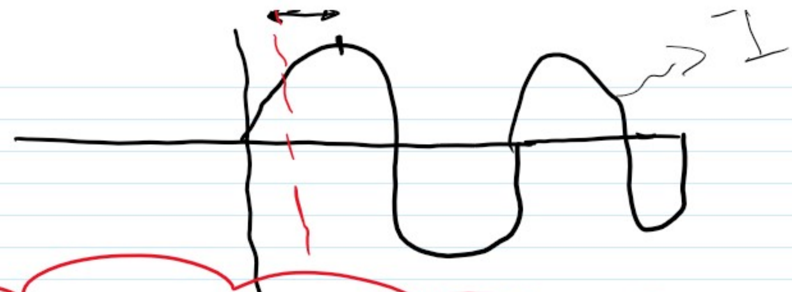
I lag 90° ← 90 → pure L
→ L
in phase ← 0 → R
→ C
I lead 90° ← -90 pure C

⊛ current and voltage in ⸺ᴏᴏᴏ⸺ :

I Lag $\bar{V}$ by 90° → y-axis

إذا طلب أن تحدد y-axis



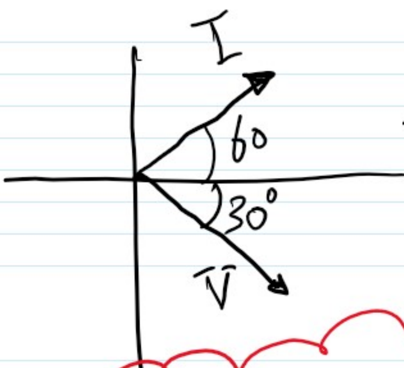


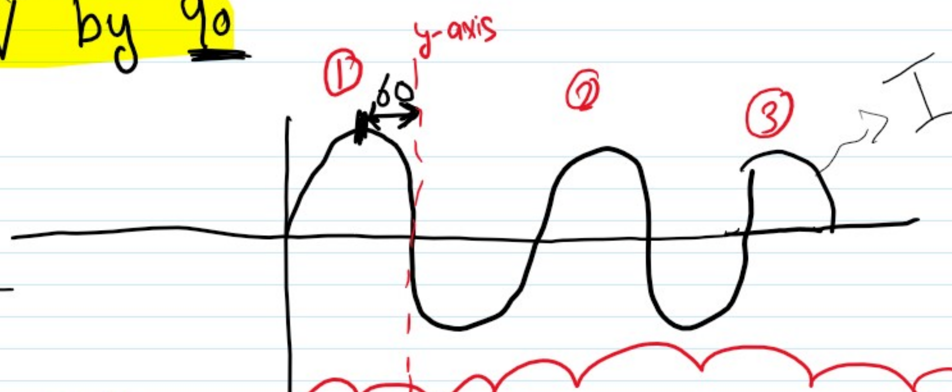
$\phi_v - \phi_i = 90$

⊛ زاوية ال I سالبة لذا تكون
القمة على يمين ال y-axis
(يسار القمة y-axis)
بمقدار الزاوية

⊛ current and Voltage in —||— :

I Lead V by 90°





$\phi_v - \phi_i = -90°$

⊛ زاوية I موجبة لذا تكون القمة
على يسار ال y-axis (y-axis يمين القمة)
بمقدار الزاوية

ex: $\vec{V} = 100\angle 25^\circ$, 20mH , $F = 50\ Hz$

Sole: $Z = j\omega L = 1\cancel{0}\cancel{0}\pi j \dfrac{2\cancel{0}}{1\cancel{0}\cancel{0}\cancel{0}} = \underline{2\pi j}$

$\omega = 2\pi F = 100\pi$

$$\vec{I} = \frac{\vec{V}}{Z} = \frac{100\angle 25}{2\pi j} = \frac{50}{\pi}\angle 25-90 = 15{,}9\angle -65$$

$\boxed{\pi = 3{,}14}$

$$i(t) = 15{,}9\cos(100\pi t - 65)$$

remember:

$\boxed{1}$ $A\cos(\omega t \pm \phi) \Longrightarrow A\angle\phi$

$\boxed{2}$ $A\sin(\omega t + \phi) \Longrightarrow A\angle\phi - 90^\circ$

$$5\cos(\omega t - 90) \Rightarrow 5\angle -90$$

$$\sin \Rightarrow 5\angle -90-90 = 5\angle -180$$

Lecture 3

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power:

⊛ power in DC $\Longrightarrow$ $V(t)\, i(t) = i(t)^2 R = \frac{V(t)^2}{R}$

$\boxed{⊛\ P = IV \ (DC)}$

⊛ effective or RMS value (root mean square)

→ RMS in general $\Longrightarrow$ $X_{rms} = \sqrt{\frac{1}{T}\int_0^T x^2\, dt}$

periode function

→ RMS for sinsoidal $\Longrightarrow$ $\frac{V_m}{\sqrt{2}}$, $\frac{I_m}{\sqrt{2}}$

1 instantanens power:

$V(t) = V_m \cos(\omega t + \phi_v)$

$i(t) = I_m \cos(\omega t + \phi_i)$

$P(t) = V(t)\, i(t) = V_m I_m \cos(\omega t + \phi_v) \cos(\omega t + \phi_i)$ $\Longrightarrow$ ثم مطابقة

Pt depend on

Final result $\Longrightarrow$ $\frac{1}{2} V_m I_m \left[\cos(\phi_v - \phi_i) + \cos(2\omega t + \phi_i + \phi_v)\right]$

$\boxed{\phi_{P_t} = \phi_i + \phi_v}$

2 Avarege power:

⊛ avarege power in general $\Longrightarrow$ $P = \frac{1}{T}\int_0^T P(t)\, dt$

period

instantanens power

periodic

$\frac{1}{2T}\int_{-T}^{T} p(t)\, dt$

Final result:

$P = \underbrace{\frac{1}{2} V_m I_m}_{\text{apparent power}} \cos(\phi_v - \phi_i)$ ⇝ الجزء الاول في P(t)

$= \frac{1}{2} I_m^2 R = \frac{1}{2}\frac{V_m^2}{R}$

$P = V_{rms} I_{rms} \cos(\phi_v - \phi_i)$

⊛ avarege power for —ww— , —||— (pure)

$P = V_{rms} I_{rms} \cos(\phi_v - \phi_i)$

✻ avarege power for —, — (pure) equale zero $(\cos(\pm 90) = \text{zero})$

3 apparent power:

$$S = V_{rms} I_{rms} = \sqrt{P^2 + Q^2}$$

$$\therefore PF = \frac{P}{S}$$

✻ PF for —, — (pure) equale zero

✻ remember:

$$P = \frac{1}{2} V_m I_m \cos(\phi_v - \phi_i)$$

$$= \frac{V_m}{\sqrt{2}} \frac{I_m}{\sqrt{2}} \cos(\phi_v - \phi_i)$$

angle factor

rms

S

PF

$$\boxed{P = S \cdot PF}$$

4 Complex power:

$$S = V_{rms} I^*_{rms} = P + jQ$$

5 Reactive power:

$$Q = V_{rms} I_{rms} \sin(\phi_v - \phi_i)$$

Summary .

$$\text{Complex Power} = \mathbf{S} = P + jQ = \mathbf{V}_{\text{rms}}(\mathbf{I}_{\text{rms}})^*$$

$$= |\mathbf{V}_{\text{rms}}|\,|\mathbf{I}_{\text{rms}}| \underline{/ \theta_v - \theta_i}$$

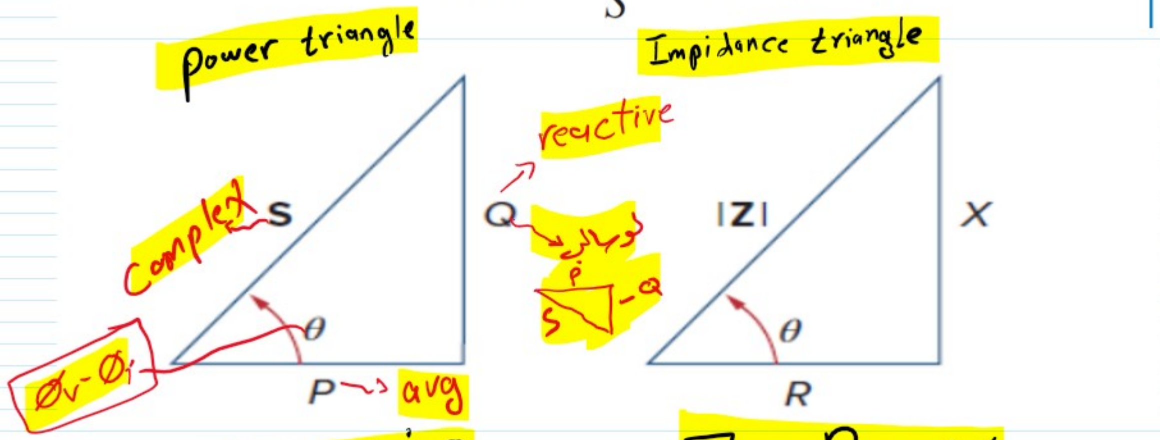
$$\text{Apparent Power} = S = |\mathbf{S}| = |\mathbf{V}_{\text{rms}}|\,|\mathbf{I}_{\text{rms}}| = \sqrt{P^2 + Q^2}$$

$$\text{Real Power} = P = \text{Re}(\mathbf{S}) = S\cos(\theta_v - \theta_i)$$

$$\text{Reactive Power} = Q = \text{Im}(\mathbf{S}) = S\sin(\theta_v - \theta_i)$$

$$\text{Power Factor} = \frac{P}{S} = \cos(\theta_v - \theta_i)$$

$$\text{Power Factor} = \frac{P}{S} = \cos(\theta_v - \theta_i)$$



$S = P + jQ$

$Z = R + jX$

examples :

1

$i(t) = 200 \cos(160\,\omega t - 90)$ (m → $\times 10^{-3}$)

$v_1(t) = 300 \cos(160\,\omega t - 90)$

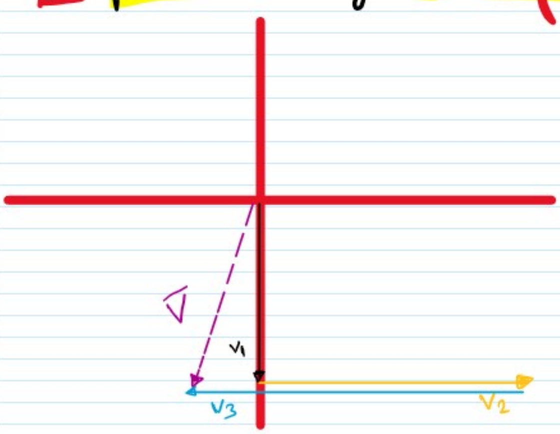
$v_2(t) = 350 \cos(160\,\omega t - 0)$

$v_3(t) = 400 \cos(160\,\omega t - 180)$

1- draw phasar diagram

2- draw the circits

P phasore diagrame (مهم)



$i(t) = 200 \angle -90$

$V_1 = 300 \angle -90$

$V_2 = 350 \angle 0$

$V_3 = 400 \angle 180$

* عند رسم الphasore نجمع ال $\bar{V}$ $(V_3+V_2+V_1)$

نبدأ بالاول ثم من رأس الاول نرسم الثاني ثم من

رأس الثاني نرسم الثالث ثم نصله بين البداية والنهاية

$\bar{V} = 300\angle -90 + 350\angle 0 + 400\angle 180$

$-j300 \quad + 350 \quad - 400$

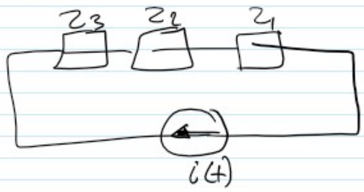
$\boxed{-50 - 300j}$

means Find Impedance element

you must Find V, I

means find Impedance elemenT
you must find V, I

ب Draw the circits :



⊛ بما أنه لدينا تيار واحد
وعدة فولتيات
∴ الـ element على التوالي

⊛ If we have 1 I and multiple V
element in series

⊛ If we have multiple I
element in parallel

$$Z_1 = \frac{V_1}{I} = \frac{300\angle 90}{200\angle 90} = 1{,}5\,\Omega \times 10^3$$

$$Z_2 = \frac{V_2}{I} = \frac{350\angle 0}{200\angle 90} = 1{,}75j\,\Omega \times 10^3$$

$$Z_3 = \frac{V_3}{I} = \frac{400\angle -180}{200\angle 90} = 2-j\,\Omega \times 10^3$$

⊛ إذا طلب أي نوع power يتم التعويض
على القوانين السابقة

apparent

$$S_1 = \frac{1}{2} V_1 I = \frac{1}{2}\ 300\angle 90\ \ 200\times 10^{-3}\angle 90 = 30\ W$$

$$S_2 = \frac{1}{2} V_2 I = \frac{1}{2}\ 350\angle 0\ \ 200\times 10^{-3}\angle 90 = -35j\ VAR$$

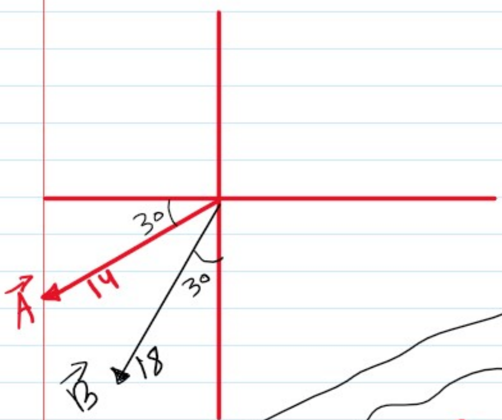
$$S_3 = \frac{1}{2} V_3 I = \text{〃}\ 400\angle -180\ \ \text{〃 〃 〃 〃} = 40j\ VAR$$

$$S_{tot} = (S_1 + S_2 + S_3)\ VA$$

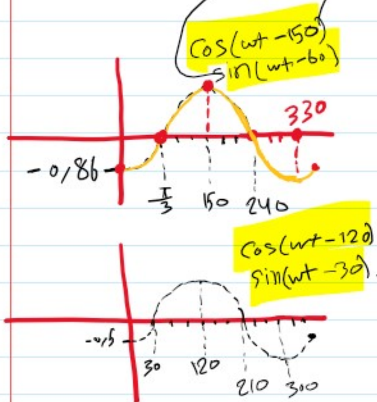
example:

time domain $\Longrightarrow$ ~ , exprission

express $\vec{A}$ and $\vec{B}$ in phasore and time Domain.



Sole:



same

$\vec{A} = 14\cos(\omega t + 210) = 14\sin(\omega t + 120)$

$\vec{B} = 18\cos(\omega t + 240) = 14\sin(\omega t + 150)$

same

$\cos \Longrightarrow \underbrace{+210 = -150}_{360^\circ}$

مع اتجاهات مختلفة

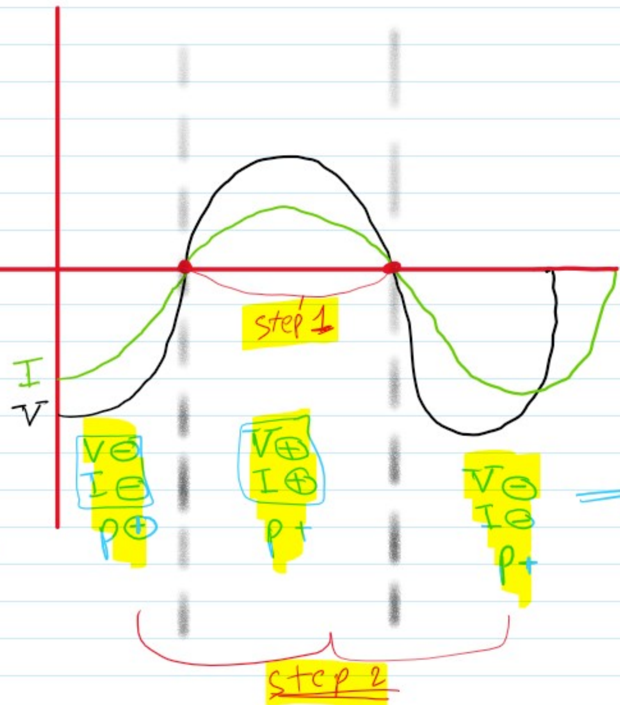
$\sin \Longrightarrow \underbrace{+150 = -30}_{180^\circ}$

" " "

$$\frac{1}{2} V I^* = \frac{1}{2} \overbrace{V \frac{V^*}{Z^*}}^{V^2} = \frac{1}{2} \frac{|V|^2}{Z^*}$$

- for $R = \frac{1}{2} \frac{V^2}{R=Z}$
- for $C, L = \frac{1}{2} \frac{V^2}{Z^*}$

Draw the power throught V, I :



$avg_p = \frac{1}{2} V I$

$avg = max - \left(\frac{max - min}{2}\right)$

للتأكد

قيم غير صحيحة ⟹

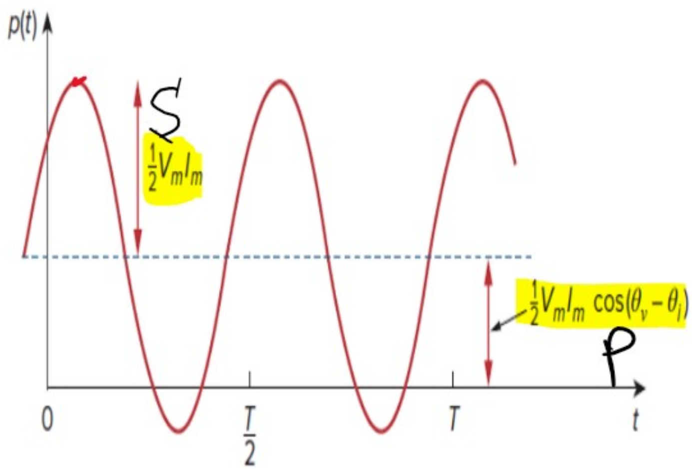
ركز على نفس طريقة الحل

$P(t)_{max} = \frac{1}{2} V I \cos\phi + \frac{1}{2} V I \,(1)$

$P(t)_{min} = \frac{1}{2} V I \cos\phi + \frac{1}{2} V I \,(-1)$

اجزاء أكبر قيمة
cos لل

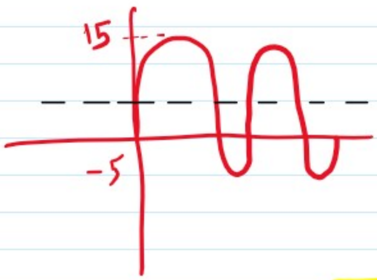
- The instantaneous power in the equation has a time varying part and a time invariant part as shown in the figure.



الواجب رقم 8

* اذا اعطاك رسمة ال power ولم يعين ال x-axis

ينصف الرسمة على ايجاد avg power ثم تحديد x-axis جديد



$\Longrightarrow \text{avg} = 15 - \left(\frac{15 - -5}{2}\right) = 15 - 10 = \boxed{5}$

X-axis new

⊛ أثناء الحل تعتمد X-axis new

$P_{max} = 10$

واجب رقم ١٠

⊛ إذا اعطاك سؤال سيركت وطلب power حول الـelement

إلى Impedance

LECTURE 5

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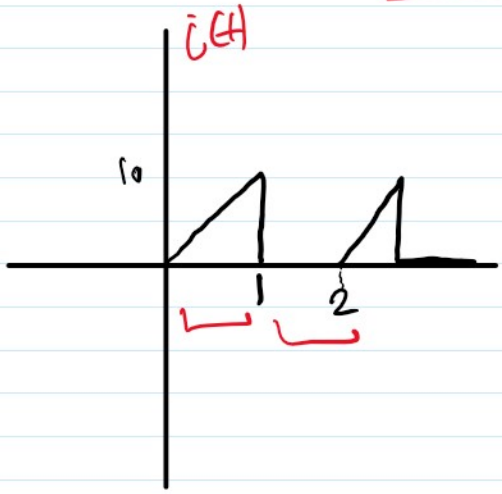
* Rms value

- sinosoidal $\Longrightarrow \dfrac{\text{Peak}}{\sqrt{2}}$
- Function $\Longrightarrow \sqrt{\dfrac{1}{T}\int_0^T (F)^2\,dt}$

ex:

Find Rms value

$$\boxed{y = mx + b}$$



$$i(t)\begin{cases} 0<t<1, & 10t \\ 1<t<2, & 0 \end{cases}$$

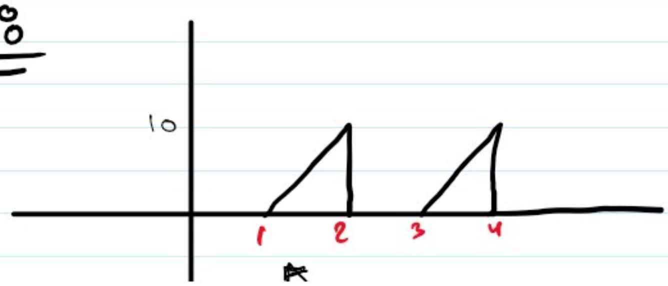
$$\sqrt{\frac{1}{2}\int_0^1 100t^2\,dt}$$

$$\sqrt{\frac{1}{2}\left[\frac{100}{3}t^3\right]_0^1}$$

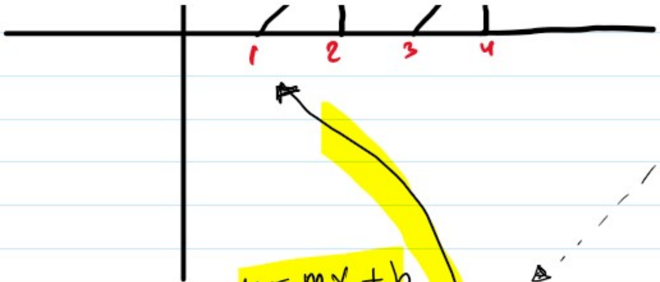
$$\sqrt{\frac{1}{2}\cdot\frac{100}{3}}$$

$$\sqrt{\frac{100}{6}} = \boxed{\frac{10}{\sqrt{6}}}$$

ex:



$$\begin{cases} 0<t<1, & 0 \\ 1<t<2, & 10x-10 \\ 2<t<3, & 0 \end{cases}$$



$2 < t < 3 \;,\; 0$

ثم تكامل لما في المثال السابق

$y = mx + b$

$\frac{10}{2-1} = 10$

$\Downarrow$

$y = 10x + b$ بالتعويض

$\boxed{x = 1 \;,\; y = 0}$

$\Longrightarrow 0 = 10 + b$

$\boxed{b = -10}$

$y = 10x - 10$

Lecture 6

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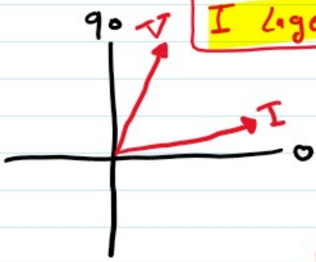
⊛ express the Inductive Loud in
- time domain ①
- phasore ,, ②
- power triangle ③
- Impedance ,, ④
- admitance ,, ⑤

Sole: Inductive ⇒ ϕ $0<\phi<90$

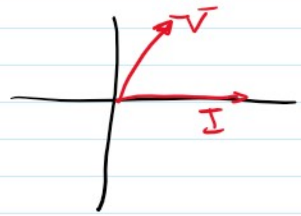
$\phi = V, I$ الزاوية بين

I Lage V

②



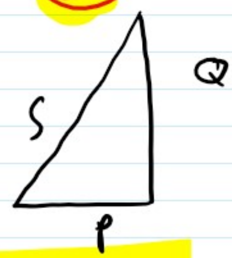
or



① time domain ⇒ رسم ال vector

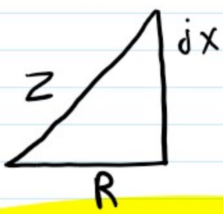
For L Impedance (Z) = $R \pm jX$

③



$S = P \pm jQ$

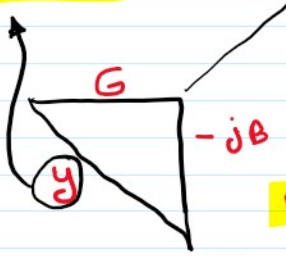
④



⊛ **Admitance:**

p triangle عكس

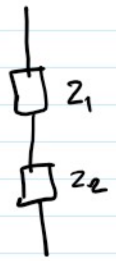
triangle



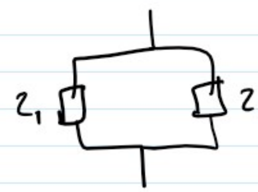
⇒ $y = G - jB = \frac{1}{Z}$ (y: Z parallel)

R parallel ⟷ $G = \frac{1}{R}$

C, L ⟶ X parallel ⟷ $B = \frac{1}{X}$

① 

$\Longrightarrow Z_1 + Z_2$ series

② 

$\Longrightarrow \frac{1}{Z_1} + \frac{1}{Z_2} = y_1 + y_2$

$$y = \frac{1}{Z} = \frac{1}{R+jX} \times \frac{R-jX}{R-jX} \Longrightarrow \frac{R-jX}{R^2+(X)^2}$$

$$\Longrightarrow \overbrace{\frac{R_s}{R_s^2+(X_s)^2} - \frac{jX_s}{R_s^2+(X_s)^2}}^{\text{sereis}}$$

$$R_p - jX_p$$

$$- G = \frac{1}{R_s} = R_{parallel} = \frac{R_s^2 + X_s^2}{R_s} = \frac{1}{R_s}\left(R_s^2 + X_s^2\right) \Longrightarrow \frac{1}{R_s} R_s^2 \left(1+\left(\frac{X_s}{R_s}\right)^2\right)$$

$R_{parallel}$

عامل مشترك

$$- B = \frac{1}{X_s} = X_{parallel} = \frac{R_s^2 + X_s^2}{X_s} = , \; ,, \; ,,, \Longrightarrow \frac{1}{X_s} X_s^2 \left(1+\frac{R_s}{X_s}\right)^2$$

⊛ Quality Factor (Q) $\Longrightarrow$ series $\left(\frac{X_s}{R_s}\right)$, parallel $\left(\frac{R_p}{X_p}\right)$

Summery :

$$Z = R + jX \longleftrightarrow y = G + jB$$

$R, X \Rightarrow$ in series

$G, B \Rightarrow R, X$ in parallel $\Rightarrow \frac{1}{R}, \frac{1}{X}$

$$G = \underset{\text{parallel}}{R_p} = \underset{\text{series}}{R_s} \underbrace{(1 + Q^2)}_{\text{Quality}}$$

$$B = X_p = X_s \left(1 + \frac{1}{Q^2}\right)$$

ex : Find the system in parallel

Sole:

$$Q = \frac{X_s}{R_s} = \frac{200}{20} = \boxed{10}$$

$$X_p = X_s \left(1 + \frac{1}{Q^2}\right) = 200 \left(1 + \frac{1}{100}\right) = 202\ \Omega$$

$$R_p = R_s (1 + Q^2) = 20 (1 + 100) = 2020\ \Omega$$

Lecture 7

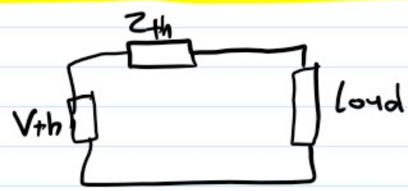
Saturday, October 29, 2022 12:07 PM

⊛ Max. Avg. power:

⊛ في حال تم اعطائك دائرة معينة وطلب ايجاد اكبر قيمة power على element load

Sole:

1. Convert the circit to the thervnine circit.



2. $Z_L = Z_{th}^{2}$ ⟹ في هذه الحالة تكون لها ≤ max power

⊛ $Z_L = R_L \pm jX$

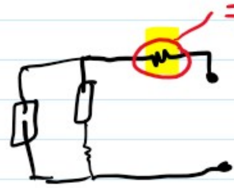
3. $power = \frac{1}{2} I^2 R_L$

نجدها من الدائرة النهائية

$I = \frac{V_{th}}{Z_L + Z_{th}}$

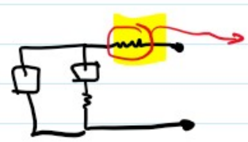
Remember:

① Find V_{th} ⟹



$=0$, $I=0$, open circit

② Find R_{th} ⟹

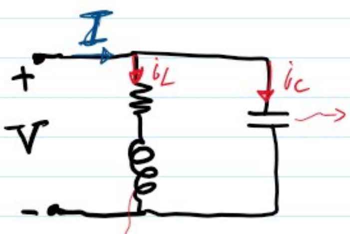


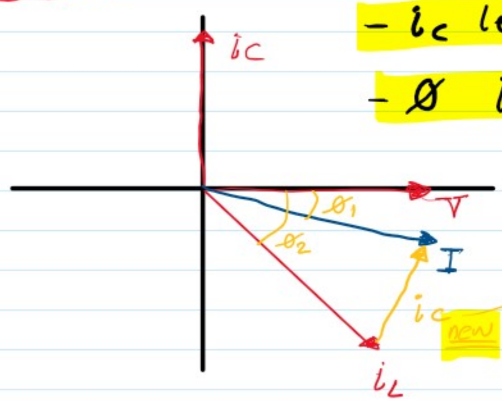
تبقى

$V_{source} \longrightarrow$ short circit

$I_{source} \longrightarrow$ open circit

⊛ power factor correction:





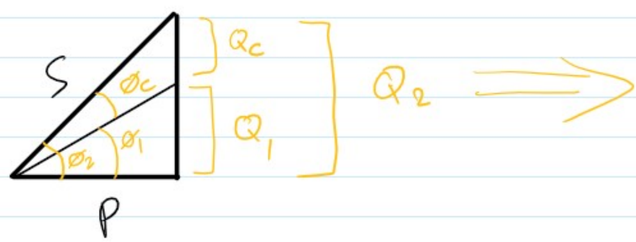
- i_C lead V by 90 (pure)
- ϕ i_L and $V \Rightarrow -90 < i_L < 0$ (I lag V)

⊛ $I - I_L = I_C$

$\phi_C = \phi_I - \phi_L$

$\cos\phi_2 > \cos\phi_1$

⊛ power triangle:



$$Q_C = Q_2 - Q_1$$

$$= p\tan\phi_2 - p\tan\phi_1$$

⊛ $\tan\phi = \frac{Q}{P}$

$Q_1 = p\tan\phi_1$

$$\Downarrow$$

$$Q_C = \frac{V_{rms}^2}{X_C} = \frac{V_{rms}^2}{\frac{1}{wC}} = wC\,V_{rms}^2$$

$$C = \frac{Q_C}{\omega V_{rms}^2} = \frac{p\tan\phi_2 - p\tan\phi_1}{\omega V_{rms}^2}$$

⊛ $PF = \frac{P}{S} \Longrightarrow S\uparrow \longleftrightarrow PF\downarrow$

⊛ $PF\uparrow \longleftrightarrow Q\downarrow$

$$Q_L = \frac{V_{rms}^2}{X_L} = \frac{V_{rms}^2}{wL}$$

$$L = \frac{V_{rms}^2}{wQ_L}$$

$$Q_L = Q_2 - Q_1$$

ex: when connected 120 V (rms), Load absorbe 4 kW, with Laging pf 0,8 then the pf equal = 0,95, F = 60 Hz

$\cos\phi = 0{,}8$ $\qquad$ $\cos\phi_2 = 0{,}95$

Find the value of Capacitance

Sole:

$$S_1 = \frac{P}{\cos\phi_1} = \frac{4000}{0{,}8} = \boxed{5000}$$

$\cos\phi = 0{,}8$

$\phi = \cos^{-1}(0{,}8) = 36{,}8$

$$Q_1 = S_1 \sin\phi = 5000 \sin 36{,}8 = \boxed{3000}$$

$$S_2 = \frac{P}{\cos\phi_2} = \frac{4000}{0{,}95} = \boxed{4210}$$

$\cos\phi = 0{,}95$

$\phi = 18{,}1$

$$Q_2 = 4210 \sin\phi = 4210 \sin 18{,}1 = \boxed{1307}$$

pf اقل

$$Q_C = Q_1 - Q_2$$

$$= 3000 - 1307 = \boxed{1693}$$

$$C = \frac{Q_C}{\omega V_{rms}^2} \Rightarrow \frac{1693}{2\pi \cdot 60 \cdot (120)^2}$$

$\omega = 2\pi F$