تقدم لجنة ElCoM الاكاديمية

دفتر لمادة:

دوائر كهربائية (2)

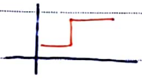
من شرح:

م.زهرة غانم

جزيل الشكر للطالبة:

تسنيم كريج

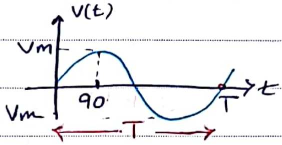
Chapter 10 Sinusoidal analysis at steady state



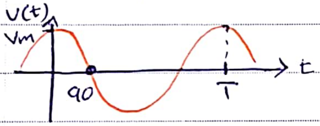
For C / L

For Resistance

$v(t) = \overset{\text{Peak value}}{\underline{V_m}} \sin \omega t$



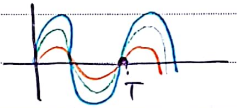
- ▫ Vm : Amplitude : peak value (V)
  $V_{p-p} = 2V_p = 2V_m$
- ▫ ω : angular frequency (rad/s)
  $\omega = 2\pi f$ ▫ f : frequency (Hz)
  $f = \frac{1}{T} \rightarrow \left(\frac{1}{s} = Hz\right)$
  $\omega = \frac{2\pi}{T}$



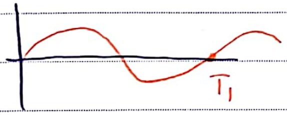
$v(t) = V_m \cos \omega t$

$= V_m \cos \frac{2\pi}{T} t$

$i(t) = 2 \sin \omega t$

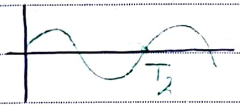


* تغير ال frequency يؤثر على ال signal اما يضغطها أو العكس



$T_1 > T_2 > T_3$

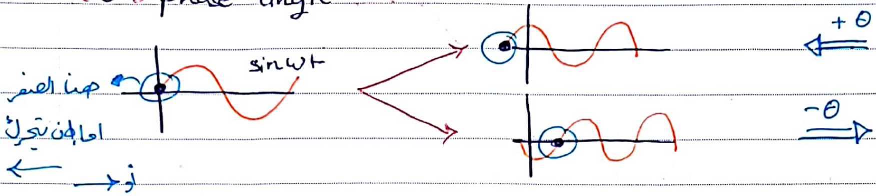
$f = \frac{1}{T}$

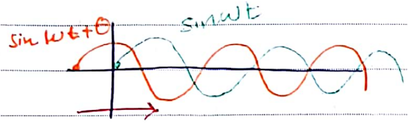


$f_3 > f_2 > f_1$

$v(t) = V_m \sin(\omega t \pm \theta)$

- θ : phase angle





- sin ωt lag sin ωt +θ متأخر
- sin ωt+θ lead sin ωt سابق

phase مختلفين في ال << out of phase >>

$v_1(t) = V_1 \sin(\omega t + \theta_1)$

$v_2(t) = V_2 \sin(\omega t + \theta_2)$

- IF $\theta_1 = \theta_2$ ▷ v_1 , v_2 in phase
- If $\theta_1 \neq \theta_2$ ▷ phase shift → out of phase (lead or lag)

\# To compare between two signales :

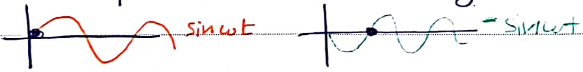
1- have the same frequency

2- Sin OR cos

$$\left\{\begin{aligned} \sin \omega t &= \cos(\omega t - 90) \\ \cos \omega t &= \sin(\omega t + 90) \end{aligned}\right\}$$

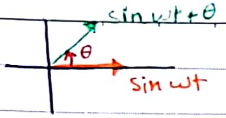
3- two positive ⊕ or two negative ⊖

* دائماً نحول الى الموجب ⊕ لانه اصح



$$\left\{\begin{aligned} -\sin \omega t &= \sin(\omega t \pm 180) \\ -\cos \omega t &= \cos(\omega t \pm 180) \end{aligned}\right\}$$

No.



اتجاه الدوران عكس عقارب الساعة

Ex $i_1(t) = 5\cos(\boxed{3}t+30)$

$i_2(t) = 2\sin(\boxed{3}t+20)$

اول خطوة نتأكد من الfrequency وهنا متساوية

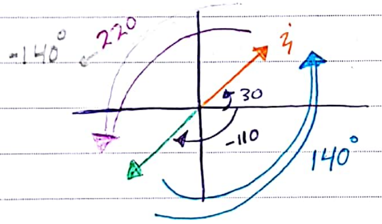
$\omega = 3 \text{ rad/s} = 2\pi f$

$f = \frac{\omega}{2\pi}$ (H) , $T = \frac{1}{f}$

$i_2(t) = 2\cos(3t - 20 \boxed{-90})$ حولنا الثانية من sin الى cos بطرح 90

$= 2\cos(3t - 110)$

$i_1(t)$ and $i_2(t)$ are out of phase



- i_1 lead i_2 by 140°
- i_2 lag i_1 by 140

OR

- i_1 lag i_2 by 220°, -140°
- i_2 lead i_1 by 220°, -140°

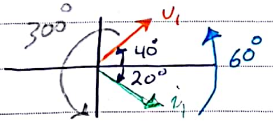
Ex $v_1(t) = 2\cos(\pi t - 50)$

$i_1(t) = 10\sin(\pi t - 20)$

$v_1 = 2\sin(\pi - l - 50 \boxed{+90}) = 2\sin(\pi t + 40)$ حول cos الى sin

out of phase

- v_1 lead i_1 by 60°
- i_1 lag v_1 by 60°



i_1 lead v_1 by 300°, -60°

v_1 lag i_1 by 300°, -60°

Ex $v = -3\cos(t-50)$

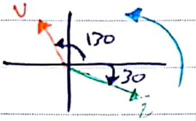
$i = 15\cos(t-30)$

نحول ⊖ الى ⊕

نأخذ ⊕ او ⊖ 180 حسب الزاوية بحيث نتعامل مع زوايا أصغر فقط ويجوز أخذ اي منها

$v = 3\cos(t-50\ \boxed{\pm 180})$

$v = 3\cos(t+\underline{130})$ الزاوية الأصغر



v lead i by 160°

i lag v by 160°

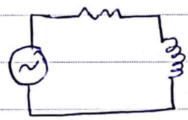
لو أخذنا -180 تكون الزاوية -250

نفس الشيء

i lead v by 200°, -160°

v lag i by 200°, -160°

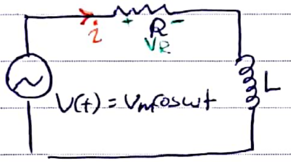
« Forced response to sin function »



$i_L = i_f + (i_0 - i_f)\, e^{-t/\tau}$

$V_C = V_f + (V_0 - V_f)\, e^{-t/\tau}$

For RL ▷



$v(t) = V_R + V_L$

$V_m\cos\omega t = i(t)R + L\frac{di}{dt}$

first order diff equation

$i(t) = i_{Homo} + i_p$

$Ri_h + \frac{L\,di_h}{dt} = 0 \rightarrow$ natural response

لا تؤثر وغير مهم لذلك نترك i_H ونحسب i_p

- $V_L = L\frac{di}{dt}$
- $i_c = \frac{c\,dV}{dt}$
- $V = iR$

- $v(t) = \text{constant} \longrightarrow i_p = k$
- $v(t) = e^t \longrightarrow i_p = ke^t$
- $v(t) = V_m\cos\omega t \longrightarrow i_p = A_i\cos\omega t + A_i\sin\omega t$

كيف نفرض بالدرس

وبعد التعويض في المعادلة التفاضلية ينتج :-

$$i(t) = \boxed{\frac{R\,V_m}{i^2\,\omega^2 R^2}}\,\underline{\cos\omega t} + \boxed{\frac{L\omega\,V_m}{L^2\omega^2+R^2}}\,\underline{\sin\omega t}$$

مطابقة $\rightarrow$ $A\cos(\omega t-\theta) = \boxed{A\cos\theta}\,\underline{\cos\omega t} + \boxed{A\sin n\,\theta}\,\underline{\sin\omega t}$

بمساواة المتشابهات $\rightarrow$ $\frac{R\,V_m}{R^2+L^2\omega^2} = A\cos\theta \dashrightarrow$ ① eq^{n}

$$\frac{L\omega\,V_m}{\omega^2L^2+R^2} = A\sin\theta \longrightarrow ②\ \text{eq}^{n}$$

$$\sqrt{①^2+②^2} = A = \frac{\cancel{\varpi}\,V_m}{\sqrt{R^2+\omega^2L^2}}$$

$$\frac{②}{①} = \tan\theta = \frac{\omega L}{R}$$

$$\boxed{i(t) = \frac{V_m}{\sqrt{R^2+\omega^2L^2}}\cos\left(\omega t - \tan^{-1}\frac{\omega L}{R}\right)}$$

No. 19.9.2018

⇒ For RL

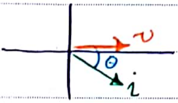
$v(t) = V_m \cos \underline{\underline{\omega t}}$

$i(t) = \frac{V_m}{\sqrt{R^2 + \omega^2 L^2}} \cos(\underline{\underline{\omega t}} - \tan^{-1}\frac{\omega L}{R})$

الـ Frequency تبقى ثابتة

أما الـamplitude يتغير

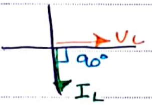
▪ ω : excitative frequency

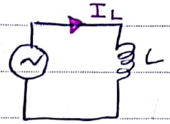


* i_L lag v by $\tan^{-1}\frac{\omega L}{R}$ for RL

- for $\boxed{R=0}$

$i(t) = \cos(\omega t - 90)$





for pure Inductive circuit I_L lag V_L by 90°

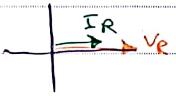
وحتى لو كان هناك مقاومة فيبقى I lag V ولكن الزاوية ليست 90°

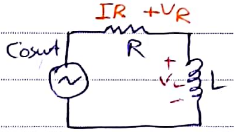
- for $\boxed{L=0}$

for pure Resistance

$i(t) = \frac{V_m}{R} \cos \omega t$

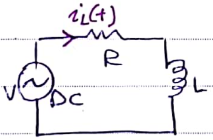
i_R , V_R in phase





- for $\boxed{\omega=0}$

DC

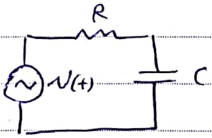


$i_L(t) = \frac{V}{R}$

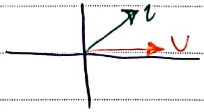
→ For RC

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

$i_C(t) = \frac{V_m C \omega}{\sqrt{1 + \omega^2 R^2 C^2}} \cos(\omega t + \tan^{-1}\frac{1}{\omega RC})$



i lead v by $\tan^{-1}\frac{1}{\omega RC}$



$$v(t) = v_R + v_c$$

$$\left[V_m \cos \omega t = iR + \frac{1}{c}\int i\,dt\right] \rightarrow \frac{d}{dt}$$ تشتق

→ for Rc

i lead v by $\tan^{-1}\frac{1}{\omega Rc}$

for pure capasitive

$i(t) = \cos(\omega t + 90)$

i_c lead v_c by 90 → for pure

* اذا كان هناك R,c,L فنحسب equivelent فمثلاً لو كان مكانئة L أكثر ← RL
او اذا كانت c أكثر ← Rc حسب الدارة

*Complex plane

⇒ $x + jy$ (Rectangular form)

$r = \sqrt{x^2 + y^2}$, $\theta = \tan^{-1}\frac{y}{x}$

⇒ (polar form) $re^{j\theta}$ → $x = r\cos\theta$ Real
→ $y = r\sin\theta$ Imaginary

$$v(t) = V_m \cos(\omega t + \theta)$$

$$v(t) = \text{Real}\left\{\underbrace{V_m \cos(\omega t+\theta)}_{x \text{ Real}} + \underbrace{j\,V_m \sin(\omega t+\theta)}_{jy}\right\} \rightarrow \text{Rectang } x+jy$$

$$= \text{Real}\left\{\underset{\downarrow}{V_m}\, e^{j\underset{\downarrow}{(\omega t+\theta)}}\right\} \rightarrow \text{polar } re^{j\theta}$$

V_m: نتجت من $\sqrt{\text{الاول}^2 + \text{الثاني}^2}$

$(\omega t+\theta)$: نتجت من $\tan^{-1}\left(\frac{\omega t+\theta \text{ الاول}}{\omega t+\theta \text{ الثاني}}\right) = \theta$

No.

$v(t) = \text{Real}\{V_m e^{j\omega t} e^{j\theta}\}$

$\vec{v}$ $V = V_m e^{j\theta} = \underline{\underline{V_m}} \angle \boxed{\theta}$ → ≪phasor form≫

$= V_m \cos\theta + j V_m \sin\theta$ بشرط أن تكون ال frequency نفسه

هنا حولنا من time D إلى phasor D و للتحويل نأخذ Vm وال phase

Ex - $v(t) = 2\cos\omega t \rightarrow V = 2\angle 0$

- $v(t) = 2\cos(\omega t + 20) \rightarrow V = 2\angle 20$ $2e^{j20} = 2\cos 20 + j2\sin 20$
- $v(t) = 3\cos(\omega t - 50) \rightarrow V = 3\angle -50$
- $v(t) = 4\sin\omega t \rightarrow v(t) = 4\cos(\omega t - 90) \rightarrow V = 4\angle -90$

اما نبقي المصدر sin ولكن في النهاية نعيده او من البداية نحوله cos

- $v(t) = -2\sin(\pi t - 70) \rightarrow v(t) = 2\cos(\pi t - 70 - 90 \pm 180)$

$v(t) = 2\cos(\pi t + 20) \rightarrow V = 2\angle 20$

Ex $v(t) = 3\cos 20t - 5\sin(20t + 110)$

$v(t) = 3\cos 20t + 5\cos(20t + 110 - 90 \pm 180)$

$= 3\cos \underline{\underline{20}}t + 5\cos(\underline{\underline{20}}t + 200)$

$V = 3\angle 0 + 5\angle 200$ → هنا لا نعرف ما هو ال frequency لذلك

قبل أن نجمع نتأكد من الخطوة التي قبل ان ال frequency نفسه

$= (3\cos 0 + j3\sin 0) + (5\cos 200 + j5\sin 200)$

$= -1.7 - j1.7$

$= \boxed{2.4} \angle \boxed{-135}$ → 2.4 نتجت من $\sqrt{(1.7)^2 + (j1.7)^2}$

و 135 نتجت من $\tan^{-1}\left(\frac{1.7}{j1.7}\right)$

$v(t) = \underline{\underline{2.4}} \cos(20t \underline{\underline{-135}})$

Ex If $\omega = 2000$ rad/s , Find Instantanoes Value of Current at $t = 1$ ms If :

A- $I = j10\,A \rightarrow 0+j10$

هنا x = صفر لايوجد سوى ← $\underline{\underline{x}}+jy$

$= 10\angle 90$

$\left\{\begin{array}{l} +j5 = 5\angle 90 \\ -j5 = 5\angle -90 \end{array}\right\}$ $j = 90$

$i(t) = 10\cos(2000t+90)$

$i(1m) = 10\cos(\underset{\curvearrowright}{2}+90^\circ) \rightarrow 2 \times \frac{180}{\pi}$

حول rad إلى Deg

$i(1m) = -9\ A$

B- $I = 20+j10$

$I = \sqrt{20^2+10^2}\ \angle \tan^{-1}\left(\frac{10}{20}\right) \equiv V_m\angle\theta$

$I = 22.36\angle 26.57$

$i(t) = 22.36\cos(2000t+26.57) \rightarrow$ # مهم أن نحول في النهاية إلى Time domain

$i(1m) = -17.4\ A$

(10.5) « phasor relations for R,L,C »

$v(t) = i(t)\,R$

θ ← ثيتا ← V للفولتية

Φ ← فاي ← I للتيار

$v(t) = V_m\cos(\omega t+\theta)$ $\quad Re\{V_m e^{j(\omega t+\theta)}\}$

$i(t) = I_m\cos(\omega t+\phi)$ $\quad Re\{i_m e^{(j\omega+\phi)}\}$

$V_m e^{j(\cancel{\omega t}+\theta)} = R\, I_m e^{j(\cancel{\omega t}+\Phi)}$

$V_m e^{j\theta} = R\, I_m e^{j\Phi}$

$V = RI$, $R = \frac{V}{I}$

V_R inphase I_R

No. 24.9.2018

* phasors for R, L, C :

- $v(t) = V_m \cos(\omega t + \theta)$
  $= \mathrm{Re}\{V_m e^{j(\omega t+\theta)}\}$
- $i(t) = I_m \cos(\omega t + \phi)$
  $= \mathrm{Re}\{I_m e^{j(\omega t+\phi)}\}$

* $\boxed{\text{For R}}$ $v(t) = R\, i(t)$, $V = IR$

V, I in phase , $\frac{V}{I} \rightarrow$ Impedance (Z)

$Z_R = \frac{V}{I} = R \rightarrow Z = \frac{\text{Phasor voltage}}{\text{phasor current}}$, $Z = (\Omega)$

* $\boxed{\text{For L}}$ $v_L = L\frac{di}{dt}$

$V_m e^{j\omega t} e^{j\theta} = L\frac{d}{dt} I_m e^{j\omega t} e^{j\phi}$

$V_m \cancel{e^{j\omega t}} e^{j\theta} = L\, I_m e^{j\phi}\, j\omega \cancel{e^{j\omega t}}$

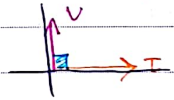
$V = j\omega L\, I \rightarrow Z_L = \frac{V}{I} = j\omega L$ ممانعة (L) تعتمد على

- $\omega = 0$ $\xrightarrow{DC}$ $Z_L = 0$ s.c الـ frequency كلما زاد (ω)
- $\omega = \infty \rightarrow Z_L = \infty$ o.c تزيد (Z_L)

Inductive Reactance $\rightarrow X_L = \omega L$ (بدون j)

$\boxed{V_L = Z_L I}$, $V = \omega L\ I \angle 90^\circ$

I_L Lag V_L by 90°



$j10 = 10\angle 90^\circ$ *

* $\boxed{\text{For c}}$

$i_c = C\frac{dv}{dt}$, $I_m e^{j\omega t} e^{j\phi} = C\frac{d}{dt} V_m e^{j\omega t} e^{j\theta}$

$I_m \cancel{e^{j\omega t}} e^{j\phi} = C\, V_m e^{v\theta}\, j\omega \cancel{e^{j\omega t}}$

$I = j\omega C\, V \rightarrow V = \frac{1}{j\omega C} I = -\frac{J}{\omega C} I$

$Z_C = \frac{V}{I} = \frac{1}{j\omega C} = \frac{-J}{\omega C}$

- $\omega = 0 \xrightarrow{DC} Z_c = \infty$ o.c
- $\omega = \infty \rightarrow Z_c = 0$ S.C

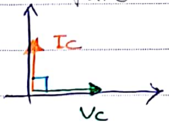
$X_c = \frac{1}{\omega C}$ Reactance

* اما ان نعتبر Imp ⊖ و Reac ⊕
او نعتبر Imp ⊕ و Reac ⊖

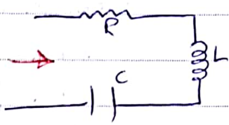
$\underset{C}{Z = -j2}$ $\underset{L}{Z = j2}$ $\underset{pure}{Z = 2}$ $Z = 2 \pm j2$

$V = \frac{1}{\omega C} I \angle -90$

I_c lead V_c by 90°



$$\boxed{V = Z I}$$



لا يمكن جمع R, L, C
في هذه الحالة لذلك
نحول الى Impedance ⇒

$Z_T = R + j\omega L + \frac{1}{j\omega C}$

اذا كانت اكبر من $\frac{1}{\omega C}$ بكون الجزء ⊕ ← L
اما اذا العكس بكون ⊖ ← C
و هكذا

$Z = \underbrace{R}_{Real} + \underbrace{j\left(\omega L - \frac{1}{\omega C}\right)}_{Imaginary}$

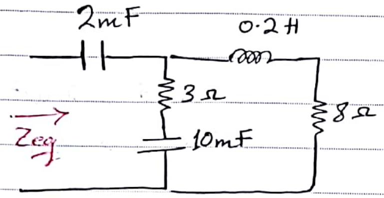
- If $R + jx$ → Inductive
- If $R - jx$ → ~~capacitive~~ capacitive
- If R → pure Resistance of Resonant اذا الجزء التخيلي صفر
- If $+jx$ → pure Inductive
- If $-jx$ → pure capacitive

$$\boxed{Y = \frac{1}{Z} = \frac{I}{V}}$$, Admittance (S)   سماحية

$G = \frac{1}{R}$ (S) , $\cancel{Z}$

No.

Ex

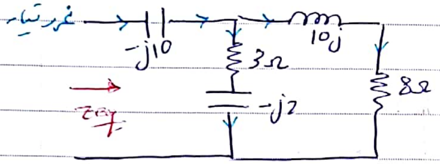


- $\omega = 50$ rad/s

$Z_C = \frac{1}{j\omega c} = -j10\,\Omega$

$Z_C = \frac{1}{j\omega c} = -j2\,\Omega$

$Z_L = j\omega L = j10\,\Omega$



$Z_{eq} = (8+j10) // (3-j2) - j10$

$= 3.2 \boxed{-} j\,11.07\,\Omega$

$= A \angle \boxed{-}\varphi$

Capacitive لأنها سالبة

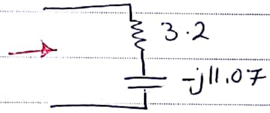
$R_{eq} = 3.2$

$x_{eq} = 11.07$

$A\cos\varphi = 3.2$

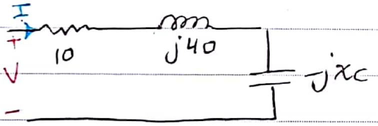
$A\sin\varphi = 11.07$

Capacitive Impedance



* لو كان هناك مصدر (V)
فيكون out of phase I, V
ويكون I lead V
لأنه Capacitive Zeq

Ex



- $V = V_m \angle -25$
- $I = I_m \angle -70$

find x_c ??

$Z_{eq} = 10 + j40 - jx_c = \frac{V}{I}$

$\frac{V_m \angle -25}{I_m \angle -70} = 10 + j[40 - x_c]$

* لو كانت $\frac{V_m}{I_m}$ معلومة:

$\frac{V_m}{I_m} \angle 45 = 10 + j[40 - x_t]$

$\frac{V_m}{I_m}\cos(45) = 10$

$\frac{V_m}{I_m}\sin(45) = 40 - x_c$

$\sqrt{10^2 + (40 - x_c)^2} = \frac{V_m}{I_m}$ غير مفيدة X, $\tan^{-1}\frac{40 - x_c}{10} = 45$ ✓ *

فيها مجهول واحد فقط

$\frac{40 - x_c}{10} = 1 \rightarrow x_c = 30\,\Omega$

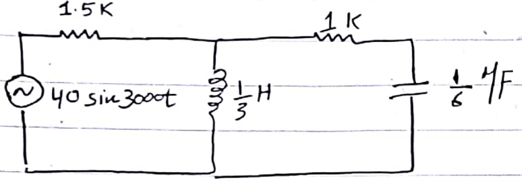
* لو طلب (C) يجب ان يعطي ω

$x_c = \frac{1}{\omega c} = 30 \cdots$

بوقت المحاضرة 15 الاثنين

No. 17 الاربعاء

Ex



- Find $i(t)$??

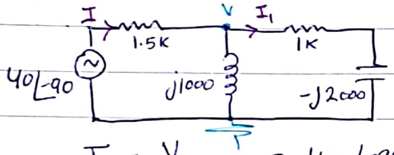
$\omega = 3000$ rad/s

* المصدر (sin) اما أن نبقيه وبعد الحل نتنبه انو لم نحوله أو نحوله الى (cos) من البداية.

$Z_L = j\omega L = j\,1000\,\Omega$

$Z_C = \frac{1}{j\omega C} = -j\,2000\,\Omega$

$V(t) = 40\cos(3000t - 90) \xrightarrow{\text{phasor نحولها الى}} V = 40\angle{-90}$



$Z_{eq} = (1k - j2000) // \cancel{j}\, j1000 + 1.5k$

$= 2.5\angle 36.87\ k\Omega$

Inductive ← ⊕ بما انها موجبة

$I = \frac{V}{Z_{eq}} = \frac{40\angle{-90}}{25\angle 36.57k}$

127 -90

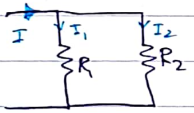
$I = 16\angle{-127}$ A , I Lag V by 36.87

$i(t) = 16\cos(3000t - 127)$ A

نعيد التيار الى time domain لانه طلب في السؤال $i(t)$

$I_1 = \frac{j1000}{-j1000 + 1k - j2000} = I$

■ Current division



■ $I_1 = \frac{R_2}{R_1+R_2} \cdot I$

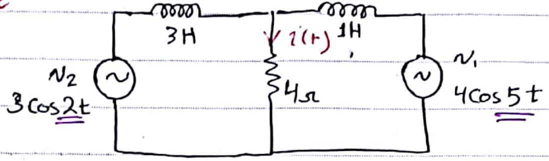
■ $I_2 = \frac{R_1}{R_1+R_2} \cdot I$

■ Nodal $\frac{V}{j1000} + \frac{V}{1k\ j2000} + \frac{V - 40\angle{-90}}{1.5k} = 0 \rightarrow$ نحولهم الى (polar).

$\frac{V}{j000\angle 90} \rightarrow 0.001\angle{-90}\ V$ ← نرفع الارقام للأعلى

No. 26.9.2018

Ex



- Find i(t)??

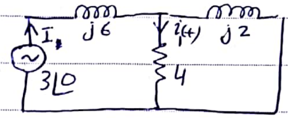
* اذا كان هناك أكثر من مصدر وكانت (w) مختلفة لهم فيجب أن نستخدم (supper position)

- Kill $v_1 \rightarrow v_1 = 0 \rightarrow$ S.C , $I = 0 \rightarrow$ O.C

$\boxed{\omega_2 = 2 \text{ rad/s}}$

$Z_L = j\omega L$

$I = \frac{3\angle 0}{j2 // 4 + j6} \rightarrow I_1 = \frac{j2}{j2+4} \cdot I =$

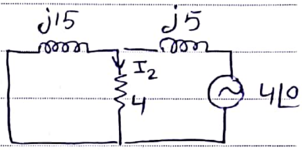


$I_1 = 0.176 \angle -20.55$

- Kill $v_2 \rightarrow v_2 = 0 \rightarrow$ S.C

$\boxed{\omega_1 = 5 \text{ rad/s}}$

$I_2 = \frac{j15}{j15+4} \cdot \frac{4\angle 0}{j15 // 4 + j5} = 0.55 \angle -43.16$ A



$* \; I = I_1 + I_2$

$= 0.176 \angle -20.55 + 6.55 \angle -43.16$

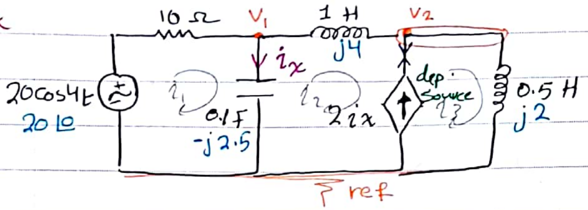
* جمع التيارات خطأ لانهم مختلفين بال (w) لذلك تبقى هكذا بأبسط صورة

$* \; i(t) = i_1(t) + i_2(t)$

$= 0.176 \cos(2t - 20.55) + 0.55 \cos(5t - 43.16)$

No.

Ex



- Find $i_x(t)$??

$Z_L = j\omega L$

$Z_C = \frac{1}{j\omega C}$ (سالبة دائماً)

Nodal , Mesh

$$\frac{V_1 - 20\angle 0}{10} + \frac{V_1}{-j2.5} + \frac{V_1 - V_2}{j4} = 0 \rightarrow ①$$

نضرب المعادلة ب (j100) $\longrightarrow$ $(1 + j1.5)V_1 + j2.5\, V_2 = 20$

سالبة لانه التيار طالع من النود وهي عكسة

$$\frac{V_2 - V_1}{j4} + \frac{V_2}{j2} + (-2ix) = 0 \rightarrow ②$$

$ix = \frac{V_1}{-j2.5}$

$11\, V_1 + 15\, V_2 = 0$ (Matrex) * لسهولة المعادلة الثانية يمكن الحل بالتعويض ولكن الافضل

$$\underbrace{\begin{bmatrix} 1 + j1.5 & j2.5 \\ 11 & 15 \end{bmatrix}}_{\Delta \text{ محددة}} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 20 \\ 0 \end{bmatrix}$$

$$V_1 = \frac{\begin{bmatrix} 20 & j2.5 \\ 0 & 15 \end{bmatrix}}{\Delta} \qquad V_2 = \frac{\begin{bmatrix} 1+j1.5 & 20 \\ 11 & 0 \end{bmatrix}}{\Delta}$$

$$\Delta = (1+j1.5)(15) - j2.5 * 11 = 15 - j5$$

$-\ V_1 = 19\ \angle 18.43\ \ V \qquad -\ V_2 = 14\angle 198.3\ \ V$

$$i_x = \frac{V_1}{-j2.5} = 7.6\ \angle 108.4\ A$$

$$i_x(t) = 7.6\cos(4t + 108.4)\ \ A$$

29/10/2018 الاثنين
8 - الساعة

No.

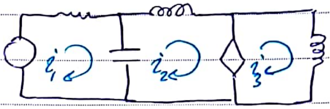
* ممكن حل السؤال السابق بطريقة أخرى (Mesh) :-

■ Mesh ①: $20\angle 0 = 10 I_1 + (I_1 - I_2)(-j2.5)$ → ①

■ Super Mesh: $-j2.5(i_2 - i_1) + j4\, i_2 + j2\, i_3$ → ②

$i_3 - i_2 = 2 i_x$ → ③

$\boxed{i_x = i_1 - i_2}$

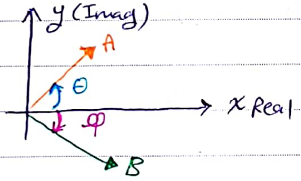


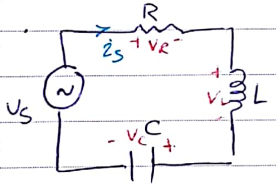
sec (10.10) «phasor diagram»

sketch in a complex plane for all voltages and currents

$A\angle\theta$

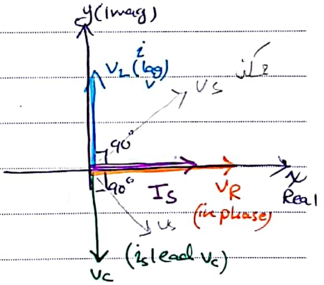
$B\angle\varphi$





■ Choose (I_s) as a refrence :

$\underline{I_s = 1\angle 0}$



Ex $R = 10\,\Omega$

$Z_L = j50$

$Z_c = -j50$

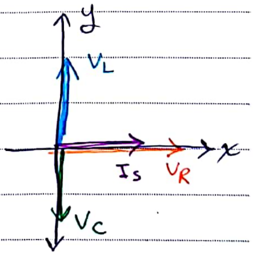
■ Choose $I_s = 1\angle 0$

- $V_R = i_s R = 10\angle 0$ v

- $V_L = Z_L I_s = j50\angle 0 = j50 = 50\angle 90$ v

- $V_c = Z_c I_s = -j50\angle 0 = -j50 = 50\angle -90°$ v

$V_s = V_R + V_C + V_L = 10\angle 0$



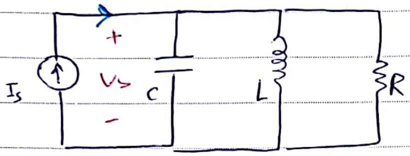
7th طبعة

23, 24, 25 / 26, 31, 32, 53, 56
57, 74, 34, 39, 81

No.

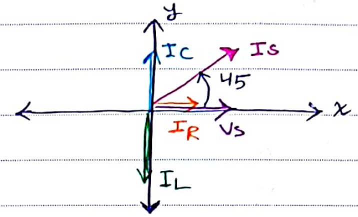
8th طبعة

18, 19, 24, 25, 32, 34, 43
59, 73, 79



🟥 Choose Vs as refrence :-

$V_s = 1\angle 0$



Ex $Z_C = j0.3$ S

$Z_L = -j0.1$ S

$Z_R = 0.2$ S.

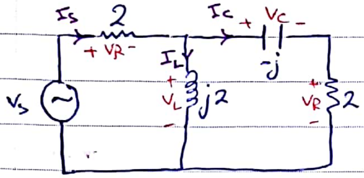
🟦 $I_C = \frac{V_s}{Z_C} = Y_C V_s = (j0.3)(1\angle 0) = j0.3 = 0.3\angle 90$

🟩 $I_L = \frac{V_s}{Z_L} = Y_L V_s = (-j0.1)(1\angle 0) = -j0.1 = 0.1\angle -90$

🟧 $I_R = \frac{V}{R} = Y_R V = 0.2 V$

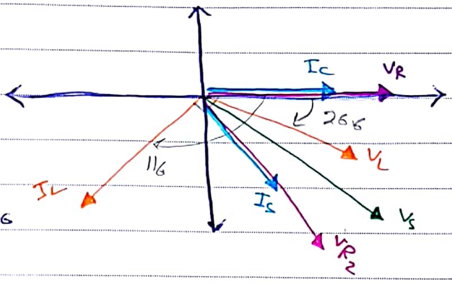
🟪 $I_S = I_R + I_C + I_L = 0.283 \angle 45$ A

No. 1/10/2018



■ Choose Ic as a refrence

$I_C = 1\angle 0$



$I_C = 1\angle 0$

$V_C = I_C Z_C = -j = 1\angle -90$

$V_R = R\,I_C = 2\angle 0$

$V_L = V_R + V_C = 2j = 2.2\angle -26.6$

$I_L = \frac{V_L}{Z_L} = 1.12\angle -116.6$

$I_s = I_C + I_L = 1.12\angle -63.4$ A

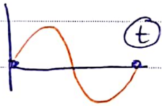
$V_{R_2} = 2\,I_s = 2.24\angle -63.4$

$V_s = V_{R_2} + V_L = 4.24\angle -45$ V

Chapter 11 << AC power Analysis >>

$p(t) = v(t)\, i(t)$

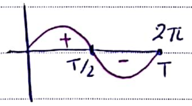
$p = VI$

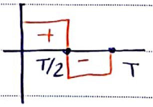


Average value and RMS values

✗ Average value y(t)

$$Y_{avg} = \frac{1}{T}\int_0^T y(t)\, dt$$

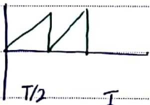


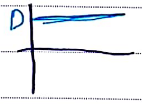


■ for half symmetry function

$Y_{avg} = \text{zero}$

(sin, cos)





$$\int_0 V + \int_{T/2}^{T} -V$$

No.

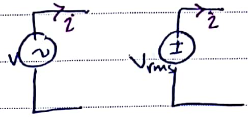
$$Y_{avg} = \frac{1}{2\pi}\int_0^{2\pi} \cos \omega t\,dt \quad = 0$$

\# **RMS:** Root mean square value effective value

F

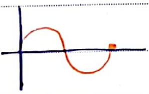
$$Y_{eff} = Y_{RMS}$$

The valued the DC current that deliveres the same power as an AC # current.



$$Y_{rms} = Y_{eff} = \sqrt{\frac{1}{T}\int_0^T y^2(t)\,dt}$$

$$v(t) = V_m \cos(\omega t + \theta)$$



$$\boxed{V_{avg} = 0}$$

$$V_{rms} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} V_m^2 \cos^2(\underline{\omega t} + \theta)\,d\omega t} \rightsquigarrow \int_0^{\frac{2\pi}{\omega}} dt$$

T يساوي $\frac{2\pi}{\cancel{\omega t}}$

[illegible] sin [illegible]

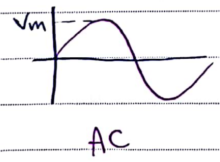
$$V_{rms}^2 = \frac{V_m^2}{2\pi}\int_0^{2\pi} \frac{1}{2} \textcircled{+} \int_0^{2\pi} \frac{1}{2} \overset{\nearrow 0}{\cos(\underline{2\omega t + 2\theta})}\,d\omega t$$

{. متطابقة $\cos^2 A = \frac{1}{2} + \frac{1}{2}\cos 2A$ }

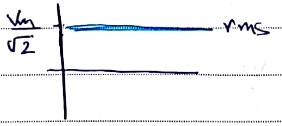
$$V_{rms}^2 = \frac{V_m^2}{2} + 0$$

$$\boxed{V_{rms} = \frac{V_m}{\sqrt{2}}} \qquad \boxed{I_{rms} = \frac{I_m}{\sqrt{2}}}$$

و $\underline{\underline{V_{avg} = 0}}$ كل cos و sin نشتق على البداية

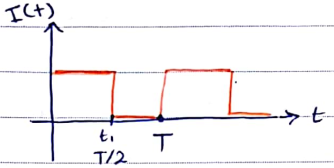


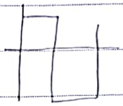
AC



DC

Ex





- $I_{avg} = \frac{1}{T}\int_0^T i(t)\,dt = \frac{1}{T}\left[\int_0^{t_1} I\,dt + \cancel{\int_{t_1}^{T} 0}\right]$

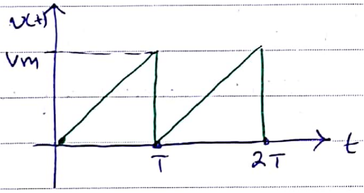
$$I_{avg} = \frac{t_1}{T} I_m$$

- $I_{rms} = I_{eff} = \sqrt{\frac{1}{T}\int_0^T i^2(t)\,dt}$

$$I_{rms}^2 = \frac{1}{T}\left[\int_0^{t_1} I_{rms}^2\,dt + \cancel{\int_{t_1}^{T} 0}\right] \sim I_{rms}^2 = \frac{t_1}{T} I_m^2$$

$$I_{rms} = \sqrt{\frac{t_1}{T}}\; I_m$$

Ex



* هنا يجب ان نستخدم معادلة الخط المستقيم

$$y - y_0 = slope\,(x - x_0)$$

$$Slope = \frac{y_2 - y_1}{x_2 - x_1}$$

$\Downarrow$

$$V - 0 = \frac{V_m - 0}{T - 0}\,(t - 0)$$

$$\boxed{V(t) = \frac{V_m}{T}\,t} \rightarrow$$ معادلة الخط المستقيم

- $V_{avg} = \frac{1}{T}\int_0^T v(t)\,dt$

$$V_{avg} = \frac{1}{T}\int_0^T \frac{V_m}{\cancel{T}}\,\cancel{t}\;dt$$

$$V_{avg} = \frac{V_m}{2}$$

- $V_{rms}^2 = \frac{1}{T}\int_0^T \frac{V_m^2}{T^2}\,t^2\,dt \rightarrow$

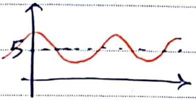
$$V_{rms}^2 = \frac{V_m^2}{3}$$

$$V_{rms} = \frac{V_m}{\sqrt{3}}$$

$v(t) = \cos wt + \sin wt + A$ الها طريقة خاصة

$V = 5 \rightarrow DC \quad , V = V_{avg} = V_{rms}$

Ex $5 + 4\cos wt$



$V_{avg} = 5$

$$V_{rms}^2 = \frac{1}{2\pi}\int_0^{2\pi}(5+4\cos wt)^2 \, dtw$$

$$V_{rms}^2 = \frac{1}{2\pi}\int_0^{2\pi}(25 + 40\cos wt + \underbrace{16\cos^2 wt}) \, dwt$$

متطابقة

$$V_{rms}^2 = \frac{1}{2\pi}\int_0^{2\pi} 25 + 40\overset{0}{\cancel{\cos wt}} + \underbrace{16\left[\frac{1}{2} + \frac{1}{2}\overset{0}{\cancel{\cos 2wt}}\right]} \, dwt$$

$$V_{rms}^2 = \frac{1}{2\pi}\int_0^{2\pi} 33\,dt = 33 \Rightarrow V_{rms} = \sqrt{33} \text{ V}$$

---

* If $y(t) = y_1(t) + y_2(t) + y_3(t)$ to find RMS $y(t)$:-

① $Y_{rms} = \sqrt{\frac{1}{T}\int_0^t y^2(t)\,dt}$

② if y_1, y_2, y_3 have the same frequency بنجمعهم

③ if y_1, y_2, y_3 have the different frequency :

$$Y_{rms} = \sqrt{Y_{rms_1}^2 + Y_{rms_2}^2 + Y_{rms_3}^2}$$

Ex ⇒ $v(t) = \overset{0}{\overset{\uparrow}{5}} + 4\cos \overset{\omega}{\overset{\uparrow}{\omega}} t$ different frequency

$$V_{rms} = \sqrt{5^2 + \left(\frac{4}{\sqrt{2}}\right)^2} = \sqrt{33} \quad \#$$

No.

Ex $v(t) = 3\cos \pi t + 4 \sin^2 \pi t$

$= 3\cos \pi t + \frac{4}{2}(1 - \cos 2\pi t)$

$v(t) = \underbrace{3\cos \pi t}_{\pi} + \underbrace{2}_{0} - \underbrace{2\cos 2\pi t}_{2\pi}$ different frequency

$V_{avg} = 2\,v$

$V_{rms} = \sqrt{\left(\frac{3}{\sqrt{2}}\right)^2 + 2^2 + \left(\frac{2}{\sqrt{3}}\right)^2}$

Ex $v(t) = 10 + \underline{3\cos 10t} + \underline{4\cos(10t - 120)}$

$V_{avg} = 10\ v$ نفس (w) نحولهم phasor ونجمع

$v(t) = 10 + 3\angle 0 + 4\angle -120 = 10 + 3.6\angle -73.8$

$v(t) = 10 + 3.6\cos(10t - 73.8)$

$V_{rms} = \sqrt{10^2 + \left(\frac{3.6}{\sqrt{2}}\right)^2} = 10.3$

Ex $v(t) = \cos 5t + 3\sin(5t + 10)$ → نفس w نحول sin الى cos ثم نجمع

$= 1\angle 0 + 3\cos(5t + 10 - 90)$

$= 1\angle 0 + 3\cos(5t - 80) = 1\angle 0 + 3\angle -80$

$v = 3.36\angle -63.13$

$V_{rms} = \frac{3.36}{\sqrt{2}}$

No. 3.10.2018

"power calculation"

$P = VI \rightsquigarrow p(t) = v(t)\, i(t) \rightarrow$ Instantanous power(P_t) (ω)

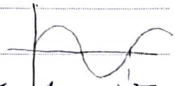
$p(t) = V_m \cos(\omega t + \theta)\, I_m \cos(\omega t + \phi)$

$\cos A \cos B = \frac{1}{2}\left[\cos(A-B) + \cos(A+B)\right]$ ← متطابقة

$$P_t = P(t) = \underbrace{\frac{V_m I_m}{2} \cos(\theta - \phi)}_{\text{constant}} + \underbrace{\frac{V_m I_m}{2} \cos(2\omega t + \theta + \phi)}_{\text{Double } (\omega)}$$

$$P_{avg} = \frac{1}{T} \int_0^T P_t\, dt$$

&



$$P_{avg} = \frac{1}{2\pi} \int_0^{2\pi} \frac{V_m I_m}{2} \cos(\theta - \phi)\, d\omega t + \cancel{\frac{1}{2\pi} \int_0^{2\pi} \frac{V_m I_m}{2} \cos(2\omega t + \theta + \phi)} T \xrightarrow{} \text{zero}$$

$$\boxed{P_{avg} = \frac{V_m I_m}{2} \cos(\theta - \phi)}$$

(Average power, Active power, Real power)

$$P_t = P_{avg} + \frac{V_m I_m}{2} \cos(2\omega t + \theta + \phi)$$

$V_{rms} = \frac{V_m}{\sqrt{2}}$, $I_{rms} = \frac{I_m}{\sqrt{2}}$

$$\boxed{P_{avg} = V_{rms} I_{rms} \cos(\theta - \phi} \quad (\omega)$$

Ex. $P = \overset{P_{avg}}{2} + \underset{2\omega}{2 \cos t}$. ω

$P = 2\ \omega$

$P_{app} = S = |S| = \frac{V_m I_m}{2} = V_{rms} I_{rms}$

(Apperant power) VA → * وحدتها فولت أمبير للتمييز عن الـ(P) السابقة.

power Factor → $PF = \cos(\theta - \phi)$ → * هي زاوية الـ Impedance وتحدد نوعه في الدارة

$Z = \frac{V \angle \theta}{I \angle \phi} = \frac{V}{I} \angle \theta - \phi$ →

smile for life

$0 \le PF = \cos(\theta - \phi) \le 1$ (Unity PF)

- $\cos(\pm 90) = 0$
- $\cos(90) \rightarrow$ pure Inductive
- $\cos(-90) \rightarrow$ pure capacitive

- $\cos(0) = 1$

$\theta = \phi \rightarrow$ Inphase

- pure Resistance

Ex $\cos(\underline{\pm 36}) = 0.8$

ننظر الى $(\theta - \phi)$ قبل أخذ ال cos

- $(\theta - \phi) \rightarrow \oplus$ Inductive $\rightarrow$ lagging PF
- $(\theta - \phi) \rightarrow \ominus$ capacitive $\rightarrow$ leading PF

* $\boxed{\text{For } R}$ $\rightarrow \theta = \phi$

$\cos(\theta - \phi) = 1 = PF$

- $P_{avg} = \frac{V_m I_m}{2} = P_{app} = \frac{V_m^2}{2R} = \frac{I_m^2 R}{2}$ → peak value
- $= V_{rms} I_{rms} = P_{app} = \frac{V_{rms}^2}{R} = I_{rms}^2 R \rightarrow$ RMS

* $\boxed{\text{For pure } C \text{ , pure } L}$ $\rightarrow (\theta - \phi) = \overset{\oplus}{\underset{\ominus}{}} 90$ → L, C

$PF = 0$, $P_{avg} = 0\,W$

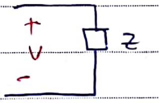
$P_{app} = V_{rms} I_{rms} = \frac{V_m I_m}{2}$

* (L,C) ← يخزنوا الطاقة

* (R) ← تعمل على تحويل الطاقة وإحيانًا تعمل على إضاعتها على شكل حرارة.

Ex $V(t) = 4 \cos \frac{\pi t}{6}$, $Z = 2 \angle 60 = 1 + j\,1.73\,\Omega$

- Find P_t , P_{avg} ??



$\left.\begin{array}{l} V = 4 \angle 0 \\ Z = 2 \angle 60 \end{array}\right]$ $I = \frac{V}{Z} = 2 \angle -60$ A

$i(t) = 2 \cos(\frac{\pi}{6} t - 60)$

- $P_t = v_t i_t = 4 \cos \frac{\pi}{6} t \cdot 2 \cos(\underbrace{\frac{\pi}{6} t}_{Rad} \underbrace{-60}_{Deg})$

* لذلك نحول ال $\frac{\pi}{6}$ إلى Deg عند الحل لأن الزوايا مختلفة.

$= 8 \cos \frac{\pi}{6} t \cos(\frac{\pi}{6} t - 60) \xrightarrow{\text{متطابقة}} = \underbrace{4 \cos(60)}_{P_{avg}} + 4 \cos(\frac{2\pi}{6} t - 60)$

- $P_{avg} = 2\,W$

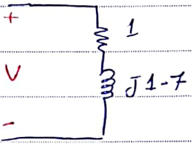
No.

طريقة اخرى $\xrightarrow{}$ لحساب (Pavg)

$$P_{avg} = \frac{VI}{2}\cos(\theta - \phi)$$

(θ_Z) Imped زاوية

$$= \frac{4 \times 2}{2}\cos(\underbrace{0 - -60}) = \underline{\underline{2\,w}}$$



طريقة ثانية $\xrightarrow{}$ لحساب (Pavg)

$$P_{avg\,L} = 0\,w$$

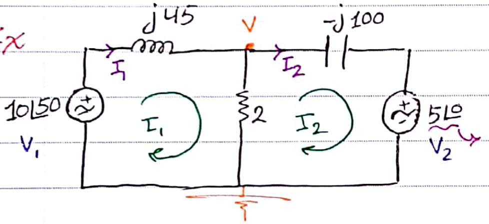
$$P_{avg} = \frac{V_m I_m}{2}\cos(\theta - \phi) = \frac{VI}{2} = \frac{I^2 R}{2} = \frac{V^2}{2R}$$

$$P = \frac{I^2 R}{2} = \frac{4 \times 1}{2} = \underline{\underline{2w}}$$

generating power = dissipated power

وكان Pavg فقط في المقاومة (R) و (L) ليس فيها.

Ex



- Calculate avarge power dilivered by each elements ??

هنا الدارة محولة الى phasor اما لو كانت في _Time يجب ان نحول اولاً قبل الحل

Node ▷ $\frac{V - 10\angle 50}{j45} + \frac{V}{2} + \frac{V - 5\angle 0}{-j100} = 0$

- $I_1 = \frac{10\angle 50 - V}{j45} = 0.22\angle -37.8$
- $I_2 = \frac{V - 5\angle 0}{-j100} = 0.0466\angle 87.8$

- $P_L = 0\,w$ - $P_c = 0\,w$

- $P_{V_1} = \frac{VI_1}{2}\cos(\theta - \phi) = \frac{(10)(0.22)}{2}\cos(50 - (-37.8))$
  $P_{V_1} = 42\,mw$ (generating) oR $P_{V_1} = -42\,mw$ (dissipating)
- $P_{V_2} = \frac{(5)(0.0466)}{2}\cos(0 - 87.8) = 4.4\,mw$ (dissipating, absorbed)

No.

$I_R = I_1 - I_2 = A \angle\theta$

$P_R = \frac{|I_1 - I_2|^2 R}{2} = \frac{A^2 R}{2} = 37.6 mW$ dissipating

$\sum P_{generating} = \sum P_{dissipating}$

$\sum P = 0$

No. 8.10.2018

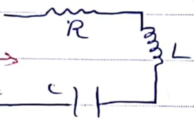
* $\boxed{PF=1}$ → pure resistance

$Z_{eq} = R_{eq} + jx_{eq}$, $x_{eq} = 0$

(Resonant frequency) → $\omega = \omega_0$
↳ $f = f_0$

- for series RLC :-

$Z_{eq} = R + j\omega L + \frac{1}{j\omega C}$



$Z_{eq} = R + j(\omega L - \frac{1}{\omega C})$

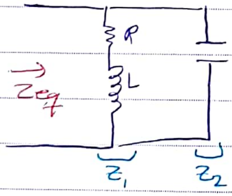
$\omega = \omega_0$

Resonant frequncy $\boxed{PF=1}$, $x = 0$

$\omega_0 L - \frac{1}{\omega_0 C} = 0 \rightarrow \omega_0 = \frac{1}{\sqrt{LC}} \rightarrow Z_{eq} = R$

- for parallel RLC :-

$\omega_0 = \frac{1}{\sqrt{LC}}$



$PF = 0.8 = \cos(\theta - \varphi)$

$= \tan^{-1} \frac{\omega C - \frac{\omega L}{R^2+\omega^2 L^2}}{\frac{R}{R^2+\omega^2 L^2}}$

$Z_{eq} = (R + j\omega L) // \frac{1}{j\omega C}$

$Y_{eq} = \frac{1}{Z_{eq}} = \frac{1}{Z_1} + \frac{1}{Z_2}$

~~PF=~~

$Y_{eq} = \left(\frac{1}{R + j\omega L}\right) + \frac{1}{1/j\omega C}$ → $PF = 1$

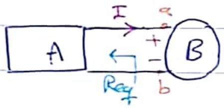
↳ $\frac{R - j\omega L}{R - j\omega L}$ المرافق $\frac{R - j\omega L}{R^2 + \omega^2 L^2} + j\omega C$

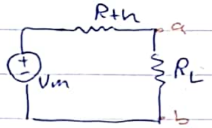
$Y_{eq} = \frac{R}{R^2 + \omega^2 L^2} + j \underbrace{\left[\omega o - \frac{\omega L}{R^2 + \omega^2 L^2}\right]}_{x}$ $x = 0$

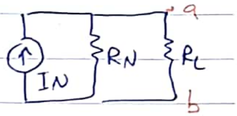
$\omega_0 C - \frac{\omega_0 L}{R^2 + \omega^2 L^2} = 0 \rightarrow \omega_0 = \sqrt{\frac{L - R^2 C}{L^2 C}}$

* at $\omega = \omega_0$ $PF = 1 \rightarrow x = 0 \longrightarrow Z_{eq} = \frac{R^2 + \omega^2 L^2}{R}$

«Thevenin and Norton»







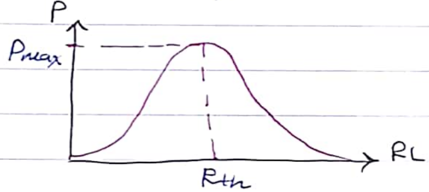
- $V_{th} = V_{(o.c)}$
- $I_n = I(s.c)$
- $V_{th} = I_N R_N$
- $I_N = \frac{V_{th}}{R_{th}}$
- $R_L = R_{th}$
- $R_{eq} = R_{th} = R_N$

▶ To get max power

- $P_{max} = \frac{V^2_{th}}{4 R_{th}}$

نحصل عند أعلى طاقة عندما تكون :

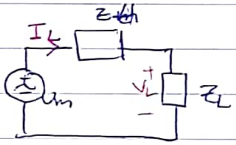
$(R_{th} = R_L)$



$Z_{eq} = Z_{th} = Z_N$

$V_{th} = I_N Z_N$

$I_N = \frac{V_{th}}{Z_{th}} \rightarrow Z_{th}$ to get max



$P_L = |V_L|\,|I_L|\cos(\theta - \phi)$, $I_L = \frac{V_{th}}{Z_L + Z_{th}}$, $V_L = I_L Z_L$

$\frac{dP_L}{dZ_L} \rightarrow \boxed{Z_L = Z^*_{th}}$

- $Z_{th} = R_{th} \pm jx_{th}$
- $Z_L = Z^*_{th} = R_{th} \mp jx_{th}$

*If $Z_L = Z^*_{th}$:-

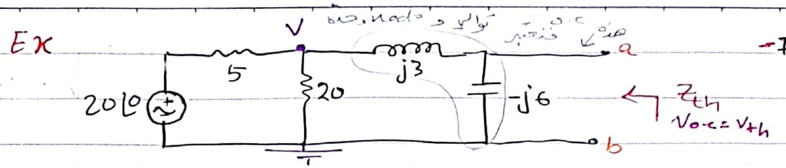
$Z_{eq} = 2R_{th} \rightarrow$ (Resistance) $PF = 1$, $\omega = \omega_0$

$I_L = \frac{V_{th}}{2R_{th}}$

$P_L max = P_L\Big|_{Z_L = Z^*_{th}} = \frac{|V_{th}|^2_{max}}{8 R_{th}} \rightarrow P_L max = \frac{|V_{th}|^2_{max}}{4R_{th}}$

$P_L max = \frac{|I_L|^2 R_{th}}{2} = |I_L|^2_{rms} R_{th}$

Ex



- Find (Z_L) to get max powerR?

To Find (Z_{th}) kill the source $V_s = 0$ s.c

$Z_{th} = ((5 // 20) + j3) // -j6$ $I_s = 0$ o.c

$Z_{th} = 5.76 - j1.68 \ \Omega$

$Z_L = Z_{th}^{*} = 5.76 + j1.68 \ \Omega$

* او نحسب Zeq ونحسب (I) الكلية ثم نعمل division ونحسب (Vth)

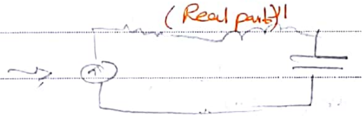
Nodal ▶ $\frac{V-20}{5} + \frac{V}{20} + \frac{V}{j3-j6} = 0 \longrightarrow I = \frac{V}{j3-j6}$

$V_{th} = I(-j6) \longrightarrow V_{th} = \underline{19.2} \angle -53.13 \ V$

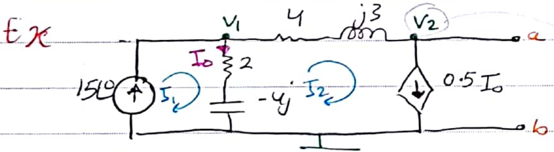
Amplitude فقط الـ

$P_{max} = \frac{|V_{th}|^2}{8 R_{th}} = \frac{(19.2)^2}{8 * 5.76} = 8 \ \omega$ → يعني Pavg لا تكون فيها أرقام complex

نعوض (R_th) فقط (Real part)



Ex



او ممكن ان لانحسبها Node

$Z_{th} = \frac{V_{th}}{I_N}$

~~Nodal~~ $\frac{V_1}{2-j4} - 15\angle 0 + 0.5 \boxed{I_o} = 0$ $\quad I_o \to \frac{V_1}{2-j4}$

$(4+j3)(0.5 I_o) + V_{th} - V_1 = 0$

$V_{th} = 55 \angle -90$

$= -j85$

No.

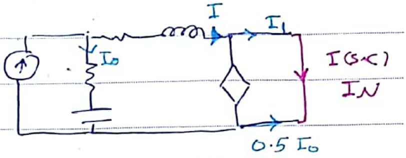
$I_N = I_{s.c}$

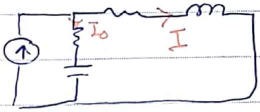
$I_N = I - 0.5 I_o$

$I = \frac{2-j4}{2-j4+4+j3} \cdot 15 \angle 0$

$I_o = 15 - I$

$I_N = 13.56 \angle -80.5$





$Z_{th} = \frac{V_t}{I_N} = 4.055 \angle -9.467 = \underset{R_{th}}{\textcircled{4}} - j\,0.667\ \Omega$

$Z_L = Z_{th}^* = \overset{R_{th}}{\textcircled{4}} + j\,0.667\ \Omega$

$P_{L\,max} = \frac{(.55)^2}{8(\textcircled{4})_{R_{th}}}$

RMS [illegible]

Sec (11.5) / (Complex power)

$P_{avg} = VI \cos(\theta - \phi)$

$S = \underbrace{VI\cos(\theta-\phi)}_{avg\ (Real)} + \underbrace{j\ VI\ \sin(\theta-\phi)}_{Q\ (Imag)}$ (complex power) S

- $P_{avg} = Re\{S\}$
- $Q = Im\{S\}$

$\divideontimes$ Complex power (S)

↳ $S = P_{avg} + jQ$ → Q → Reactive power; → P_{avg} → active power

$S = VI\cos(\theta - \phi) + jVI\sin(\theta-\phi)$

$S = VIe^{j(\theta-\phi)} = VI \angle \theta - \phi$

$P_{app} = S = |S|$

* اختلاف الوحدات للتميز

- S → VA
- $S = |S| = P_{app}$ → VA
- P_{avg} → W
- Q → VAR

$$S = VIe^{j(\theta - \phi)} = Ve^{j\theta} \cdot Ie^{-j\phi}$$

* لو لم يكن (rms) تكون
كل الحل تقسيم (2)

$$\boxed{S = V \cdot I^*}$$

$$S = V\angle\theta \cdot I\angle-\phi$$

$$S = P_{avg} + jQ = VI\angle\theta-\phi$$

$$VI = \sqrt{P_{avg}^2 + Q^2}$$

$$\tan^{-1} = \frac{Q}{P_{avg}} = \theta - \phi$$

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* Complex power (S)

$S = P_{avg} + jQ = VI \angle \theta - \phi = V I^*$

$Q = VI \sin(\theta - \phi)$ → Reactant power

▸ For pure R:

$\theta = \phi \rightarrow \theta - \phi = 0 \rightarrow \sin(0) = 0$

$Q_{R=0}$ VAR

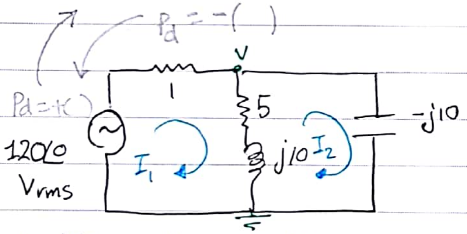
$S_R = P_{avg} + jQ = P_{avg} = VI = P_{app}$

▸ For pure C L:

$\theta - \phi = \pm 90 \longrightarrow \cos \pm 90 = 0 \longrightarrow \sin(\theta - \phi) = \pm 1$

$\Big[$ ▪ $Q_C = -VI$ ▪ $Q_L = VI$ $\Big]$ $S_{CL} = 0 \pm jVI$

Ex



- Find total complex power ??

Nodal → $\frac{V - 120}{1} + \frac{V}{5 + j10} + \frac{V}{-j10} = 0$

▪ $V = 115 \angle -1.1$ V

▪ $I_1 = \frac{120 - V}{1} = 5.16 \angle 25.46$ A

▪ $I_2 = \frac{V}{-j10} = 11.5 \angle 88.9$ A

نغير زاوية التيار لانه I^*

▪ $S_{120\angle 0} = VI_1^* = (120\angle 0)(5.16 \angle -25.46) = (559 - j266)$ VA

$\circlearrowleft I$ $P_d = +(\ )$ $\circlearrowright I$ $P_d = -(\ )$

generating

اما اذا اردنا حساب diss نغير سالب

▪ $S_1 = VI^* = \frac{V^2}{R} = I^2R = P_{avg} = P_{app}$

$S_1 = |I_1|^2 R = (5.16)^2 (1) = 26.6 + j0$ VA

$S_c = V_c I_c^* = V_c I_2^* = (115 \angle -1.1)(11.5 \angle -88.9)$ مجموعهم $-90°$ لأنه (C)

$S_c = 0 - j\,1331$ VA

$I = I_1 - I_2 = 10.3 \angle -64.5$ A_{rms}

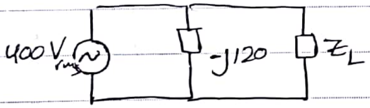
$S_{5+j10} = V I^* = (115 \angle -1.1)(10.3 \angle 64.5) = 532 + j1065$ VA

$S_{Total} = S_1 + S_2 + S_3$
$= (P_{avg_1} + P_{avg_2} + P_{avg_3}) + j(Q_1 + Q_2 + Q_3)$
$= P_{avg\ total} + J\ Q_{total}$

$S_t = S_1 + S_2 + S_3$
$VI \angle \theta - \phi = V_1 I_1 \angle \theta - \phi + V_2 I_2 \angle \theta - \phi + V_3 I_3 \angle \theta - \phi$
$A \angle \theta = B \angle \theta + C \angle \theta + F \angle \theta$

ال (Papp) لايمكن أن نجمع
مثل St لذا اردنا الجمع نحول الى Rect ثم نجمع.

Q51
من الكتاب



$\therefore S_{Source} = 1.6 + j0.5$ kVA
$A \angle \theta - \phi$

1) Find complex power delivered to ZL ??

$I_c = \frac{400}{-J120} = \frac{40}{12} J$

$S_c = V I_c^* = 1.33 \angle -90$ KVA

$S_L = S_{source} - S_c$
$= 1.6 + j1.8$ kVA $= 2.4 \angle 48.8$ KVA

* ليست (pure Inductive) لأنه الزاوية ليست 90°، وهذا يعني أنه يوجد مكونات أخرى بغض النظر عنها مقاومات، ملفات ...

No.

2) P.F of Z_L

$P.F = \cos(\underset{\sim}{48.8}) = 0.658$ lag   الزاوية (+) ← Inductor

* بعد حساب ال P.F دائماً نكتب ⊖ lead أو ⊕ lag

3) P.F of the source

$P.F = \cos(\theta - \varphi) = \cos(17.35) = 0.454$ Lag

$\theta - \varphi = \tan^{-1} \frac{0.5}{1.6}$

فرعي اضافي (4) Find Z_L

$S_L = V I_L^*$

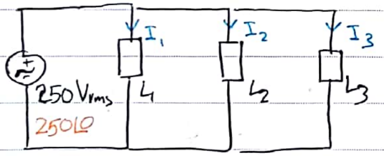
$2.4\angle 48.8 = 400 I_L^* \rightarrow I_L = 4 - j4.58$

$Z_L = \frac{400}{I_L} \rightarrow$

$S_t = V I_t^*$

Ex

Q53
من الكتاب



- $L_1 \rightarrow 20$ Kw Pavg → P.F = 1   R
- $L_2 \rightarrow 25$ KVA Papp → PF = 0.8 lag   L not pure
- $L_3 \rightarrow 30$ Kw Pavg → PF = 0.75 lag

1) Find the total Avrage power supplied by the source ??

$Pavg_s = Pavg_1 + Pavg_2 + Pavg\,3$

$= (20K) + (25K * \underset{\sim}{0.8}) + 3K \rightarrow Pavg_s = 70$ Kw

$Pavg = VI\cos(\theta - \varphi)$ ← نضربها بـ P.F لتحويلها إلى avg

$Pavg = Papp \cdot PF$

2)

$P_{avg_1} = |V|\,|I_1|\ P.F \rightarrow 20k = (250)(|I_1|)(1)$

$|I_1| = 80\ A$

*لان لاخراج زاوية (I) نستخدم P.F

$\rightarrow P.F = \cos(\overset{0}{\theta} - \varphi) = 1 \rightarrow \theta - \varphi = 0 \rightarrow \varphi = 0$

زاوية ال (V)

$I_1 = 80\angle 0$

$P_{app} = |V|\,|I_2| \rightarrow 25k = (850)(|I_2|)$

$|I_2| = 100\ A$

$P.F = \cos(\theta - \varphi) = 0.8$

$(\theta - \varphi) = \pm 36.87$ lag / lead $\rightarrow \varphi = -36.87$

$I_2 = 100\angle -36.87$

$P_{avg_3} = V|I_3|\ P.F$

$|I_3| = 160\ A$

$P.F = \cos(\theta - \varphi) = 0.75 \rightarrow \theta - \varphi = +41.4 \rightarrow \varphi = -41.4$

$I_3 = 160\angle -41.4$

$I = I_1 + I_2 + I_3$

$I = 325.4\angle -30.635\ A$

$P_{app} = |S| = (400)(325.4) = 81.3\ KVA$

$P.F = \cos(\overset{0}{\cancel{\theta}} - \varphi) = \cos(0 - -30.635) = 0.86$ Lag

لا يمكن جمع ال P.F لانها تحتوي زوايا يعني مثل Papp خطأ ان نجمع

$S_t = S\angle\theta - \varphi = S_1\angle\theta - \varphi + S_2\angle\theta - \varphi$

* قد طلب Q لكل عنصر فنقوم باخراج V|I| لكل عنصر ثم نضربه بـ sin(θ-φ)

* واذا طلب (Q tot) ←

$Q_t = VI\sin(\theta - \varphi)$

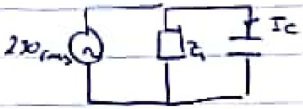
$= (400)(325.4)\sin(0 + 30.6)$

* او قد يطلب (S)

CH(11) { 11 / 17 / 22/26/27/28
41 / 48/52/54

No. 15.10.2018 (7) [illegible]

Ex load Z_1 operating at 50 kw , 0.8 Lagging p.F
a parallel capacitor is a to increase p.F to 0.95
Find (C).



$Z_1 = \frac{V}{I}$

$Z_{eq} = Z_1 \,//\, \frac{1}{j\omega c} = \text{Real} + j\,\text{Img}$

$P_F = \cos(\theta - \varphi) = \cos\left(\tan^{-1} \frac{\text{Img}}{\text{Real}}\right)$

$S = VI^* = VI \angle \theta - \varphi$

$P_{app} = VI = \frac{P_{av}}{PF}$

$S_t = S_1 + S_c$

$\frac{50k}{0.95} \angle \cos^{-1} 0.95 = \frac{50k}{0.8} \angle \cos^{-1} 0.8 \quad S_c$

$50 + j16.4\,k = 50 + j\,27.5\,k + S_c$

$S_c = -j\,21.07$ kVA

$S_c = V I_c^*$

$-j\,21.07K = (230)\,I_c^* \rightsquigarrow \frac{21.07k \angle -90}{230} = I_c^*$

$I_c = 91.6 \angle 90$ A

$Z_c = \frac{V}{I_c} = \frac{230}{91.6 \angle 90}$

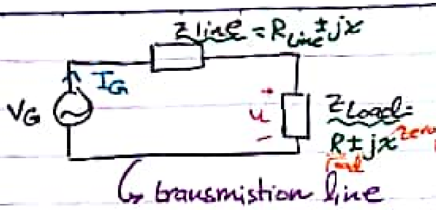
$Z_c = -j\,2.5\,\Omega = \frac{1}{j\omega c} = \frac{-j}{\omega c}$

$\omega\, 2.5 = \frac{1}{\omega c}$ $\omega = 2\pi f$, $F = 60$

$\omega \rightarrow 2\pi 60$

$\boxed{C = 1056\ \mu F}$

No.

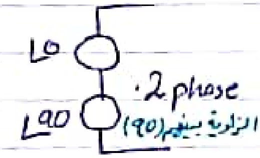


- $P_{in} : P_{source} = |V_G| \, |I_G| \; P.F$
- $P_o : P_{load} = |I_G|^2 R_{load}$
- $P_{loss} = P_{line} = |I_G|^2 R_{line}$

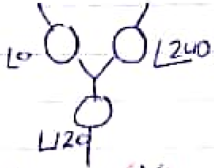
$(P_{input} = P_{output} + P_{loss})$

- effeciency $= \eta = \frac{P_o}{P_{in}} \times 100\%$

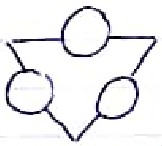
chapter (12) (poly phase)



- 2 - phase



- 3 - phase (Y)

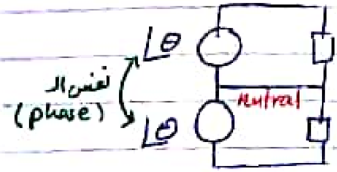


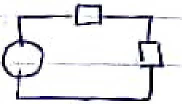
- 3 phase (Δ)

$\boxed{\begin{matrix} Y-Y \\ Y-\Delta \end{matrix}}$, Δ-Δ , Δ-Y ((Balanced system))

Y ← التركيز على ال load
Δ ←

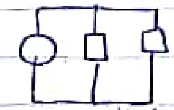
>> Single phase - 3 wires system ▷ يعني الهم نفس ال phase





series

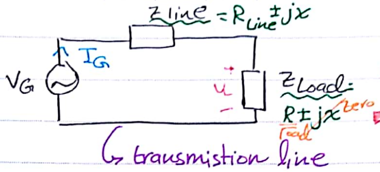
لو صار اشي ال load
لو بعيد يحل تتوقف الدائرة كلها



parallel

لو هنا نحتاج تيار كبير حتى نوصل للفولتية المطلوبة

No.

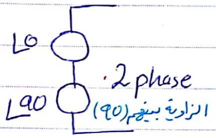


- P_{in} : P_{source} = $|V_G| \, |I_G|$ P.F
- P_o : P_{load} = $|I_G|^2 R_{load}$
- P_{loss} = P_{line} = $|I_G|^2 R_{line}$

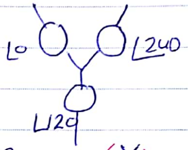
(P_{input} = P_{output} + P_{loss})

- effeciency = $\eta = \frac{P_o}{P_{in}} \times 100\%$

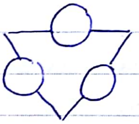
Chapter (12) (poly phase)



- 2 - phase



- 3 - phase (Y)



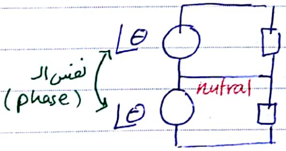
- 3 phase (Δ)

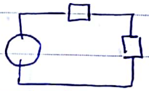
$$\boxed{\begin{matrix} Y-Y \\ Y-\Delta \end{matrix}} \;,\; \begin{matrix} \Delta-\Delta \\ \Delta-Y \end{matrix}$$

((Balanced system))

Y ← Δ ← التركيز على ال load

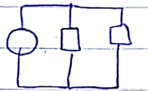
>> Single phase - 3wires system ▷ يعني إلهم نفس ال phase





series

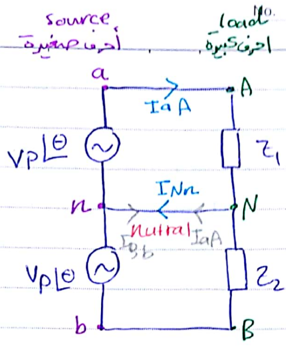
↳ هنا إذا اي ال load لم يعد يعمل تقف الدارة كلها



parallel

↳ هنا نحتاج تيار كبير حتى نوصل للفولتية المطلوبة

Scanned by CamScanner



- IaA
- INn
- $V_{an} = V_p\angle\theta$
- $V_{bn} = -V_{nb} = -V_p\angle\theta$
- $V_{NB} = V_{nb} = V_p\angle\theta$

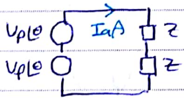
$(V_{AN} = V_{an})$

- $I_{aA} = \frac{V_{an}}{Z_1} = \frac{V_p\angle\theta}{Z_1}$

- $V_{AN} = V_{an} = V_p\angle\theta$
- $V_{NB} = V_{nb} = V_p\angle\theta$

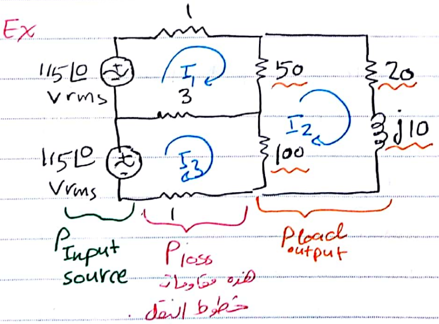
- $I_{Bb} = \frac{V_{nb}}{Z_2} = \frac{V_p\angle\theta}{Z_2}$

- $I_{nN} = I_{Bb} - I_{aA}$
- If $Z_1 = Z_2$
  - $I_{Bb} = I_{aA}$ لانهم مثل التوالي.
  - $\boxed{I_{nN} = 0}$ (Balanced system)



- $I_{aA} = \frac{Z\ V_p\angle\theta}{Z\ Z} = \frac{V_p\angle\theta}{Z}$

Ex



①$115 = I_1 + 50(I_1 - I_2) + 3(I_1 - I_3)$

②$115 = 3(I_3 - I_1) + 100(I_3 - I_2) + I_3$

③$50(I_2 - I_1) + (20 + j10\ I_2 + 100(I_2 - I_3) = 0$

- $I_1 = 11.24\angle -19.8$ A
- $I_2 = 9.4\angle -24.47$
- $I_3 = 10.37\angle -2\ 1.8$ A

$I_1 - I_2 = \underline{A}\angle\theta$

عند تربيع $(I_1 - I_2)^2$ نأخذ $(A)^2$ فقط يعني الناتج بعد طرحهم

No.

$P_{load} = P_o$

- $P_{50} = |I_1 - I_2|^2 \, 50 = 206\,w$
- $P_{100} = |I_3 - I_2|^2 \, 100 = 117\,w$
- $P_{20} = (I_2)^2 \, 20 = (9.4)^2 (20) = 17.63\,w$

$P_o = P_{load} = 2086\,w$

مجموعهم

- $P_{loss} \rightarrow P_1 = |I_1|^2 (1) = (11.24)^2 (1) = 126\,w$
  - $\rightarrow P_2 = |I_1 - I_3|^2 (3) = 3\,w$
  - $\rightarrow P_3 = |I_3|^2 (1) = 108\,w$

$P_{loss} = 126 + 108 + 3$
$= 237\,w$

مجموعهم

- $P_{in} = P_{s_1} + P_{s_2}$
  - $P_{s_1} = |V||I_1| \cos(\theta - \phi) = (115)(11.24)\cos(0 + 19.8) = 1216\,w$
  - $P_{s2} = |V||I_3| \cos(\theta - \phi) = 1107\,w$

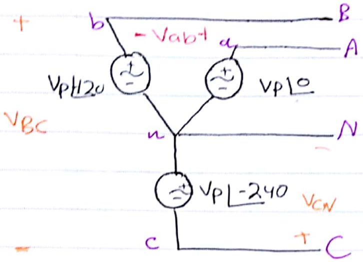
>> $P_{in} = P_o + P_{loss} = \underline{\underline{2323\,w}}$

$\eta = \frac{P_o}{P_{in}} \times 100\% = \frac{2086}{2323} \times 100\% = \underline{\underline{89.8\%}}$

الرقم ~~[illegible]~~ كرادني
40 - 50

No. 17.10.2018

(12-3) 3Φ - Y connection



- phase voltages:
  - Voltage between line and nutral
    V_{an} , V_{bn} , V_{cn}

⊕ sequence (abc)	⊖ sequence (cba)
$V_{an} = V_p \angle 0$	$V_{an} = V_p \angle 0$
$V_{bn} = V_p \angle -120$	$V_{bn} = V_p \angle 120$
$V_{cn} = V_p \angle -240$	$V_{cn} = V_p \angle 240$

-120   120

$|V_{an}| = |V_{bn}| = |V_{cn}| = V_p$

$V_{an} + V_{bn} + V_{cn} = 0$

- line Voltage :-
  - Voltage between two line
    V_{ab} , V_{bc} , V_{cn} ⊕

$V_{ab} = V_{an} - V_{bn}$

$V_{ab} = V_p \angle 0 - V_p \angle -120$

$\boxed{V_{ab} = \sqrt{3} V_p \angle 30}$

$V_{bc} = V_{bn} - V_{cn}$

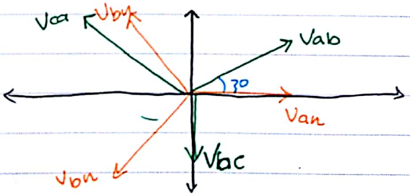
$\boxed{V_{bc} = \sqrt{3} V_p \angle -90}$

$V_{ca} = V_{cn} - V_{an}$

$\boxed{V_{ca} = \sqrt{3} V_p \angle -210}$

$|V_{ab}| = |V_{bc}| = |V_{cn}| = \sqrt{3} V_p = V_L \rightarrow V_L = \sqrt{3} V_p$

>> line voltage <u>lead</u> phase voltage by <u>30°</u>



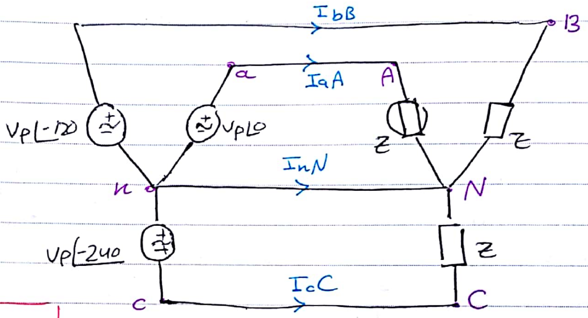
⊖ sequence

$V_{ab} = \sqrt{3}\, V_P \angle -30$ $\Big)$ $+120$

$V_{bc} = \sqrt{3}\, V_P \angle +90$

$V_{ca} = \sqrt{3}\, V_P \angle 210$

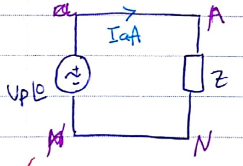
line Voltag lage phase Volrage by 30° for ⊖ sequence



$\boxed{Y-Y}$

$(I_L = I_P)$

per phase



Van = VAN

في حالة وجود (R)

تكون Van ≠ VAN

$I_{aA} = \dfrac{V_{an}}{Z} = \dfrac{V_P\angle 0}{Z}$

$I_{bB} = \dfrac{V_{bn}}{Z} = \dfrac{V_P\angle -120}{Z}$

$I_{cC} = \dfrac{V_{cn}}{Z} = \dfrac{V_P\angle -240}{Z}$

$|I_{aA}| = |I_{bB}| = |I_{cC}| = I_L = I_P = \dfrac{V_P}{|Z|}$

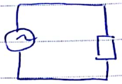
$\rightarrow I_{nN} = I_{aA} + I_{bB} + I_{cC} = 0$ (For balanced)

$P_{loss\,N} = 0 \rightarrow I_N = 0$

No.

Ex Find phase, line voltages and currents, Total power dissipated by the load for 3Q (Y-Y) connection If $\underset{\text{phase}}{V_{an}} = 200\angle 0$ Vrms , $Z_L = 100\angle 60\ \Omega$ ⊕ sequence.

$$\left.\begin{aligned} V_{an} &= 200\angle 0 \\ V_{bn} &= 200\angle -120 \\ V_{cn} &= 200\angle -240 \end{aligned}\right\} \text{phase Voltage}$$



$$\boxed{I_L = I_p}$$

$V_L = \sqrt{3}\,V_p = \sqrt{3}\ 200$

$V_{ab} = \sqrt{3}\,\cancel{V}_p \angle 30$

$$\left.\begin{aligned} V_{ab} &= \sqrt{3}\ 200\angle 30 \quad \Big)\ -120 \\ V_{bc} &= \sqrt{3}\ 200\angle -90 \quad \Big)\ -120 \\ V_{ca} &= \sqrt{3}\ 200\angle -210 \end{aligned}\right\} \text{Line voltage}$$

$I_{aA} = \frac{V_{an}}{Z} = \frac{200\angle 0}{100\angle 60}$

$I_{aA} = 2\angle -60$ $\Big)\ -120$

$I_{bB} = 2\angle -180$ $\Big)\ -120$

$I_{cC} = 2\angle -300$

$P_{phase} = |V_P|\,|I|\cos(\theta - \varphi) = (200)(2)\cos(60) = 200\ W$

$P_{total} = 3 * 200 = 600$

$\Rightarrow P_{phase} = V_p I_p \cos(\theta - \varphi)$

$\Rightarrow P_{total} = 3 * V_p I_p \cos(\theta - \varphi) = 3 * P_{phase}$

(OR) $\Rightarrow P_{phase} = \frac{V_L}{\sqrt{3}} I_L \cos(\theta - \varphi)$

$$\Rightarrow \boxed{P_{total} = 3P_{phase} = \sqrt{3}\ V_L I_L \cos(\theta - \varphi).}$$

No.

Ex Balanced 3Φ (Y-Y) $\boxed{V_L = 300\,V}$ supplying total load with 1200w at 0.8 Leading p.F find I_L, per phase Impedance. → (Z)

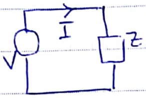
phase نحولها إلى

لأنه في (Y-Y) لا نحتاج (VL)

اعطانا (total) فنقسمها على (3)

وهذه (P) لل 3load ويكون

لكل (per load)



(1) $V_L = \sqrt{3}\, V_P$

$V_P = \frac{V_L}{\sqrt{3}} = \frac{300}{\sqrt{3}}$

$P_{phase} = \frac{P_{total}}{3} = V_P I_P\, p.F$

$\frac{1200}{3} = \frac{300}{\sqrt{3}} I_P (0.8) \rightarrow \boxed{I_P = I_L = 2.9\,A}$

(2) $Z = \frac{V_P}{I_P} \angle \theta - \varphi \rightarrow Z = \frac{300/\sqrt{3}}{2.9} \angle -\cos^{-1}(p.F)$

$\pm \cos^{-1}(p.F)$; + → lag ; − → lead

$\boxed{Z = 60 \angle -36.87\,\Omega}$

إضافي (3) I_{aA}, I_{bB}, I_{cC}, V_{ab}, V_{bn} ⊕ sequence

$\{V_L = 300\}$

- $V_{ab} = 300 \angle 0$
- $V_{bc} = 300 \angle -120$) −120
- $V_{ca} = 300 \angle -240$

line Voltage

$\{V_P = \frac{300}{\sqrt{3}}\}$

- $V_{an} = \frac{300}{\sqrt{3}} \angle -30$
- $V_{bn} = \frac{300}{\sqrt{3}} \angle -150$) −120
- $V_{cn} = \frac{300}{\sqrt{3}} \angle -270$

phase Voltage

$$\boxed{\theta_P + 30^\circ = \theta_L}$$

$I_L = I_P$

$I_{aA} = 2.9 \angle 6.87$

$I_{bB} = 2.9 \angle 6.87$) −120 −120

$\cos(\theta - \varphi) = 0.8$

زاوية $\underline{\theta}$ − φ = ⊖36.87 → leading

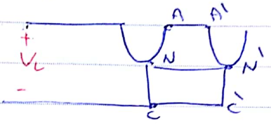
phase

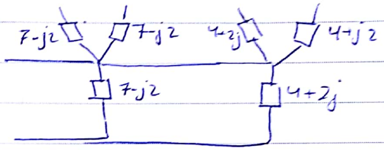
Van = −30

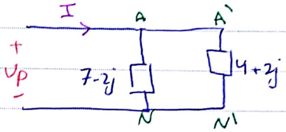
$\underline{\varphi = 6.87}$

No. 22.10.2018

Ex (V_L = 500 v), 2 ballanced parallel Y connected load to 3φ system, one is capacitive (7-j2 Ω) the other is Inductive (4+2j Ω) Find Vp, I_L, total power by the source, PF







- $V_p = \frac{V_L}{\sqrt{3}} = \frac{500}{\sqrt{3}}$ V

$I_L = I_p$

- $Z_{eq} = (7-j2) // (4+j2) = 3 \angle 10.65 \ \Omega$

- $V_L = 500 \angle 0 \xrightarrow{} V_p = \frac{500}{\sqrt{3}} \angle -30$

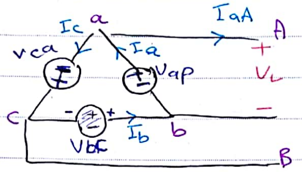
$I_L = I_p = \frac{V_p}{|Z|} = \frac{500/\sqrt{3}}{3} = 97.5$

- $I_{aA} = \frac{V_p \angle -30}{Z} = \frac{500/\sqrt{3} \angle -30}{3 \angle 10.65} = 97.5 \angle -40.65$

- $P_t = 3 \text{ phase} = (3)(V_p)(I_p)\cos(\theta) = (3)\left(\frac{500}{\sqrt{3}}\right)(97.5)\cos(10.65)$
$= 83 \text{ K}\omega$

- $pf = \cos(10.65) = 0983$ lagging

Δ → Source



$\boxed{V_L = V_p}$

⊕ sequence Δ

- phase current

$I_a = I_p \angle 0$
$I_b = I_p \angle -120$
$I_c = I_p \angle -240$

-120

- line current

$I_{aA} = \sqrt{3} I_p \angle -30$
$I_{bB} = \sqrt{3} I_p \angle -150$
$I_{cC} = \sqrt{3} I_p \angle -270$

-120

$\boxed{I_L = \sqrt{3} I_p}$

≫ line currents lag phase current by 30°

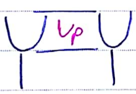
⊖ sequence

$I_a = I_p \angle 0$
$I_b = I_p \angle 120$
$I_c = I_p \angle 240$

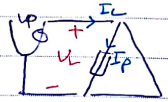
} phase

$I_{aA} = \sqrt{3} I_p \angle 30$
$I_{bB} = \sqrt{3} I_p \angle 150$
$I_{cC} = \sqrt{3} I_p \angle 270$

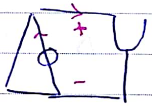
} line



هنا نحتاج (Vp)

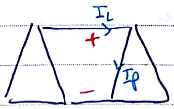


هنا ما بنغيرها ولا نحتاج
(Van)



$V_L \ , \ I_p = \frac{V_L}{Z}$

$I_L = \sqrt{3} I_p$



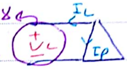
No.

In 3Ø system Line Voltage of (300 V) supplied total power (1200 w) to Δ load at 0.8, lagging p.f

Find I_L, Z.

$V_L = V_p = 300\ V$

لا نهتم لمصدر الفولتية سواء كان Y او Δ المهم ان (V_L) معلومة



$P_{phase} = \frac{P_t}{3} = V_p I_p\ p.f$

$\left(\frac{1200}{3}\right) = (300)\ I_p\ (0.8)$

$I_p = 1.67\ A$

$I_L = \sqrt{3}\ I_p = 2.9\ A$

$Z = \frac{V_p}{I_p} \angle \boxed{+} \cos^{-1} pF$ Lagging $\longrightarrow Z = \frac{300}{1.67} \angle + \cos^{-1} pF$

$Z = 180 \angle 36.87\ \Omega$

$I_{AB} = \underset{I_p}{1.67} \angle$ PF من (الزاوية نحسبها) $\rightsquigarrow pf = \cos(\theta - \Phi) = 0.8$

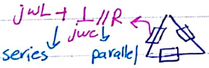
$\cancel{\theta} - \Phi = \cos^{-1} 0.8 \longrightarrow \Phi = -36.87$

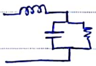
$I_{aA} = 2.9 \angle -66.87$ $\xleftarrow{-30}$

Ex Δ connected Load, Consist of 200 mH in series with parallel 5 μF and 200 Ω, $V_p = 200$ V, $w = 400$ rad/s

Find I_p, I_L, total power

$j\omega L + \frac{1}{j\omega C} // R$





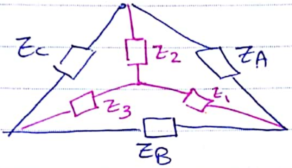
- $Z_{eq} = j\omega L + \frac{1}{j\omega C} // R$

  $Z_{eq} = 172.75 \angle 3.66\ \Omega$
- $V_p = V_L = 200\ V$
- $I_p = \frac{V_p}{|Z|} = \frac{200}{172.75} = 1.158\ A$
- $I_{AB} = 1.158 \angle -3.66$
- $I_L = \sqrt{3}\ I_p \longrightarrow \boxed{I_L = 2A}$
- $I_{aA} = 2 \angle -53.66 A$

-30

- $P_t = 3 . P_{pahase} = (3)(200)(1.158) \cos(3.66)$

  $P_t = 693\ w$



* الأفضل ان نحول من (Y ← Δ)
لأن Y أسهل الحل عليها

$Y \rightarrow \Delta$

- $Z_A = \dfrac{Z_1 Z_2 + Z_1 Z_3 + Z_2 Z_3}{Z_3}$
- $Z_B = \dfrac{Z_1 Z_2 + Z_1 Z_3 + Z_2 Z_3}{Z_2}$
- $Z_C = \dfrac{Z_1 Z_2 + Z_1 Z_3 + Z_2 Z_3}{Z_1}$

$\boxed{Z_\Delta = 3 Z_Y}$

$\Delta \rightarrow Y$

- $Z_1 = \dfrac{Z_A Z_B}{Z_A + Z_B + Z_C}$
- $Z_2 = \dfrac{Z_A Z_C}{Z_A + Z_B + Z_C}$
- $Z_3 = \dfrac{Z_B Z_C}{Z_A + Z_B + Z_C}$

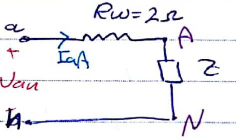
$\boxed{Z_Y = \dfrac{Z_\Delta}{3}}$

Q(16) 7th book

If $V_{an} = 2300 \angle 0$ balanced Y – Y $\underbrace{R_w = 2\,\Omega}$ (wire resistance) ⊕ sequence total power suplied by the source $\overset{P_{in}}{100} + j\,\overset{Q_{in}}{30}$ k VA find I_{aA}, V_{AN}, Z, η

(1) $I_{aA} = \dfrac{V_{an}}{Z + R_w}$ ↳ V_{AN} Voltage at the load end

V_{an} → Voltage at the source end



$S_{perphase} = \dfrac{S_{total}}{3} = V_{an} I_{aA}^*$

$\dfrac{100 + j30\,k}{3} = (2300 \angle 0)\, I_{aA}^*$

$I_{aA} = 15.13 \angle -16.7$ A → نعوض I كاملة مع الزاوية وليس peak فقط

KVL → (2) $V_{AN} = V_{an} - I_{aA} R_w \longrightarrow V_{AN} = 2271 \angle 0.219$ V

(3) $Z = \dfrac{V_{AN}}{I_{aA}} = 150 \angle 17\ \Omega = 143.3 + j44.3$

(4) $\eta = \dfrac{\text{out power}}{\text{input power}} \times 100\% = \dfrac{P_{load}}{P_{in}} \times 100\%$ → ■ $P_{load} = V_{AN} I_{aA} = P_o$

$= (2271)(15.13)\cos(17)$

OR $= (15.13)^2 (143.3)$

$= \underline{32.87\,k}$ perphase

$\eta = \dfrac{32.87\,k}{(100k/3)} = 98.6\,\%$

$P_{loss} = |I_{aA}|^2 R_W \times 3$

لو اخذنا (total) نضربها بـ(3) وناخذ Pin=100 فقط

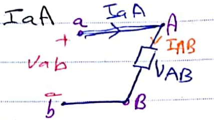
No. 24. 10. 2018

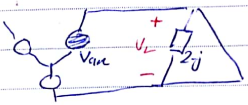
Q.25 7th Book

Balanced 3wires, 3ϕ Y - Δ $\boxed{R_w=0}$ → Rwire

$V_{an}=200\angle 60$, power per phase = 2-j KVA ⊕ sequence

Find V_{bc}, Z, I_{aA}





phase ⇒ $V_{an}=200\angle 60$) +30

line ⇒ $V_{ab}=200\sqrt{3}\angle 90$) −120

$V_{bc}=200\sqrt{3}\angle -30$

$I_{aA}=\frac{V_{ab}}{Z}$ → لا نستخدم هذا القانون لإن غير موجودة (Z)

$S=V_{AB}I^{*}_{AB} \longrightarrow 2000-j1000=(200\sqrt{3}\angle 90)\,I^{*}_{AB}$

$I_{AB}=6.47\angle 116.566$ → phase current

$I_{aA}=\sqrt{3}\;6.44\angle 116.566\;(-30)$ لكن المطلوب Line current لذلك نطرح -30

$I_{aA}=11.2\angle 86.57$ A → line current

$Z=\frac{V_{AB}}{I_{AB}}=\frac{200\sqrt{3}\angle 90}{6.47\angle 110.565}=53.67\angle -26.57\,\Omega$

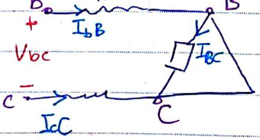
Q 26 Δ load Requires = 15 KV/A at 0.8 lagging p.F ⊕ Sequence

(معنى ال load) on $V_{BC}=180\angle 30$, $R_w=0.75\,\Omega$ *هنا لا يهمنا ال source (Y, Δ) لا يوجد analysis عليه

Find V_{bc}, total complex power generating by the source

بسبب وجود (R_w) ≠ (معنى ال source)

لو لم تكن موجودة $V_{BC}=V_{bc}$ لأنها Δ



7'th ⇒ 11 / 17 / 21 / 23 / 26 / 28 / 30 / 31
8th ⇒ 3 / 4 / 5 / 12 / 15 / 19 / 27 / 30 / 31

$\boxed{Q\ 12.13}$

No.

S - small = Papp ↩ $\underline{\underline{S}}_{load\ per\ phase} = \frac{15\ k}{3} = 5\ K$

S-Capital = complex power ↩ $\underline{\underline{S}}_{load} = P_{app} \angle \overset{lag}{\oplus} \underset{lead}{\ominus} \cos^{-1} pF$

$= 5 \angle 36.87 = V_{BE}\ I^{*}_{BC}$ phase أيضا (I_{AB}, I_{CA})

$I_{BC} = 27.78 \angle -6.87 \rightarrow$ phase current

$I_{bB} = 27.78\ \sqrt{3} \angle -6.87 \ \boxed{-30}$ للتحويل لـ line

$I_{bB} = 48 \angle -36.87$
$I_{cC} = 48 \angle -156.87$ -120

$V_{bc} = I_{bB} R_w + V_{BC} - I_{cC} R_w$

$V_{bc} = 233 \angle 120.74\ V$

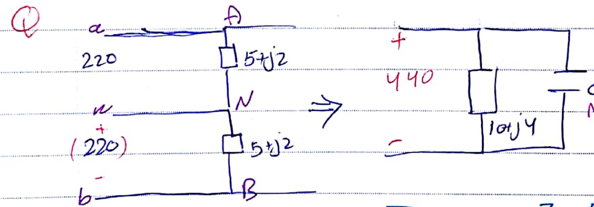
Complex ↩ $\underline{\underline{S}}_{input} = S_{load} + S_{line}$ نضرب بـ(٣) لانه الـ total المطلوب

$= 15\ K \angle \cos^{-1} P.F + \boxed{3}\ I_L R_w$

$= 15\ K \angle \cos^{-1} P.F + 3(48)^2 (0.75) = 15K \angle \cos^{-1} P.F + 5208$

$S_{in} = 17.2 + j9\ KVA$

Q



* Balanced sing/phase
VAN = 220V , 60 Hz
عادة بـ Balanced نزيل خط N
ونجمع الـ Source والـ (load)

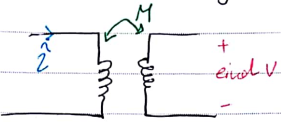
$Z_{eq} = R + jX \rightarrow X = 0\ \boxed{at\ w_0}$ * حتى نحصل على (unity P.F) يعني $Z_{eq} = R$

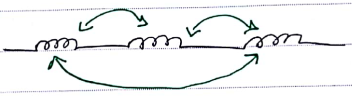
$Y_{in} = \frac{1}{10+4j} + jwc \rightarrow \frac{10-j4}{10-j4} \cdot \frac{1}{10+j4} + jwc$

$\frac{10-j4}{116} + jwc \rightarrow \frac{10}{116} + j\left(wc - \frac{4}{116}\right)$.

2πf
2π60 ↩ $\boxed{w} c - \frac{4}{116} = 0 \rightarrow C = 91.5\ MF$

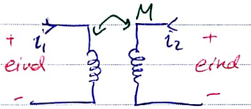
CH 13 << Magnetically capled circuit >>





- M: Mutual Inductance

To describe the Voltage in a coil due to the current Pass through another coil (current - carrying wire) Produce flux around



$$e_{ind} = M \frac{di_1}{dt}$$

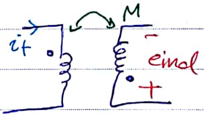
$$M_{12} = \frac{di_1}{dt}$$

$$M_{21} = \frac{di_2}{dt}$$

$$\boxed{M_{12} = M_{21} = M}$$

>> Dot convention → وضعنا نقطة لتحديد اتجاه التيار، والفولتيج

- If the current enters the dott - end → eind ⊕ at dotted - end

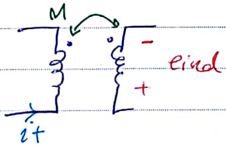


هنا التيار داخل في ال dott

فنضع موجب عند ال dott

- If the current enters undotted - eind

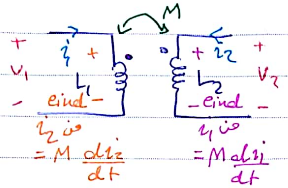
eind ⊖ at undotted - end

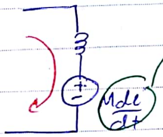


هنا التيار داخل في undott

فنضع الموجب عند undott

Ex





* أصبحت ال eind
وكأنها مصدر موجود
على التوالي مع الملف

$$V_1(t) = \underbrace{L_1\frac{di_1}{dt}}_{} + \underbrace{M\frac{di_2}{dt}}_{}$$

فولتية ناتجة من مرور
تيار في (L) ذاتية *

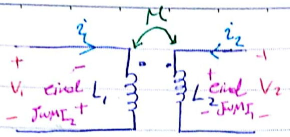
فولتية ناتجة
من تأثير (i_2)
عليه (eind)

$$V_2(t) = L_2\frac{di_2}{dt} + M\frac{di_1}{dt}$$

$$V_1 = j\omega L_1 I_1 + j\omega M I_2$$

$$V_2 = j\omega L_2 I_2 + j\omega M I_1$$

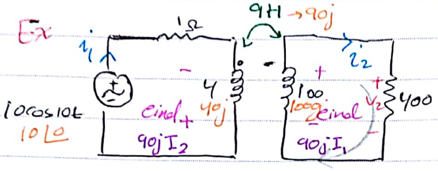
No. 31. 10 . 2018



$V_1 = j\omega L_1 I_1 + j\omega M I_2$

$V_2 = j\omega L_2 I_2 - j\omega M I_1$

Ex



-Find V_2 ??

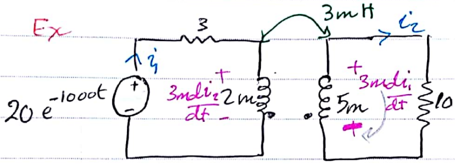
$\omega = 10$

$400 i_2 + j1000 I_2 - j90 I_1 = 0 \dashrightarrow ①$

$I_1 + 40j I_1 - 90j I_2 = 10\angle 0 \longrightarrow ②$

$V_2 = 400 I_2$

Ex



* هذه المعادلات لا تحل إلا ب diff-equ

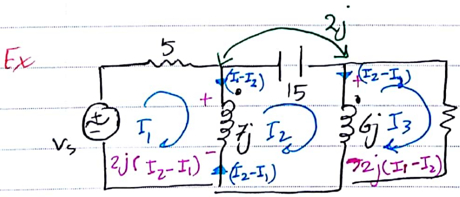
ولا يمكن ان نحول إلى phasor

وذلك لأن الـ soure ليس (sinusoidal)

$① \dashleftarrow 20e^{-1000t} = 3i_1 + 2m\frac{di_1}{dt} - 3m\frac{di_2}{dt}$ ($\mathcal{L}$) وفي مثل هذا النوع نحول إلى

$② \longleftarrow 10i_2 + 5m\frac{di_2}{dt} - 3m\frac{di_1}{dt} = 0$

Ex



المعادلات في (Time domain)

$$\begin{cases} V_s = 5i_1 + \frac{3d(i_1-i_2)}{dt} + 2\frac{d(i_2-i_3)}{dt} \\ \frac{1}{c}\int i_2 + 6\frac{d(i_2-i_3)}{dt} + 7d\frac{i_2-i_3}{dt} \end{cases}$$

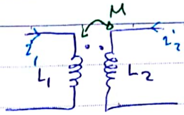
المعادلات في الـ phasor Domain

$$\begin{cases} V_s = 5I_1 + j7(I_1-I_2) + j2(I_2-I_3) \dashrightarrow ① \\ -jI_2 + j6(I_2-I_3) + j7(I_2-I_1) + j2(I_1-I_2) - j2(I_2-I_3) = 0 \rightarrow ② \\ 3I_3 + j6(I_3-I_2) - j2(I_1-I_2) = 0 \dashrightarrow ③ \end{cases}$$

No.

$$w_C = \frac{1}{2} C V^2$$

$$w_L = \frac{1}{2} L I^2$$



(w_L)

هي الطاقة المخزنة في L

$$\boxed{w_L(t) = \frac{1}{2} L_1 i_1^2(t) + \frac{1}{2} L_2 i_2^2(t) \pm M\, i_1(t)\, i_2(t)}$$

اذا كانوا متشابهين يعني سوا داخلين او طالعين تكون ⊕

↳ ⊕ i_1, i_2 → enter or leav dott

اذا كانوا مختلفين يعني واحد داخل والثاني طالع او العكس ⊖

↳ ⊖ i_1 enter dot and i_2 leaves dot

oR i_1 leaves dot and i_2 enter dot

$$(\quad)(\quad) \geq 0$$

$$\boxed{M = k\sqrt{L_1 L_2}}$$

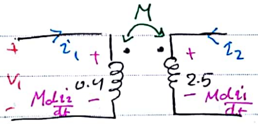
- K : constant coupling coefficent

$$0 \leq K \leq 1$$

0 ↙ No coupling

1 ↘ Tightly coupled.

Ex



$$i_1 = 4 i_2 = 20\cos(500t - 30) \quad mA$$

$$i_2(t) = 5\cos(\underline{500t} - \underline{20}) \quad mA$$

$K = 0.6$

نعوض (0) ↳ $i_2(0) = 4.7\, mA$

↪ الانتباه لتحويل الزوايا

لانهم مختلفين (rad - Deg)

$$M = k\sqrt{L_1 L_2} \rightarrow M = 0.6\, H$$

$$V_1 = 0.4 \frac{di_1}{dt} + 0.6 \frac{di_2}{dt} \xrightarrow{\text{نعوض (0)}} V_1(0) = 1.88\, V$$

$$w_L(t) = \frac{1}{2} L_1 I_1^2 + \frac{1}{2} L_2 i_2^2 + M\, d_i\, i_2$$

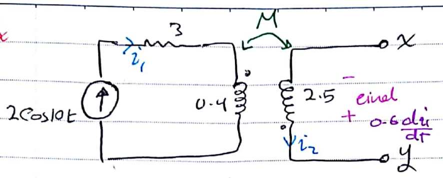
$$= \left(\frac{1}{2}\right)(0.4)(20\cos(500t - 20))^2$$

$$w_L(0) = 151\, \mu J$$

smile for life

Scanned by CamScanner

Ex



$M = K\sqrt{L_1 L_2}$

$= 0.6\,H$

K=0.6

(1) $w_L(0)$, If x , y open $\boxed{i_2=0}$ (open) ـــ يعتبر التيار =0

$w_L(t)=\frac{1}{2}L_1 i_1^2$, $\xrightarrow{\text{نعوض (0)}}$ $w_L(0)=0.8\,J$

(2) $w_L(0)$, If x , y shorted.

Shorted

$e_{ind}=0.6\frac{di_1}{dt}=-12\sin 10t$

$2.5\frac{di_2}{dt}\underbrace{-0.6\frac{di_1}{dt}}_{e_{ind}}=0$

$2.5\frac{di_2}{dt}=-12\sin 10t \xrightarrow{\text{تكامل}} i_2=\frac{-12}{2.5}\int \sin 10t$

$\boxed{i_2(t)=0.48\cos 10t}$

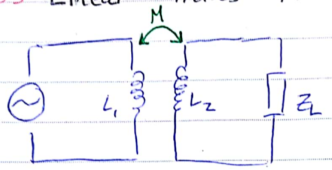
$w_L(t)=\frac{1}{2}L_1 i_1^2+\frac{1}{2}L_2 i_2^2-M d_1 L_2$

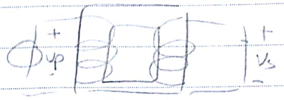
$w_L(0)=0.512\,J$ قلت الـ (w) لانه التيارات بعكس بعض

$$\left\{\begin{matrix} j25I_2-j6I_1=0 \\ e_{ind}=j6I_1 \end{matrix}\right\} \rightarrow \text{in phasor}$$

No. 5.11.2018

13.3 Linear Transformer

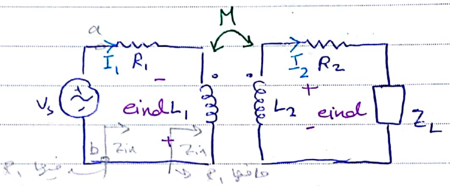




Transformer

primary side   secondary side

Transformer



Zin = $R_1 + j\omega L_1$

لوما في مشترك (M)

تكون توالي.

اذا ازدادت (Z)

($\frac{V}{I}$)

$V_s = I_1 R_1 + j\omega L_1 I_1 - j\omega M I_2$ ---- ①

$R_2 I_2 + Z_L I_2 + j\omega L_2 I_2 - j\omega M I_1 = 0$ --- ②

$(R_2 + j\omega L_2 + Z_L) I_2 = j\omega M I_1$

$$V_s = (R_1 + j\omega L_1) I_1 - j\omega M \frac{j\omega M I_1}{R_2 + j\omega L_2 + Z_L}$$

$$\frac{V_s}{I_1} = (R_1 + j\omega L_1) + \frac{\omega^2 M^2}{R_2 + j\omega L_2 + Z_L} \rightarrow$$ Reflected Impedance from Secondary to primary

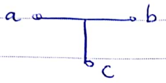
- $M = 0 \rightarrow Zin = R_1 + j\omega L_1$

$$\boxed{Zin = Z_{11} + \frac{\omega^2 M^2}{Z_{22}}}$$

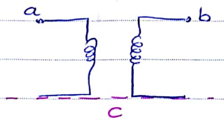
$$Zin = \left(j\omega L_1 \left(\frac{\omega^2 M^2}{j\omega L_2 + R_2 + Z_L}\right)\right) // Z + R$$

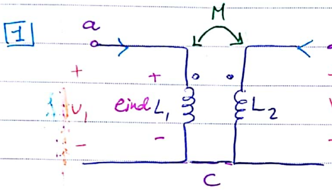
No.

» T-model «



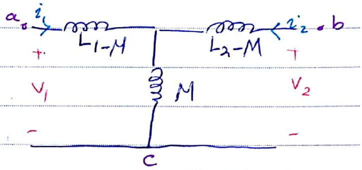
» π-model «





$\Longrightarrow$

نحولها إلى (T)



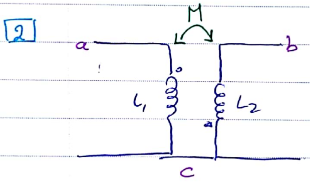
جمع لان التيارين داخلين في النود

■ $V_1 = j\omega L_1 I_1 + j\omega M I_2$

$V_1 = j\omega(L-M)\,I_1 + j\omega M\underbrace{(I_1+I_2)}$

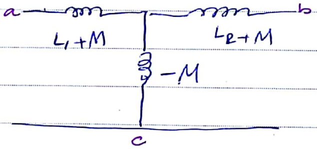
نفس الشئ

■ $V_1 = j\omega L_1 I_1 + j\omega M I_2$



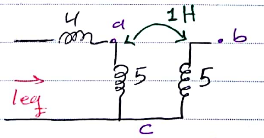
$\Longrightarrow$

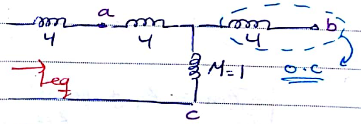
نحولها إلى (T)



* في الحالة ← [1] إذا كانوا الـ(dot) في نفس الإتجاه ← ⊕M ونطرح (L − M)
  ← [2] إذا كانوا الـ(dot) مختلفين بالاتجاه ← ⊖M ونضع (L + M)

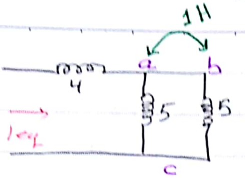
Ex

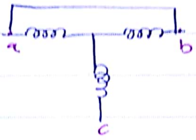


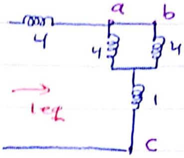


$\therefore L_{eq} = 4+4+1 = 9$

Ex

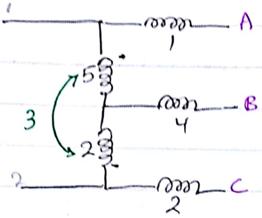


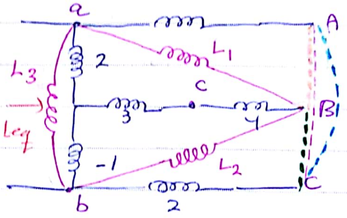




Leq = 4//4 + 1+4 = 7H

Ex
Q35
7th book

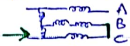




Leq = 2-1 = 1H

- 🟧 AB shorted → Leq = (1+4+3) // 2 - 1 = 0.6 H →

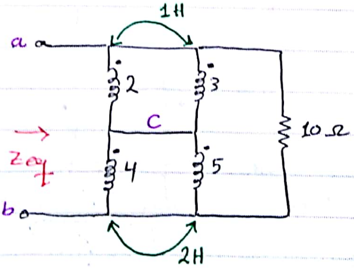
- 🟩 BC Shorted → Leq = (3+4+2)// -1 + 2 = 0.875 H →

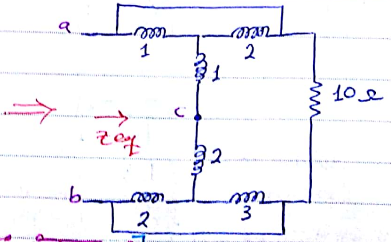


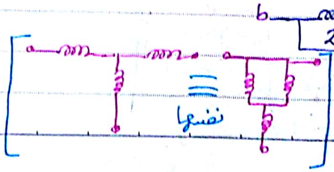
- 🟦 AC shorted → Leq = (1+2) // (3-1) = 0.75 H →

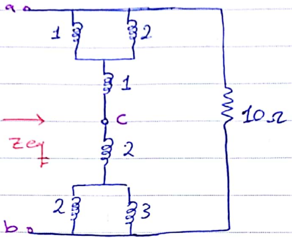
- 🟪 ABC shorted → Leq = (L1 //1)+ (L2//2) // L3 بعد آن نحول الى (Δ)

Ex







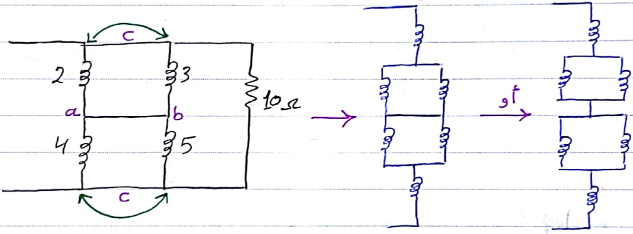


- $L_{eq} = 1//2 + 1 + 2 + 2//3$
  $= 4.8\ H$

- $Z_{eq} = j\omega L_{eq} // 10$
  $=$

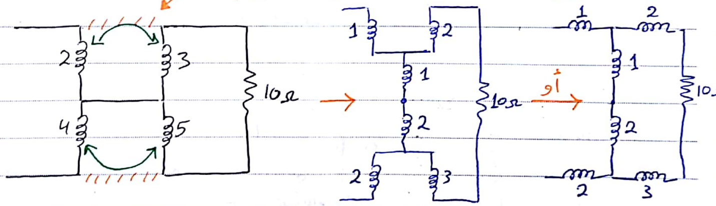
* لو أعتبرنا (c) فوق و (a,b) تحت نفس الرسمة ولكن بالعكس

Ex



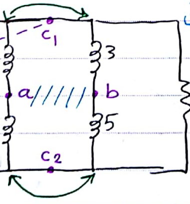
* لو كان لا يوجد خطوط من الأعلى والاسفل تصل بينهم

Ex

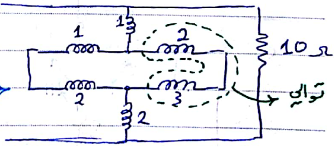


Ex

هنا من الضروري وضع (C) هنا لانها النقطة الوحيدة المشتركة.



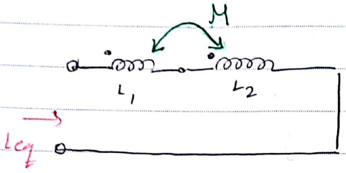
*لو كان هناك فراغ بالوسط

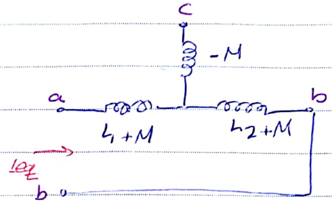


$(2+3)//(1+2) + 1 + 2$

No. 7.11.2018

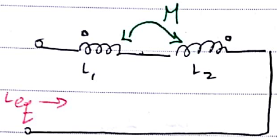
Ex





$L_{eq} = L_1 + M + L_2 + M = L_1 + L_2 + 2M$

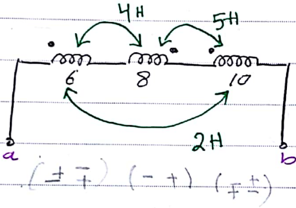
Ex



$L_{eq} = L_1 - M + L_2 - M$

$= L_1 + L_2 - 2M$

Ex

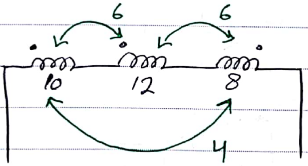


$L_{eq} = 6-4+2+8-4-5+10-5+2$

$= 10$ H

or use $V_L = L\frac{di}{dt}$

H.w



$= 22$H

No.

chapter (14) (Complex frequency)

$v(t) = V_m \cos \omega t + \theta$

$v(t) = \text{Real} \{ V_m e^{j(\omega t + \theta)} \}$

$= \text{Real} \{ V_m e^{j\omega t} e^{j\theta} \}$

$A + jB$

$S = \delta + j\omega$

- s : complex frequency (s^{-1})
- δ : neper frequency (neper/s)
- ω : angular frequency (rad/s) → $\omega = 2\pi f$
- f : frequency (HZ) or $(\frac{1}{s})$

>> $f(t) = K e^{st}$ $s = \delta + j\omega$

$\boxed{1}$ $S = 0$:

$f(t) = K$ $\cos \omega t$ (Dc source)

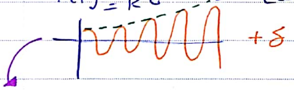
$\boxed{2}$ $S = \delta$:

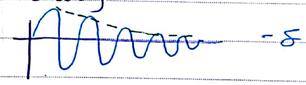
$f(t) = K e^{\delta t}$ → $+\delta$ (increasing)

exponentail → $-\delta$ (decreasing)

$\boxed{3}$ $S = j\omega$:

$f(t) = K e^{j\omega} = K [\cos \omega t + j \sin \omega t] \rightarrow \sin$





$\boxed{4}$ $S = \delta + j\omega$:

$f(t) = K e^{(\delta + j\omega)t} = K e^{\delta t} [\cos \omega t + j \sin \omega t$

Damped sin

smile for life

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No.

$\gg v(t) = V_m \cos(\omega t + \theta)$

$= \frac{V_m}{2}\left[e^{j(\omega t+\theta)} + e^{-j(\omega t+\theta)}\right]$

$= \left[e^{j\omega t} e^{j\theta} + e^{-j\omega t} e^{-j\theta}\right]$

$* \; S = \pm j\omega \rightarrow s_1 = +j\omega$

$\qquad\qquad\quad \rightarrow s_2 = -j\omega$

$- \; v(t) = 2 \sin 5t \rightarrow S = \pm 5j$

Ex $\cos(10t + 50) \rightarrow S = \pm j10$

$s(t) = \left(\underset{-100}{3 e^{-100t}} + \underset{-200}{e^{-200t}}\right) \sin 2000t \qquad \pm j2000$

$\left(\frac{e^{j2000t} - e^{-j2000t}}{2J}\right)$

$\underline{S} \downarrow$

$(-100 + j2000)$, $(-100 - j2000)$

$(-200 + j2000)$, $(-2000 - j2000)$

$* \; e^{j2} \rightarrow$ phase

$* \; e^{j2t} \rightarrow$ frequency ω

$* \; e^{2t} \rightarrow \delta$

$* \; e^{2} \rightarrow$ Constant

Ex $(2 . e^{-10t}) \underbrace{\cos(4t+30)}$ $\pm j4$

$2\cos(4t+30) - e^{-j10t} \cos 4t + 30$

$(+j4)$, $(-j4)$, $(-10+j4)$, $(-10-j4)$

Ex constanct atime domain signals

(1) $S = 0$, 10^{δ} , -10^{δ} $\quad s^{-1}$

$v(t) = A + Be^{10t} + Ce^{-10t}$

(2) $s = -5^{\delta}$, $j\omega 8$, $-5-j8$ $\quad s^{-1}$ $\qquad \left[s = (\delta + j\omega)t\right]$

$v(t) = Ae^{-st} + \underbrace{B\cos(8t+\theta)}_{B\sin(8t)} + Ce^{-st}\cos(8t)$

No.

Ex $V = 12 \angle 35$ V , Find $v(t)$??

(1) $s = 0$ $\rightarrow$ $\delta = 0$, $\omega = 0$

$v(t) = A e^{\delta t} \cos(\omega t + \theta)$

$v(t) = 12 e^{0t} \cos(0t + 35)$

$v(t) = 12 \cos(35) = 9.8$ V

(2) $s = -20 \; s^{-1}$

$v(t) = 12 e^{-20t} \cos(0t + 35)$

$v(t) = 9.8 e^{-20t}$

(3) $s = j5$

$v(t) = 12 \cos(5t + 35)$

(4) $s = 20 + j5$

$v(t) = 12 e^{-20t} \cos(5t + 35)$

مادة الفاينل

No. 12. 11. 2018

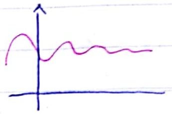
(14.3) Laplace

- Convert from time to frequency (s) domain

$\int_{-\infty}^{0}$ inetial value

$F(t) \Longleftrightarrow F(s)$

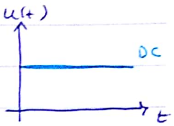
$$F(s) = \int_{-\infty}^{\infty} f(t)\, e^{-st}\, dt$$



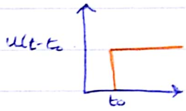
$$\int (f(t)\, u(t))$$

$$F(s) = \int_{0}^{\infty} f(t)\, e^{-st}\, dt$$

$$u(t) = \begin{cases} 1 & , t>0 \\ 0 & , t<0 \end{cases}$$



$A\, u(t)$	$\int_{0}^{\infty} A e^{-st} dt$	$\frac{A}{s}$
$A u(t-t_0)$	$\int_{t_0}^{\infty} A e^{-st} dt$	$\frac{-A e^{-t_0 s}}{s}$
$A e^{-at} u(t)$	$\int_{0}^{\infty} A e^{-at} e^{-st} dt$	$\frac{A}{s+a}$
$A e^{at} u(t)$		$\frac{A}{s-a}$
$A\, t\, u(t)$	$\int_{0}^{\infty} A t e^{-st} dt$	$\frac{A}{s^2}$
$A t^n u(t)$		$\frac{A n!}{s^{n+1}}$
$A t e^{-at} u(t)$		$\frac{A}{(s+a)^2}$
$A\, \delta(t)$		A
$A\, \delta(t-t_0)$		$A e^{-t_0 s}$



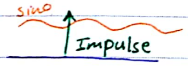
$A \sin \omega t \rightarrow \frac{A \omega}{s^2+\omega^2}$

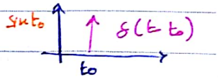
$A \cos \omega t \rightarrow \frac{A s}{s^2+\omega^2}$

cos, sin لانستخدم

في L [illegible]

phasor [illegible] L





Ex $v(t) = 5\,\delta(t) - 2u(t)$

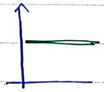
$V(s) = 5 - \frac{2}{s}$

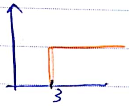
Ex $v(t) = 4\delta(t-2) - 2t\,u(t)$

$V(s) = 4e^{-2s} - \frac{2}{s^2}$

Ex $u(t)\,u(t-3) = u(t-3)$

$\frac{e^{-3s}}{s}$





Ex $N(s) = 10$

$N(t) = 10\,\delta(t)$

$\left(\frac{N}{D}\right)$

■ $N < D$ partial fraction

■ $N \geq D$ long division

Ex $V(s) = \frac{10}{s} \longrightarrow 10u(t)$

Ex $V(s) = \frac{10}{s^2} \longrightarrow 10t\,u(t)$

Ex≫ $V(s) = \frac{10}{s(s+10)} = \frac{A}{s} + \frac{B}{s+10}$

$As + 10A + Bs = 10$.

■ $10A = 10 \rightarrow \boxed{A=1}$

■ $A + B = 0 \rightarrow \boxed{B=-1}$

$V(s) = \frac{1}{s} + \frac{-1}{s+10} \longrightarrow N(t) = u(t) - e^{-10t}u(t)$

Ex $V(s) = \frac{10s}{s+10} \rightarrow$ long divison

$V(s) = 10 - \frac{100}{s+10}$

10

$s+10 \,\overline{)\,10s}$

$-\,10s + 100$

-100

$V(t) = 10\,\delta(t) - 100e^{-10t}u(t)$

No.

Ex $V(s) = \dfrac{3s^2-4}{s^2} \rightarrow = 3 - \dfrac{4}{s^2}$

$V(t) = 3\delta(t) - 4t\,u(t)$

Ex $V(s) = \dfrac{11s+30}{s^2+3s} \rightarrow = \dfrac{11s+30}{s(s+3)}$

$V(s) = \dfrac{A}{s} + \dfrac{B}{(s+3)}$ $\boxed{A=10}$ $\boxed{B=1}$

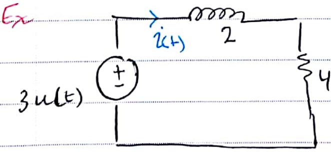
$V(t) = A\,u(t) + B e^{-2t} u(t)$

$As + 3A + Bs = 11s + 30$

$$\left\{\begin{array}{l} \mathcal{L}\left(\dfrac{dv}{dt}\right) \Longleftrightarrow s\,V(s) - V(0^-) \\ \mathcal{L}\,\dfrac{d^2v}{dt^2} \Longleftrightarrow s^2 V(s) - s V(0) - V'(0^-) \end{array}\right]$$

لو لم يذكرها بالسؤال نحسب initial ← يكون المفتاح مغلق يعني i=0 ولكن يجب ان تكون 20+3u(t)

Ex



Find $i(t)$, $\underline{i(0^-) = 5A}$

$\mathcal{L}\left(3u(t) = 2\dfrac{di}{dt} + 4i\right)$

$\dfrac{3}{s} = 2\left[sI(s) - I(0)\right] + 4I(s)$

$\dfrac{3}{s} = 2sI(s) - 10 + 4I(s)$

$\dfrac{\frac{3}{s}+10}{2s+4} = I(s) = \dfrac{3+10s}{2s(s+2)}$

$I_L = I_f + (I_0 - I_f)e^{-t/\textcircled{\tau}}$

$I_f\,(t=\infty) \rightarrow (L : s.c) \rightarrow I_f = \dfrac{3}{4}$

$\tau = \dfrac{L}{R} = \dfrac{2}{4}$

$$\frac{A}{2s} + \frac{B}{s+2}$$

$$I(s) = \frac{3/4}{s} + \frac{4.25}{s+2}$$

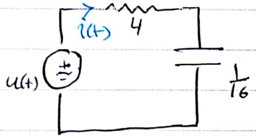
$$i(t) = \frac{3}{4} u(t) + 4.25 e^{-2t} u(t)$$

$$i(t) = \left(\frac{3}{4} + 4.25 e^{-2t}\right) u(t)$$

$$\left[\mathcal{L}\left\{\int_{-\infty}^{t} f(t)\, dt = \mathcal{L}\left(\underbrace{\int_{-\infty}^{0} f(t)}_{F(0)}\right) + \mathcal{L}\int_{0}^{\infty} \underbrace{f(t)}_{t}\, dt\right\}\right.$$

$$\left. = \frac{F(0)}{s} + \frac{F(s)}{s}\right]$$

Ex



$$i(t) \longrightarrow V_c(0^+) = 9\,V$$

$$\mathcal{L}\left(u(t) = 4I + \frac{1}{c}\int_{-\infty}^{t} i(t)\right)$$

$$\frac{1}{s} = 4\, I(S) + \mathcal{L}\left(\underbrace{16\int_{-\infty}^{t} i(t)}_{V(0)} + t\int_{0}^{t} i(t)\right)$$

$$\frac{1}{s} = 4\, I(s) + \frac{V(0)}{s} + \frac{16\, I(s)}{s}$$

$$\frac{\frac{1}{s} - \frac{9}{s}}{4 + \frac{16}{s}} = I(s) \longrightarrow I(s) = \frac{-\frac{8}{s}}{4 + \frac{16}{s}} = \frac{-8}{4s+10} = \frac{-2}{s+4}$$

$$i(t) = -2e^{-4t} u(t)$$

- Inetial Value $f(0)$
- final value $f(\infty)$

>> Inetial value $f(0) = \lim_{t \to 0} f(t) \overset{OR}{=} \lim_{s \to \infty} sF(s)$

>> final value $f(\infty) = \lim_{t \to \infty} f(t) \overset{OR}{=} \lim_{s \to 0} s\,F(s)$

Ex $V(s) = \frac{5S^2 + 10}{2s(s^2+3s+5)}$

$$f(0) = \lim_{s \to \infty} s\,F(s) = \lim_{s \to \infty} \frac{5s^2+10}{2(s^2+3s+5)}$$

$$\lim_{s \to \infty} \frac{5 + \cancel{\frac{10}{s^2}}}{2(1+\cancel{\frac{3}{s}}+\cancel{\frac{5}{s^2}})} \rightarrow f(0) = \frac{5}{2}$$

Chapter (14) (Complex frequency)

$v(t) = V_m \cos \omega t + \theta$

$v(t) = \text{Real}\{V_m e^{j(\omega t+\theta)}\}$

$= \text{Real}\{V_m e^{j\omega t} e^{j\theta}\}$

$A + jB$

$S = \delta + j\omega$

- s : complex frequency (s^{-1})
- δ : neper frequency (neper/s)
- ω : angular frequency (rad/s) $\rightarrow \omega = 2\pi f$
- f : frequency (Hz) or ($\frac{1}{s}$)

>> $f(t) = K e^{st}$ $\quad s = \delta + j\omega$

$\boxed{1}$ $S = 0$:

$f(t) = K$ $\quad \cos \omega t$ (DC source)

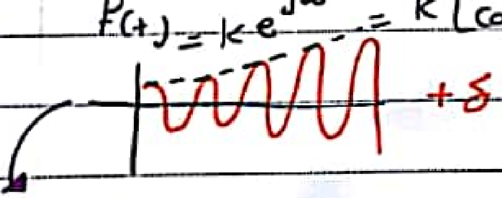
$\boxed{2}$ $S = \delta$:

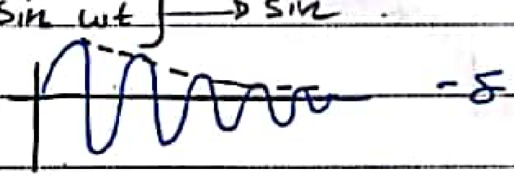
$f(t) = K e^{\delta t}$ $\rightarrow +\delta$ (increasing)

exponential $\rightarrow -\delta$ (decreasing)

$\boxed{3}$ $S = j\omega$:

$f(t) = K e^{j\omega} = K[\cos \omega t + j \sin \omega t] \rightarrow \sin$





$\boxed{4}$ $S = \delta + j\omega$:

$f(t) = K e^{(\delta + j\omega)t} = K e^{\delta t}[\cos \omega t + j \sin \omega t$

Damped sin

>> $v(t) = V_m \cos(\omega t + \theta)$

$= \frac{V_m}{2}\left[e^{j(\omega t+\theta)} + e^{-j(\omega t+\theta)}\right]$

$= \left[e^{j\omega t} e^{j\theta} + e^{-j\omega t} e^{-j\theta}\right]$

* $S = \pm j\omega \rightarrow s_1 = +j\omega$

$\rightarrow s_2 = -j\omega$

- $v(t) = 2\sin 5t \rightarrow S = \pm 5j$

Ex $\cos(10t + 50) \rightarrow S = \pm j10$

$s(t) = (\underset{-100}{3e^{-100t}} + \underset{-200}{e^{-200t}})\sin 2000t$ $\pm j2000$

$\left(\frac{e^{j2000t} - e^{-j2000t}}{2J}\right)$

$\underline{S}$ ↓

$(-100 + j2000)$, $(-100 - j2000)$

$(-200 + j2000)$, $(-2000 - j2000)$

* $e^{j2} \rightarrow$ phase

* $e^{j2t} \rightarrow$ frequncy

* $e^{2t} \rightarrow \delta$

* $e^{2} \rightarrow$ Constant

Ex $(2e^{-10t})\underbrace{\cos(4t+30)}$ $\pm j4$

$2\cos(4t+30) - e^{-j10t}\cos 4t + 30$

$(+j4)$, $(-j4)$, $(-10+j4)$, $(-10-j4)$

Ex constanct atime domain signals

(1) $S = 0$, 10^{6}, -10^{5} s^{-1}

$v(t) = A + Be^{10t} + Ce^{-10t}$

(2) $s = -5^{6}$, $j\omega 8$, $-5-j8$ s^{-1} $\left[s = (\delta + j\omega)t\right]$

$v(t) = Ae^{-5t} + \underbrace{B\cos(8t+\theta)}_{B\sin(8t)} + Ce^{-5t}\cos(8t)$

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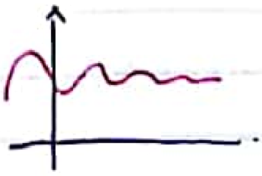
/ M 3) Laplace

- Convert from time to frequency (s) domain

$\int_{-\infty}^{0}$ initial value

$F(t) \Longleftrightarrow F(s)$

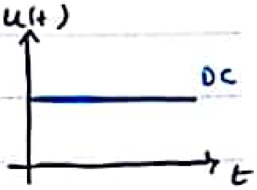
$F(s) = \int_{-\infty}^{\infty} f(t)\, e^{-st}\, dt$



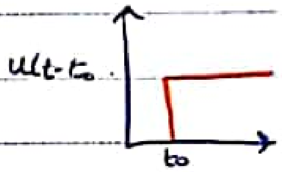
$\int (f(t)\, u(t))$

$F(s) = \int_{0}^{\infty} f(t)\, e^{-st}\, dt$

$u(t) = \begin{cases} 1 & , t > 0 \\ 0 & , t < 0 \end{cases}$



- $A\, u(t) \Rightarrow \int_{0}^{\infty} A e^{-st} dt \Rightarrow \frac{A}{s}$



- $A u(t-t_0) \Rightarrow \int_{t_0}^{\infty} A e^{-st} dt \Rightarrow \frac{-A e^{-t_0 s}}{s}$
- $A e^{-at} u(t) \Rightarrow \int_{0}^{\infty} A e^{-at} e^{-st} dt \Rightarrow \frac{A}{s+a}$
- $A e^{at} u(t) \Rightarrow \frac{A}{s-a}$
- $A\, t\, u(t) \Rightarrow \int_{0}^{\infty} A t e^{-st} dt \Rightarrow \frac{A}{s^2}$
- $A t^n u(t) \Rightarrow \frac{A n!}{s^{n+1}}$
- $A t e^{-at} u(t) \Rightarrow \frac{A}{(s+a)^2}$
- $A\, \delta(t) \Rightarrow A$
- $A\, \delta(t-t_0) \Rightarrow A e^{-t_0 s}$

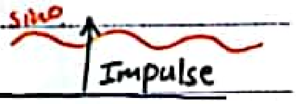
$A \sin wt \rightarrow \frac{A w}{s^2+w^2}$

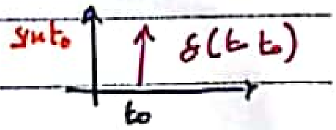
$A \cos wt \rightarrow \frac{A s}{s^2+w^2}$

لا نستخدم cos, sin

في L لأن [illegible]

phasor أسهل من L





Ex $v(t) = 5\delta(t) - 2u(t)$

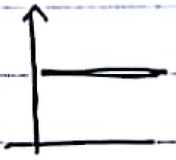
$V(s) = 5 - \frac{2}{s}$

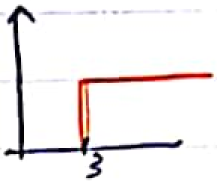
Ex $v(t) = 4\delta(t-2) - 2t\,u(t)$

$V(s) = 4e^{-2s} - \frac{2}{s^2}$

Ex $u(t)\,u(t-3) = u(t-3)$

$\frac{e^{-3s}}{s}$





Ex $N(s) = 10$

$N(t) = 10\delta(t)$

$\left(\frac{N}{D}\right)$

■ $N < D$ partial fraction

■ $N \geq D$ long division

Ex $V(s) = \frac{10}{s} \longrightarrow 10u(t)$

Ex $V(s) = \frac{10}{s^2} \longrightarrow 10t\,u(t)$

Ex>> $V(s) = \frac{10}{s(s+10)} = \frac{A}{s} + \frac{B}{s+10}$

$As + 10A + Bs = 10$ ■ $10A = 10 \rightarrow \boxed{A=1}$

■ $A + B = 0 \rightarrow \boxed{B=-1}$

$V(s) = \frac{1}{s} + \frac{-1}{s+10} \longrightarrow N(t) = u(t) - e^{-10t}u(t)$

Ex $V(s) = \frac{10s}{s+10} \longrightarrow$ Long divison

$V(s) = 10 - \frac{100}{s+10}$

$$\begin{array}{r|l} & 10 \\ \hline s+10 & 10s \\ & -10s+100 \\ \hline & -100 \end{array}$$

$V(t) = 10\delta(t) - 100e^{-10t}u(t)$

Ex $V = 12 \angle 35$ V , Find $v(t)$??

(1) $s = 0$ $\rightarrow$ $\delta = 0$, $\omega = 0$

$v(t) = A e^{\delta t} \cos(\omega t + \theta)$

$v(t) = 12 e^{0t} \cos(0t + 35)$

$v(t) = 12 \cos(35) = 9.8$ V

(2) $s = -20$ s^{-1}

$v(t) = 12 e^{-20t} \cos(0t + 35)$

$v(t) = 9.8 e^{-20t}$

(3) $s = j5$

$v(t) = 12 \cos(5t + 35)$

(4) $s = 20 + j5$

$v(t) = 12 e^{-20t} \cos(5t + 35)$

$$\frac{A}{2s} + \frac{B}{s+2}$$

$$I(s) = \frac{3/4}{s} + \frac{4.25}{s+2}$$

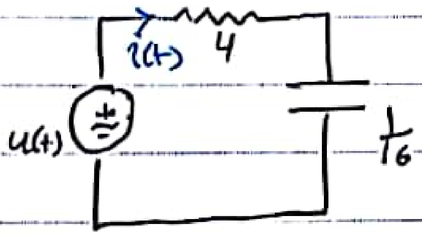
$$i(t) = \frac{3}{4}u(t) + 4.25e^{-2t}u(t)$$

$$i(t) = \left(\frac{3}{4} + 4.25\,e^{-2t}\right)u(t)$$

$$\mathcal{L}\left[\int_{-\infty}^{t} f(t)\,dt = \mathcal{L}\underbrace{\left(\int_{-\infty}^{0} f(t)\right)}_{F(0)} + \mathcal{L}\int_{0}^{\infty} \underbrace{f(t)}_{t}\,dt\right]$$

$$= \frac{F(0)}{s} + \frac{F(s)}{s}$$

Ex



$$i(t) \longrightarrow V_c(0^+) = 9\,V$$

$$\mathcal{L}\left(u(t) = 4I + \frac{1}{c}\int_{-\infty}^{t} i(t)\right)$$

$$\frac{1}{s} = 4\,I(s) + \mathcal{L}\left(\underbrace{\left(16\int_{-\infty}^{t} i(t)\right)}_{V(0)} + t\int_{0}^{t} i(t)\right)$$

$$\frac{1}{s} = 4\,I(s) + \frac{V(0)}{s} + \frac{16\,I(s)}{s}$$

$$\frac{\frac{1}{s} - \frac{9}{s}}{4 + \frac{16}{s}} = I(s) \longrightarrow I(s) = \frac{-\frac{8}{s}}{4 + \frac{16}{s}} = \frac{-8}{4s+10} = \frac{-2}{s+4}$$

$$i(t) = -2e^{-4t}u(t)$$

Ex $V(s) = \frac{3s^2-4}{s^2} \rightarrow = 3 - \frac{4}{s^2}$

$v(t) = 3\delta(t) - 4t\,u(t)$

Ex $V(s) = \frac{11s+30}{s^2+3s} \rightarrow = \frac{11s+30}{s(s+3)}$

$V(s) = \frac{A}{s} + \frac{B}{(s+3)}$ $\boxed{A=10}$ $\boxed{B=1}$

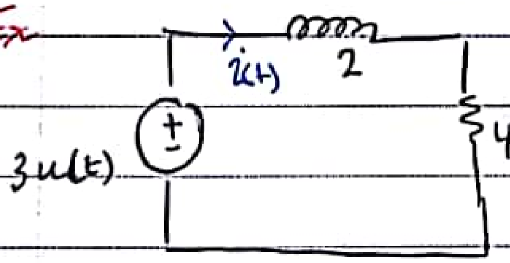
$v(t) = A\,u(t) + B e^{-2t} u(t)$

$As + 3A + Bs = 11s + 30$

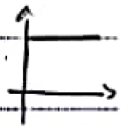
$$\left\{ \begin{array}{l} \mathcal{L}\left(\frac{dv}{dt}\right) \Leftrightarrow s\,V(s) - v(0^-) \\ \mathcal{L}\ \frac{d^2v}{dt^2} \Leftrightarrow s^2 V(s) - s\,v(0) - v'(0^-) \end{array} \right\}$$

لو لم يذكرها بالسؤال نحسب initial ← يكون المفتاح مغلق يعني $i=0$ ولكن يجب ان تكون $20+3u(t)$

Ex



▸ Find $i(t)$, $i(0^-) = 5A$



$\mathcal{L}\left(3u(t) = 2\frac{di}{dt} + 4i\right)$

$I_L = I_f + (I_0 - I_f) e^{-t/\textcircled{\tau}}$

$I_f\ (t=\infty) \rightarrow (L: s.c) \rightarrow I_f = \frac{3}{4}$

$\tau = \frac{L}{R} = \frac{2}{4}$

$\frac{3}{s} = 2\left[s I(s) - I(0)\right] + 4 I(s)$

$\frac{3}{s} = 2s I(s) - 10 + 4 I(s)$

$\frac{\frac{3}{s} + 10}{2s+4} = I(s) = \frac{3+10s}{2s(s+2)}$

No.

- Inetial Value $f(0)$
- final value $f(\infty)$

>> Inetial value $f(0) = \lim_{t\to 0} f(t) \overset{OR}{=} \lim_{s\to\infty} s F(s)$

>> final value $f(\infty) = \lim_{t\to\infty} f(t) \overset{OR}{=} \lim_{s\to 0} s F(s)$

Ex $V(s) = \frac{5S^2+10}{2s(s^2+3s+5)}$

$f(0) = \lim_{s\to\infty} s F(s) = \lim_{s\to\infty} \frac{5s^2+10}{2(s^2+3s+5)}$

$\lim_{s\to\infty} \frac{5 + \cancel{\frac{10}{s^2}}}{2(1+\cancel{\frac{3}{s}}+\cancel{\frac{5}{s^2}})} \rightarrow f(0) = \frac{5}{2}$

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Chapter(15) complex analysis

▶▶ For R:

$\mathcal{L}(v(t) = R\,i(t))$

$V(s) = R\,I(s)$

$\boxed{R = \frac{V(s)}{I(s)}} \Rightarrow Z$

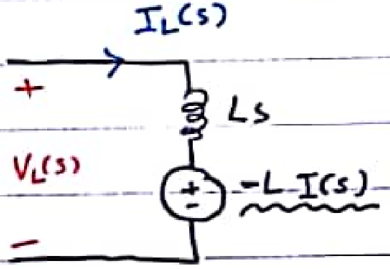
▶▶ For L:

$\mathcal{L}\left(V_L = L\frac{di}{dt}\right)$

$\boxed{V_L(s) = Ls\,I(s) - L\,I(0)}$, $I(0) = 0$

$\boxed{\frac{V_L(s)}{I(s)} = Ls} \Rightarrow Z_L(s)$

[Voltage Model] →



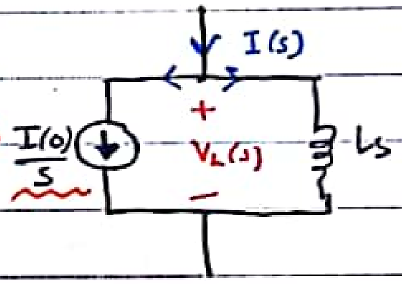
$I(s) = \frac{V_L(s)}{Ls} + \frac{\cancel{L}\,I(s)}{\cancel{L}s}$

* (V.M) و (C.M) لل (L)

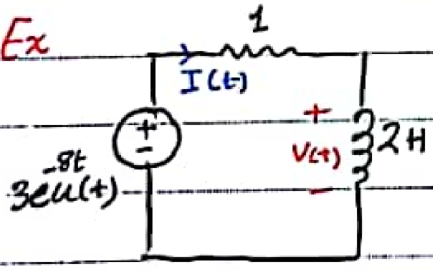
ال (L) دائما يعمل على التيار

لذلك في الحالتين يوجد (I) للقيز

[Current Model] →



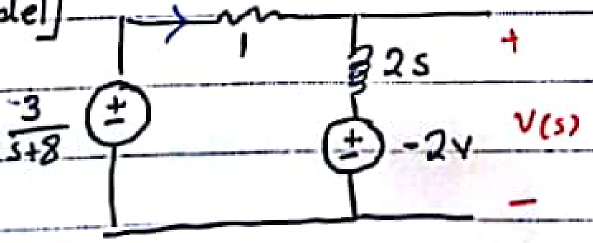
Ex



▸ Find $v(t)$, if $i(0^-) = 1A$ ، لو لم تكن موجودة نحسبها وإذا ذكر السؤال (no stored energy) يعني لا يوجد.

$I = \frac{\left(\frac{3}{s+8}\right) - (-2)}{1 + 2s}$

[Voltage Model]

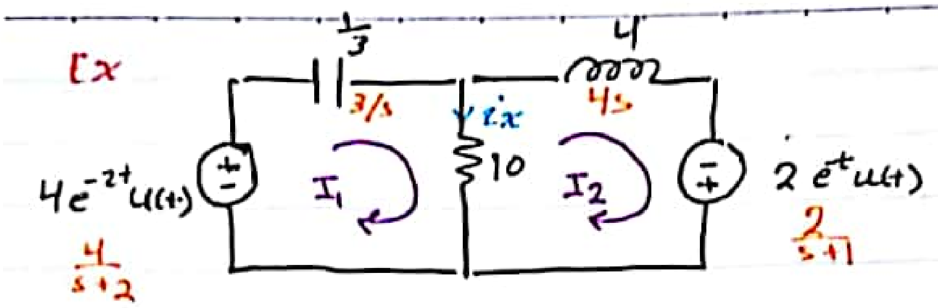


$V(s) = 2s\,I + (-2)$

$V(s) = \frac{3.2}{s+8} - \frac{1.2}{s+0.5}$

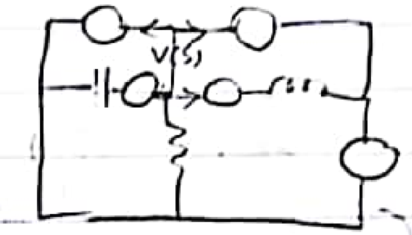
$V(t) = \left(3.2e^{-8t} + (-1.2)e^{-0.5t}\right)u(t)$

Ex



▸ Find (i_x)

, No stored energy



لو لم يذكر السؤال أن (no energy stored)

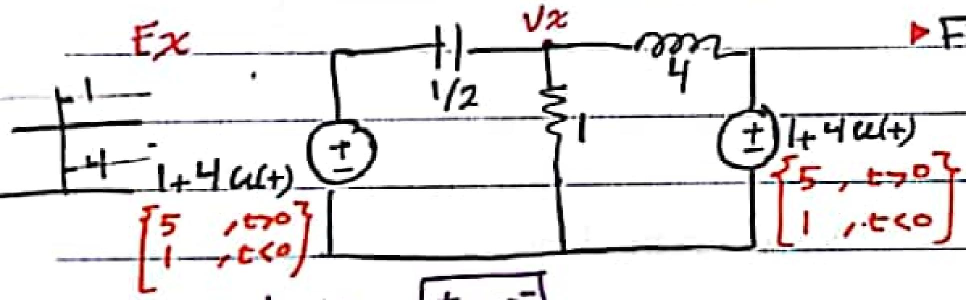
- $\frac{3}{s} I_1 + 10(I_1 - I_2) = \frac{4}{s+2} \dashrightarrow ①$
- $4s \cdot I_2 - \frac{2}{s+1} + 10(I_2 - I_1) = 0 \longrightarrow ②$

$$I_1 = \frac{2s(4s^2 + 19s + 20)}{20s^4 + 66s^3 + 73s^2 + 57s + 30}$$

$$i_1(t) = 96e^{-2t} - 344.8e^{-t} + 841e^{-0.15t} + 197.7e^{-0.15t} \sin 0.8s$$

* تيار (L) دائماً مع التيار الداخل في الـ Node و تيار (C) عكسه

Ex



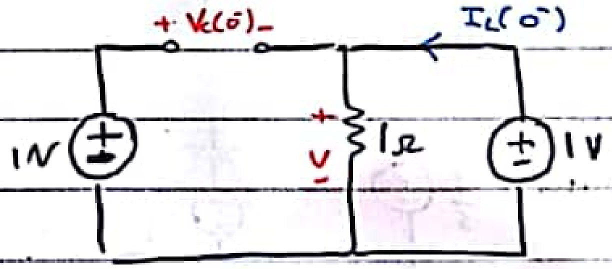
▸ Find $V_x(t)$

لم يذكر السؤال أنه (no energy)

$\Rightarrow t < 0 \quad \boxed{t = 0^-}$

$V_C(0^-) = V_C(0) = V_C(0^+)$

$I_L(0^-) = I_L(0) = I_L(0^+)$

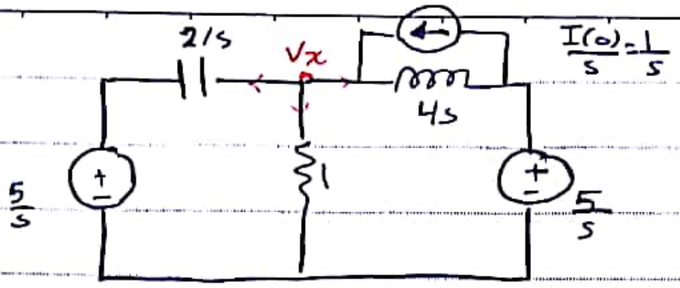


$V_C(0^-) = 1 - 1 = 0V$

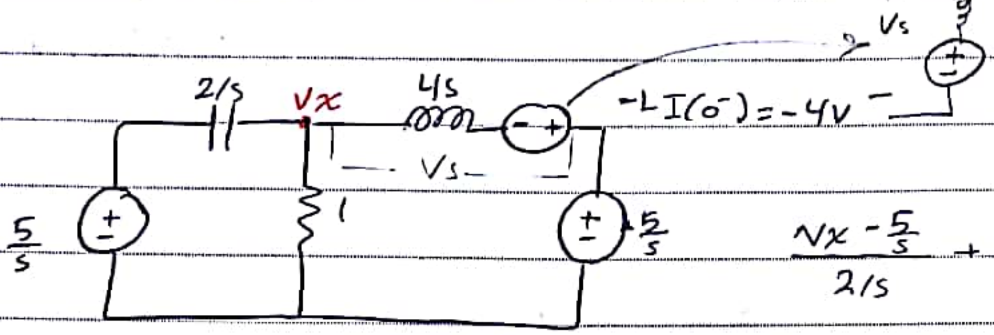
$-1 + V_C + V_R = 0$

$I_L(0^-) = \frac{1}{1} = 1A$

No.



$$\frac{vx - \frac{5}{s}}{2/s} + \frac{vx}{1} + \frac{vx - 5/s}{4s} - \frac{1}{s} = 0$$



$-I\,I_{c_0}$ [illegible]

$$\frac{Vx - \frac{5}{s}}{2/s} + \frac{Vx}{1} + \frac{Vx - 5/s - (--4)}{4s}$$

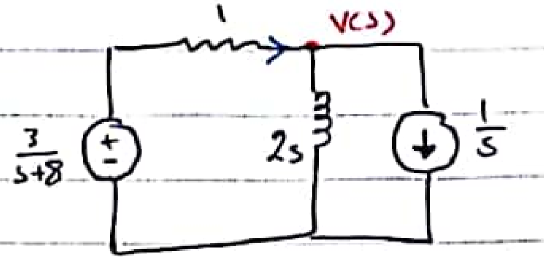
$$\frac{Vx - ([illegible])}{4s}$$

$$\frac{Vx - (5/s + (-4))}{4s}$$

$Vx - 5/s - -4$

طريقة أخرى

[Current Model]



$$\frac{V}{2s} + \frac{V - \frac{3}{s+8}}{1} + \frac{1}{s} = 0$$

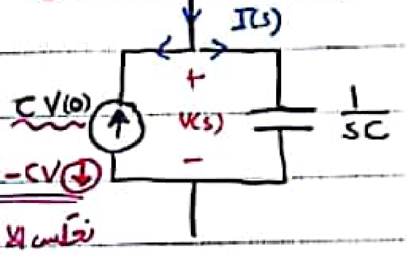
$$V(s) = \frac{3.2}{s+8} - \frac{1.2}{s+0.5}$$

▶▶ For C:

$\mathcal{L}\left(i_c = c\frac{dv}{dt}\right)$

[Current Model]

$$\boxed{i_c(s) = CsV(s) - CV(0^-)}$$



or $-CV(0)$

نعكس الاتجاه

*If $V(0^-) = 0 \rightarrow i_c(s) = Cs\,V(s)$

$$\boxed{\frac{V(s)}{I(s)} = \frac{1}{sc}}$$

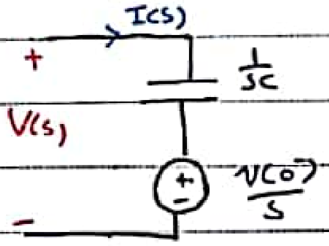
* الـ (C.M) و (V.M) للـ (C)

الـ (C) دائماً

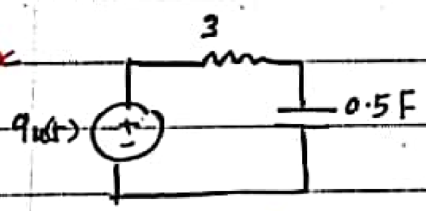
على الـ (V)

[Voltage Model]

$$V(s) = \frac{I(s)}{cs} + \frac{\cancel{c}\,V(0^-)}{\cancel{c}s}$$

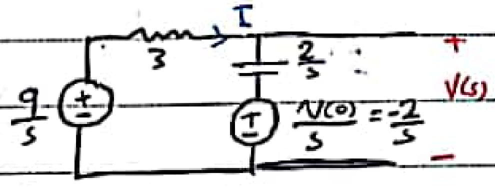


Ex



▶Find $v(t)$ if $v_c(0) = -2V$

[Voltage Model]

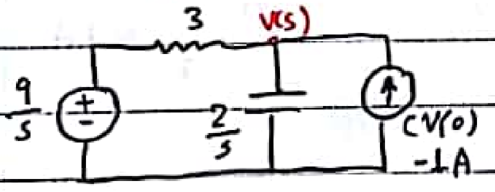


$$V(s) = \frac{2}{s}I + \left(\frac{-2}{s}\right)$$

$$I = \frac{\frac{9}{s} - \left(\frac{-2}{s}\right)}{3 +}$$

OR

[Current Model]



$$\frac{V(s)}{2/s} + \frac{V - (9/s)}{3} - (-1) = 0$$

$$V(s) = \frac{9}{s} - \frac{11}{s+2/s}$$

نفس الجواب النهائي في الطريقتين

$$v(t) = 9u(t) - 11\,e^{-2/3\,t}\,u(t)$$

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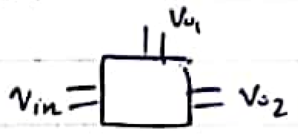
(15.4) Transfer function H(s)

- ratio between Input and output voltage in S-domain

$H(s) = \frac{V_{out}(s)}{V_{in}(s)}$, ▪ H(s) : voltage gain A_v



▪ $H(s) = \frac{I_o(s)}{I_{in}(s)}$ ▪ $H(s) = \frac{V_o(s)}{I_{in}(s)}$ ▪ $H(s) = \frac{I_o(s)}{V_{in}(s)}$

▶▶ H(s) has zero at $S = S_o$ If $H(S_o) = 0$

$H(s) = \frac{V_o(s)}{V_{in}(s)}$

▶▶ H(s) has poles at $S = S_o$ If $H(S_o) = \infty$

Ex $H(s) = \frac{7s}{s(3s^2-9s+4)}$, Find poles , Zero ??

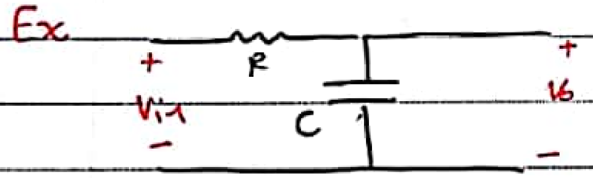
$H(s) = \frac{7s}{(3s-2)(s-2)}$ → $H(s_o) = 0 \longrightarrow$ Zero , $s_o = \infty$

→ $H(S_o) = \infty \longrightarrow$ poles

$S - 2 = 0 \longrightarrow S_o = 2$

$3S - 2 = 0 \longrightarrow S_o = \frac{2}{3}$ } poles

Ex



▪ $H(s) = \frac{V_o}{V_{in}}$??

$V_o = \frac{Z_c}{Z_c + R} V_{in}$

H(jw)

$\frac{V_o(s)}{V_{in}(s)} = \frac{\frac{1}{sc}}{\frac{1}{sc} + R} \longrightarrow \boxed{H(s) = \frac{1}{1 + sCR}} \longrightarrow |H(s)| = A_v$

▪ Zero $\longrightarrow H(s) = 0 \longrightarrow s = \infty$

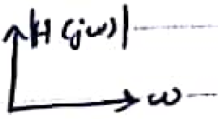
▪ poles $\longrightarrow H(s) = \infty \longrightarrow 1 + sCR = 0 \longrightarrow S = \frac{-1}{RC} \longrightarrow \underline{\underline{\tau = RC}}$

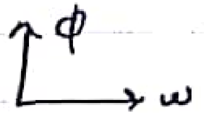
$\Rightarrow H(jw) = A + Bj = A \angle \theta$ $V_{in} = \square = V_o$ ($V_{in} \downarrow \omega$)

كلما غيرنا ال frequency(w)
تتغير ال Impedance ويتغير الكل

(16.6) Bode plot

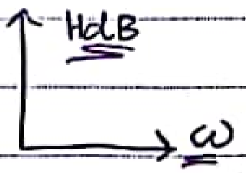
⇒ sketch of aphase and magnetude of the transfer function with "ω"





$|H(j\omega)| \longrightarrow HdB = 20 \log |H(j\omega)|$

* |H(jω)| تكون بأعداد كبيرة جداً لذلك
نستخدم [log] ونستخدم وحدة (dB)
(deci Bell) فتصبح الرسمة بين
HdB و ω ←

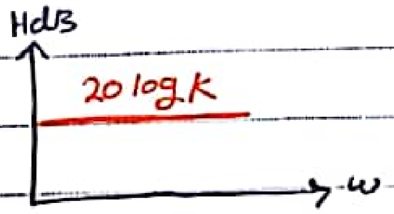


(1) $H(s) = K$

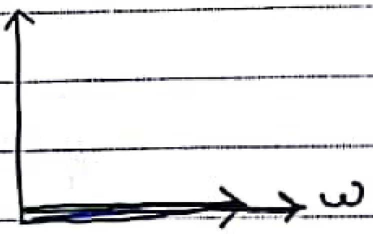
$A + Bj$
$K + 0j$

$H(j\omega) = K \rightarrow |H(j\omega)| = K$

$$\boxed{HdB = 20 \log K}$$



$\phi = \tan^{-1} \frac{0}{K} = 0$

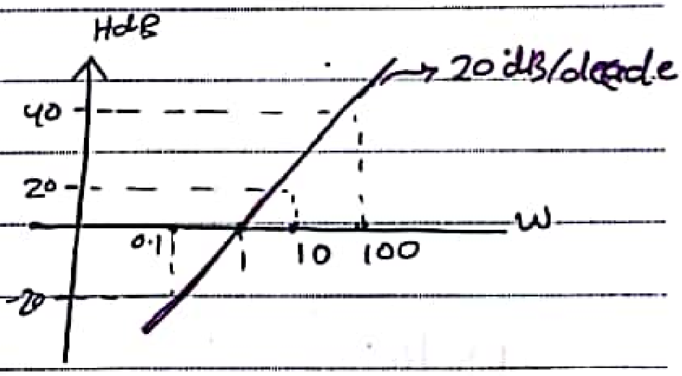


(2) $H(s) = S$

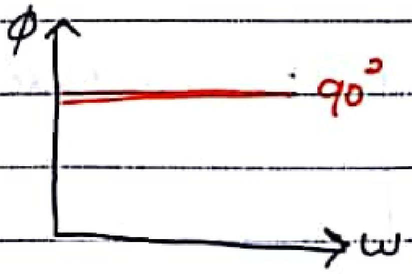
$H(j\omega) = j\omega \quad |H(j\omega)| = \omega$

$HdB = 20 \log \omega$

- $\omega = 1 \rightarrow HdB = 0$
- $\omega = 10 \rightarrow HdB = 20$
- $\omega = 100 \rightarrow HdB = 40$
- $\omega = 0.1 \rightarrow HdB = -20$



$\phi = \tan^{-1} \frac{\omega}{0} = \infty = \frac{\pi}{2} = 90°$

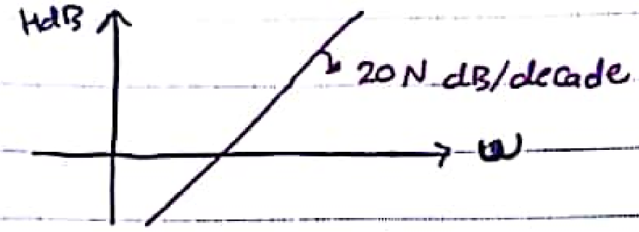


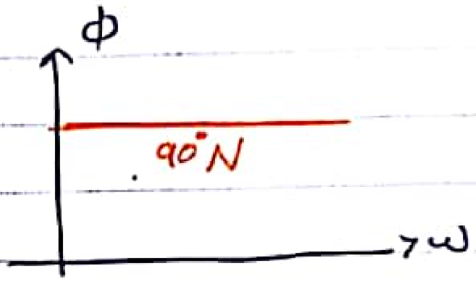
(3) $H(s) = s^2$

$H(j\omega) = (j\omega)^2 \rightarrow |H(j\omega)| = \omega^2$

$H_{dB} = 20 \log \omega^{2} = 40 \log \omega$

In general ↳ $H(s) = s^N$





Ex $H(s) = \frac{1}{s}$

$H(j\omega) = \frac{1}{j\omega} = \frac{-j}{\omega}$

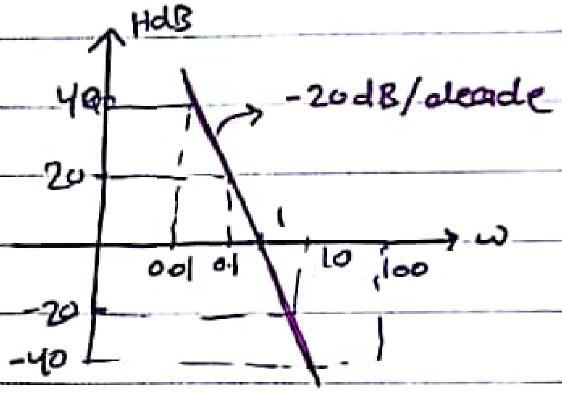
$|H(j\omega)| = \frac{1}{\omega}$

$H_{dB} = 20 \log \frac{1}{\omega} = -20 \log \omega$

■ $\omega = 1 \rightarrow 0$ ■ $\omega = 0.1 \rightarrow 20$

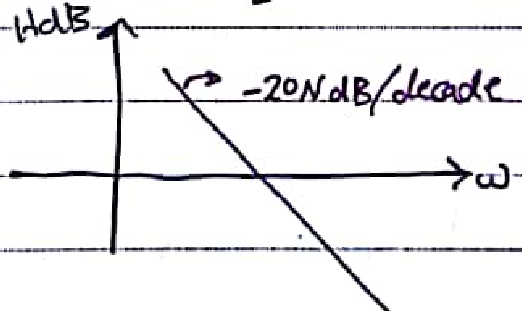
■ $\omega = 10 \rightarrow -20$ ■ $\omega = 0.01 \rightarrow 40$

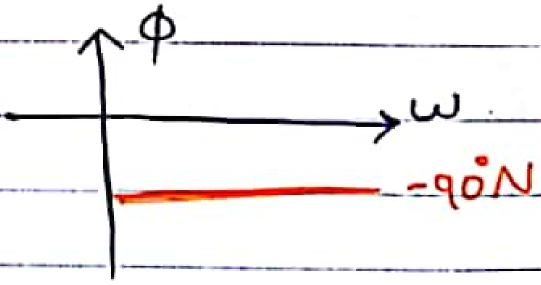
■ $\omega = 100 \rightarrow -40$



$\phi = \tan^{-1} -\infty = -90°$

In general ↳ $H(s) = \frac{1}{s^N}$





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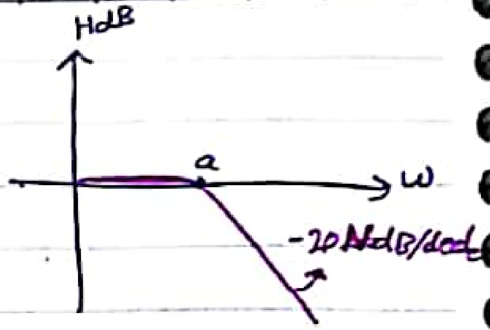
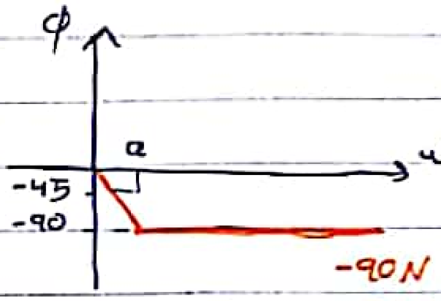
Ex $H(s) = \frac{1}{(\frac{s}{a}+1)^N}$

$H(j\omega) = \frac{1}{1+j\frac{\omega}{a}} \rightarrow 20\log\frac{1}{\sqrt{1+\frac{\omega^2}{a^2}}}$

$20\log 1 - 20\log\sqrt{1+\frac{\omega^2}{a^2}}$



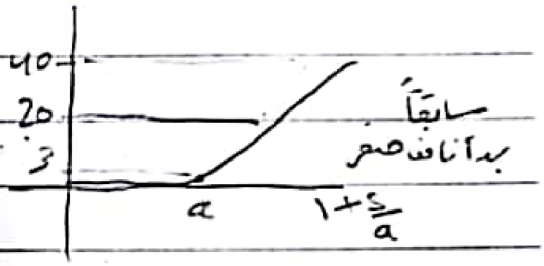


Ex $H(S) = 50 + S$

$H(s) = 50(1+\frac{S}{50})$

$H(\omega j) = 50(1+\frac{j\omega}{50})$

$|H(\omega j)| = 50\sqrt{(1+\frac{\omega^2}{50^2})}$

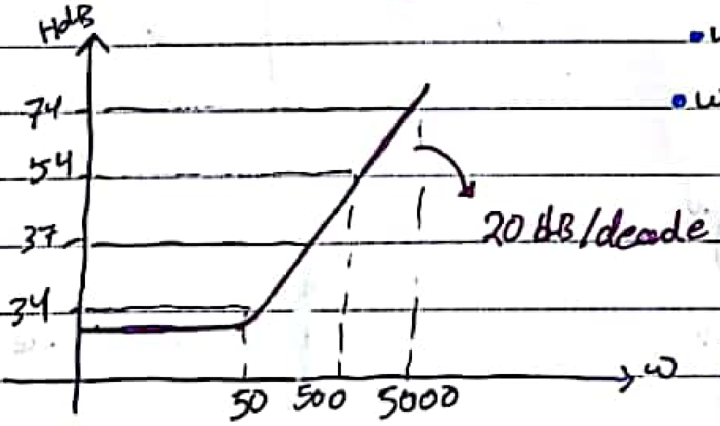


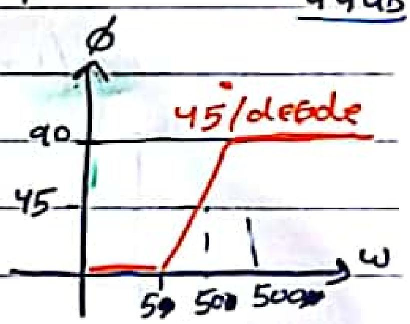
$HdB = 20\log 50\sqrt{1+\frac{\omega^2}{50^2}}$
- ■ $\omega = 50 \rightarrow HdB = 20\log 50\sqrt{2} = 37dB$
- ■ $\omega \ll 50 \rightarrow HdB = 20\log 50 = 34dB$
- ■ $\omega \gg 50 \rightarrow HdB = 20\log \omega$

• $\omega = 50 \times 10 \rightarrow HdB = 20\log 500 = 54dB$

• $\omega = 50 \times 100 \rightarrow HdB = 20\log 5000 = 74dB$

94dB





$\phi = \tan^{-1}\frac{\omega}{50} \rightarrow$ ■ $\omega \leq 50 \times 0.1 \rightarrow 0$

■ $\omega = 50 \rightarrow \phi = 45$

■ $\omega \geq 5 \times 10 \rightarrow \phi = 90$

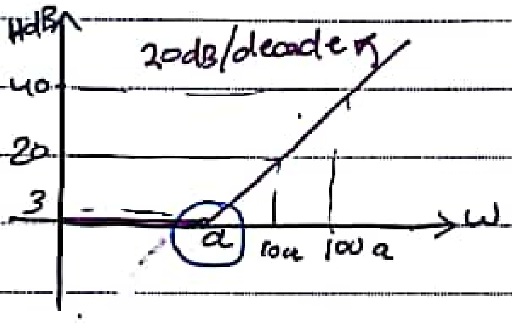
Ex $H(s) = 1 + \frac{s}{a}$

$H(j\omega) = 1 + j\frac{\omega}{a}$ $\qquad |H(j\omega)| = \sqrt{1 + \frac{\omega^2}{(a)^2}} \rightarrow$ a → Frequency

$$\therefore \boxed{HdB = 20\log\sqrt{1 + \frac{\omega^2}{a^2}}}$$

- $\underline{\omega = a} \rightarrow HdB = 20\log\sqrt{2} = 3dB$
- $\underline{\omega \ll a} \rightarrow \frac{\omega}{a} \ll 1 \rightarrow HdB = 20\log 1 = 0\,dB$
- $\underline{\omega \gg a} \rightarrow \frac{\omega}{a} \gg 1 \rightarrow HdB = 20\log\frac{\omega}{a} \rightarrow$ ▪ $\omega = 10a \rightarrow HdB = 20\log 10 = 20d$
  - ▪ $\omega = 100a \rightarrow HdB = 20\log 100 = 4$

60
80



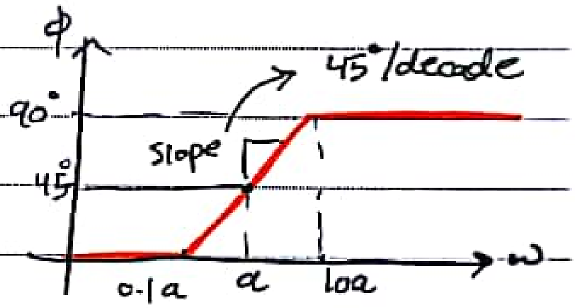
- cut off frequency
- critical frequency
- corner frequency

$\phi = \tan^{-1}\frac{\omega}{a}$

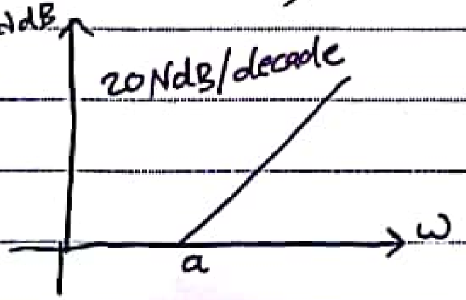
$\omega \ll a \rightarrow \omega \leq 0.1a \rightarrow \phi = 0$

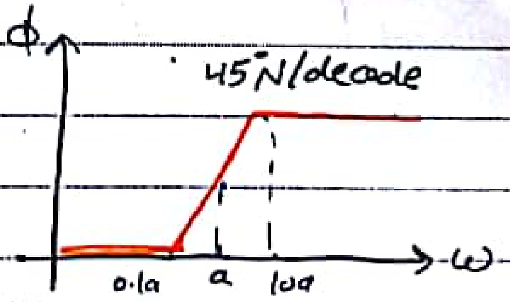
$\omega = a \rightarrow \phi = \tan^{-1} = 45°$

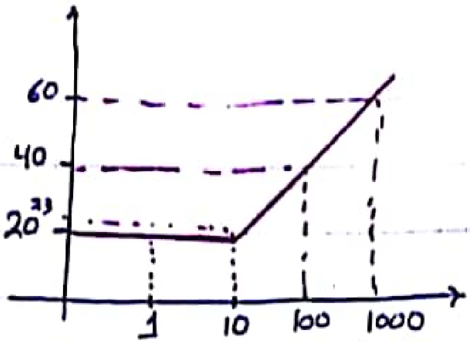
$\omega \gg a \rightarrow \omega \geq 10a \rightarrow \phi = 90°$

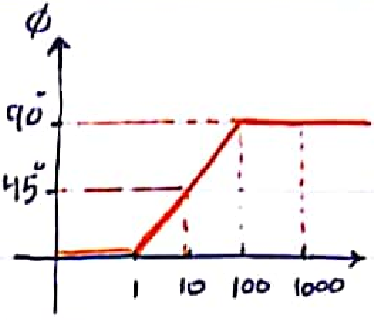


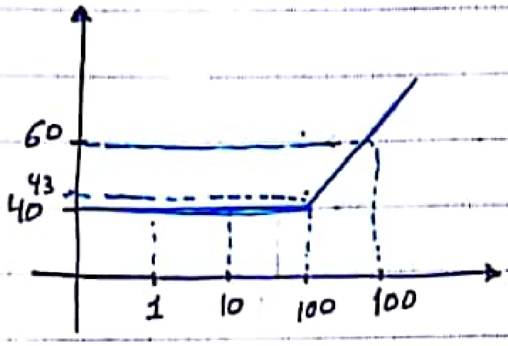
↳ $H(s) = \left(1 + \frac{s}{a}\right)^N$

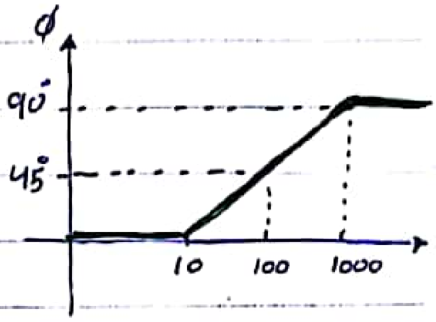


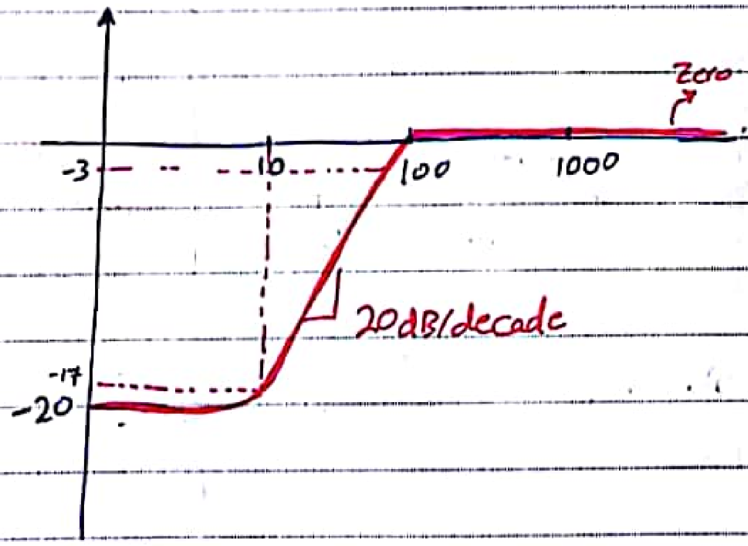


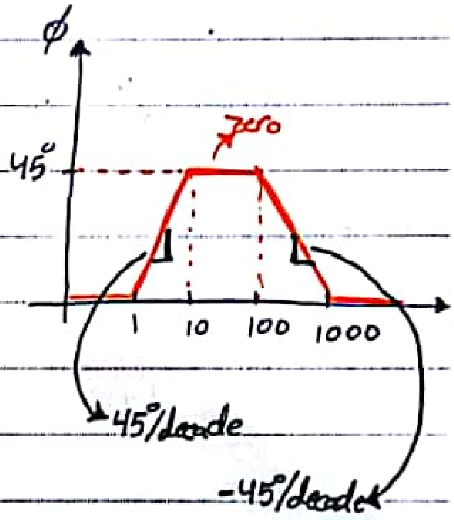








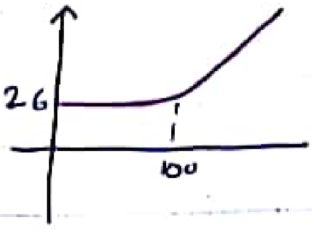




$$\left\{\begin{array}{l} \phi = \dfrac{\tan^{-1}\left(\frac{\omega}{10}\right)}{\tan^{-1}\left(\frac{\omega}{100}\right)} \\[2em] \phi = \tan^{-1}\left(\frac{\omega}{10}\right) - \tan^{-1}\left(\frac{\omega}{100}\right) \end{array}\right.$$

Hw $H(s) = 20 + 0.2S$

$20(1 + \frac{s}{100})$



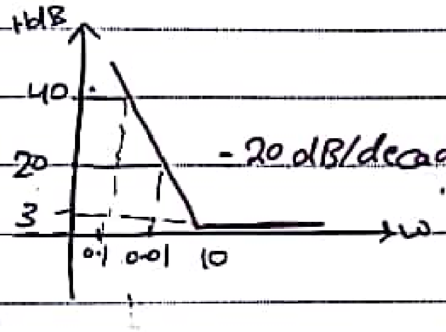
Ex $H(s) = \frac{s+10}{s}$

$H(s) = 1 + \frac{10}{s}$

$H(j\omega) = 1 - j\frac{10}{\omega} \rightarrow |H(j\omega)| = \sqrt{1 + \frac{10^2}{\omega^2}}$

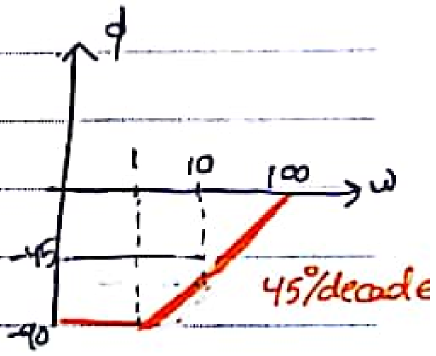
$HdB = 20 \log \sqrt{1 + \frac{10^2}{\omega^2}}$

- ■ $\underline{\omega \ll 10} \rightarrow HdB = 20 \log \frac{10}{\boxed{\omega}} \rightarrow$ • $\omega = 10 \times 0.1 \rightarrow 20$ dB ; • $\omega = 10 \times 0.01 \rightarrow 40$ dB
- ■ $\underline{\omega = 10} \rightarrow HdB = 20 \log \sqrt{2} = 3$ dB
- ■ $\underline{\omega \gg 10} \rightarrow HdB = 20 \log 1 = 0$ dB



$\phi = \tan^{-1} -\frac{10}{\omega}$

- ■ $\omega = \underset{a}{10} \rightarrow \phi = -45^{\circ}$
- ■ $\underset{\omega < 0.1 \times 10}{\omega \ll 10} \rightarrow \phi = -90$
- ■ $\underset{\omega \geq 10 \times 10}{\omega \gg 10} \rightarrow \phi = 0$



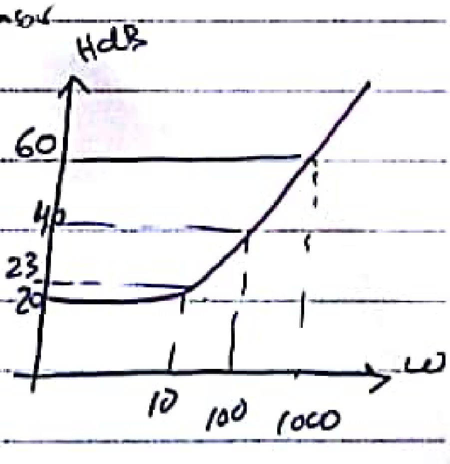
Ex $H(s) = \frac{S+10}{S+100}$

$$\frac{10\sqrt{1+\frac{\omega^2}{10^2}} \angle \tan^{-1}\frac{\omega}{10}}{100\sqrt{1+\frac{\omega^2}{100^2}} \angle \tan^{-1}\frac{\omega}{100}}$$

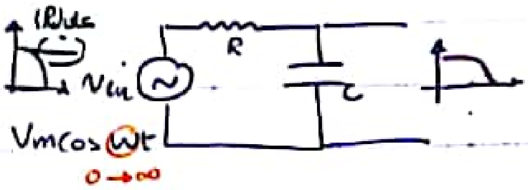
$H(j\omega) = \frac{10+j\omega}{100+j\omega} \rightarrow H(j\omega) = 10(1+j\frac{\omega}{10})$ phasor

$|H(j\omega)| = \frac{10\sqrt{1+\frac{\omega^2}{10^2}}}{100\sqrt{1+\frac{\omega^2}{100^2}}}$

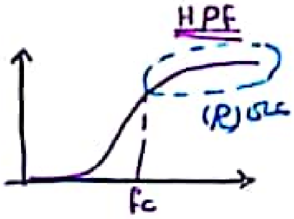
$HdB = 20 \log 10\sqrt{1+\frac{\omega^2}{10^2}} - 20 \log 100 \sqrt{1+\frac{\omega^2}{100^2}}$



$\omega = \omega_c = \frac{1}{RC} \rightarrow V_o = \frac{V_{in}}{\sqrt{2}} \rightarrow \boxed{X_c = R}$



$f_c = 10\ kHz$

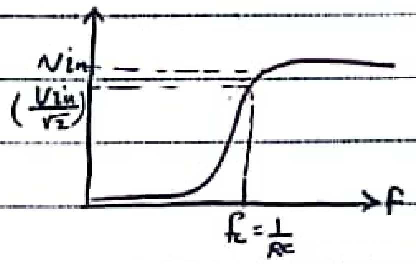


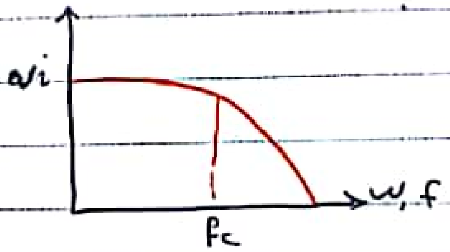
$V_{oR} \rightarrow$ ■ $\omega = 0 \rightarrow Z_c = \frac{1}{j\omega c} = \infty$ (o.c)

$V_{oR} = 0$, $V_{oc} = V_{in}$

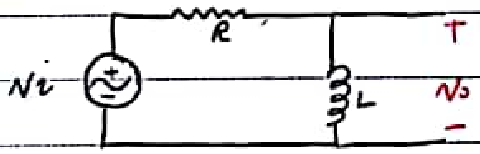
■ $\omega = \infty \rightarrow Z_c = \frac{1}{j\omega c} = 0$ (s.c)

$V_{oR} = V_{in}$, $V_{oc} = 0$





RL

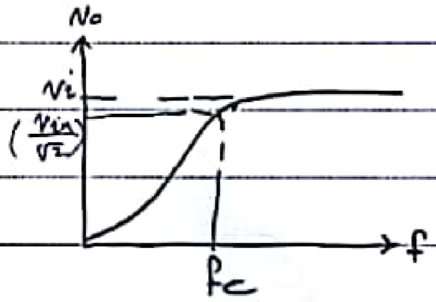


■ $\omega = 0 \rightarrow X_L = \omega L = 0$ (s.c)

$V_{oL} = 0$, $V_{oR} = V_{in}$

■ $\omega = \infty \rightarrow X_L = \omega L = \infty$ (o.c)

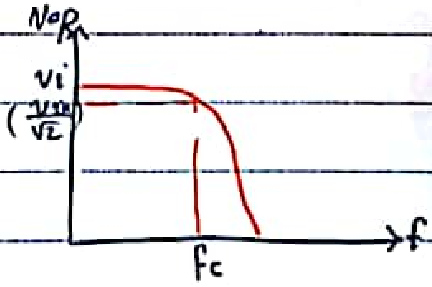
$V_{oL} = V_{in}$, $V_{oR} = 0$



$\tau = \frac{L}{R}$

$\omega = \frac{R}{L} = \frac{1}{\tau}$

$\boxed{f_c = \frac{R}{2\pi L}}$

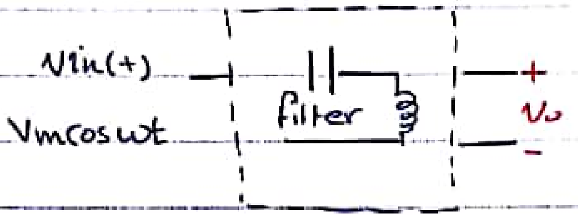


* (RC) أفضل من (RL) لان (L) مقارنته كبيره وله مجال

كما أن حجمه كبير مقارنةً مع (C)

smi)e....

sec (16.7) « Filters »



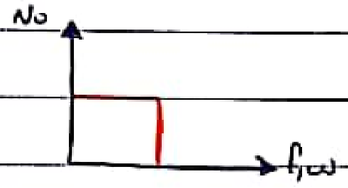
※ Filters types according to component :-

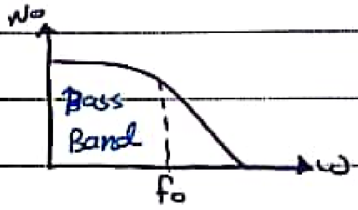
1) passive filters (R, L, C)

2) Active filters (R, L, C) + Op-Amp 

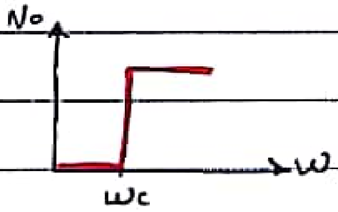
※ Filters types according to Frequency :-

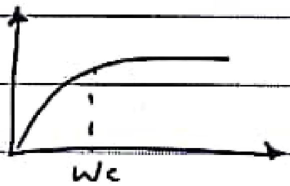
1) Low pass filter (LPF)



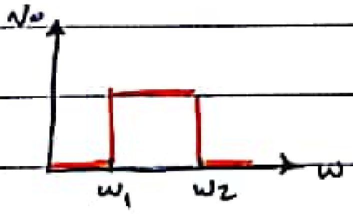


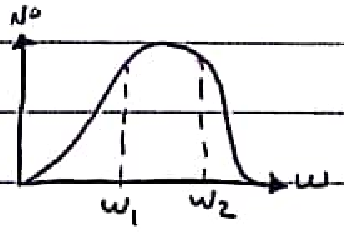
2) High pass filter (HPF),



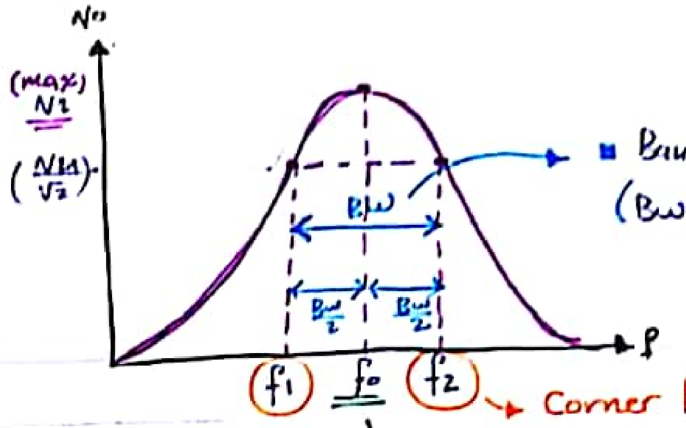


3) Band passing filter (BpF)





BPF



■ Band width ($B_w = f_2 - f_1$)

→ Corner frequency (3dB)

→ Center Frequency (Resonent frequency)

■ $f_o = f_1 + \frac{B_w}{2}$

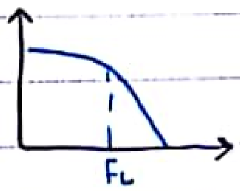
(OR)

■ $f_o = f_2 - \frac{B_w}{2}$

*وهي ال (f) التي تجعل ال(Impedance)
[pure R] يعني (Imagne part=0)

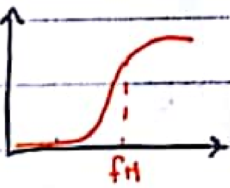
BPF

(1) LPF + HPF



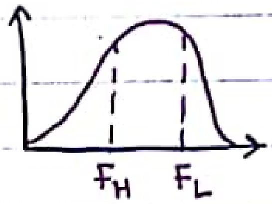
(LPF)

+



(HPF)

=



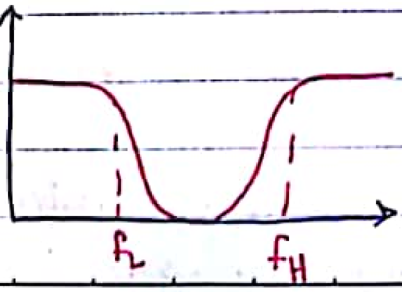
(BPF)

◄ بشرط أن تكون ($F_L > F_H$)

◄ لو كانت ($f_H > f_L$) تصبح الرسمة (BSF)

*Resonent circuit
- RLC series
- RLC parallel

(BsF)



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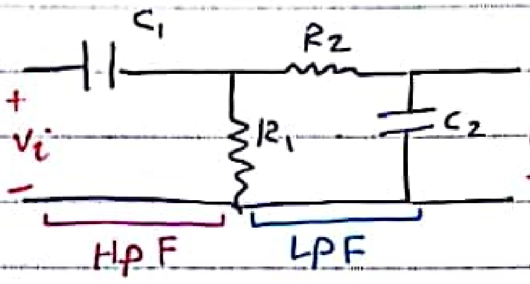
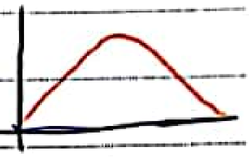
LPF + HPF



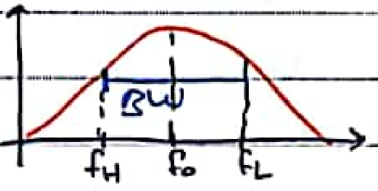
« كيف نحدد انه LPF + HPF ؟

- $\omega = 0 \rightarrow X_{C_1} = \frac{1}{\omega C_1} = o.c$
  - $X_{C_2} = o.c$
  - $V_o = 0$
- $\omega = \infty \rightarrow X_{C_1} = 0 = s.c$
  - $X_{C_2} = 0 \quad s.c$
  - $V_o = 0$

(بدأ بالصفر)
(وانتهى بالصفر)



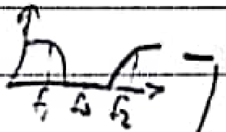
- $F_H = \frac{1}{2\pi R_1 C_1}$
- $f_L = \frac{1}{2\pi R_2 C_2}$



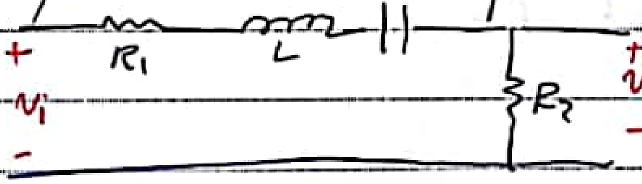
$f_o = \frac{f_L + f_H}{2}$

$BW = f_L - f_H$

$f_o = f_H + \frac{fw}{2} \longrightarrow = f_L - \frac{\varphi w}{2}$



② RLC series



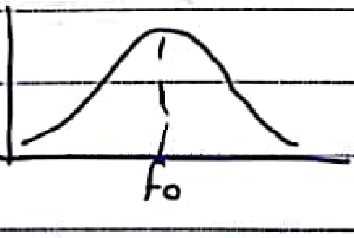
Find f_o resonant frequency

$Z_{eq} = R_1 + j\omega L + \frac{1}{j\omega C} + R_2$

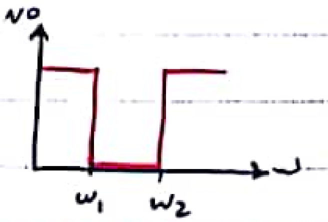
$Z_{eq} = R_1 + R_2 + j(\omega L - \frac{1}{\omega C})$

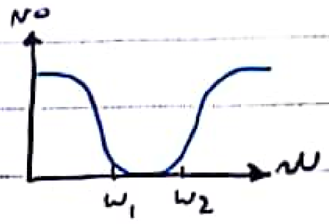
- $\omega = 0 \rightarrow X_C = \infty \ (o.c)$
  - $X_L = 0 \ (s.c)$
  - $V_o = 0$
- $\omega = \infty \rightarrow X_C = 0 \quad s.c$
  - $X_L = \infty \quad o.c$
  - $V_o = 0$

BPF

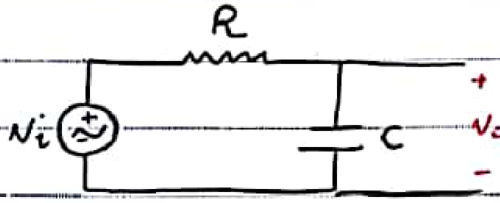


4) Band step filter (BSF)



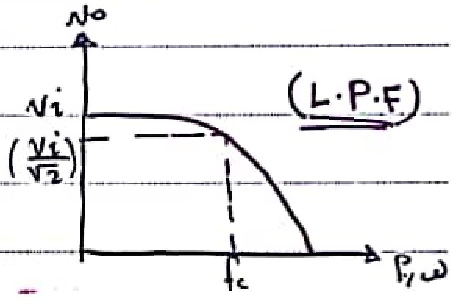


RC



$$V_o = \frac{Z_c}{Z_c+R}\cdot V_{in} \rightarrow \frac{V_o}{V_i} = \frac{Z_c}{Z_c+R} \rightarrow \frac{V_o}{V_i} = \frac{1}{1+j\omega CR}$$

$$\left|\frac{V_o}{V_i}\right| = \frac{1}{\sqrt{1+\omega^2C^2R^2}} = \frac{1}{\sqrt{1+\frac{\omega^2}{1/R^2C^2}}}$$

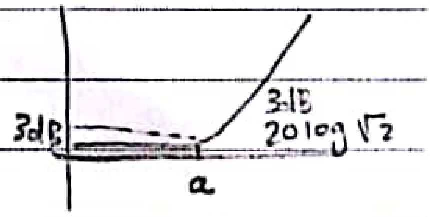


- $\omega = 0 \rightarrow \left|\frac{V_o}{V_{in}}\right| = 1 \rightarrow V_o = V_{in}$

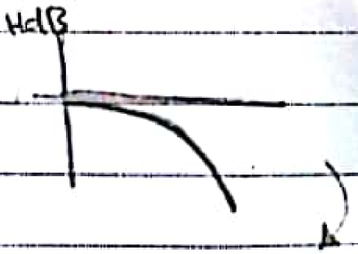
$Z_c = \frac{1}{j\omega C} = \infty$ (o.c)

- $\omega = \infty \rightarrow \left|\frac{V_o}{V_{in}}\right| = 0 \rightarrow V_o = 0$

$Z_c = \frac{1}{j\omega C} = 0$ (s.c)



$\omega_c = \frac{1}{RC} = 2\pi f \rightarrow f_c = \frac{1}{2\pi RC}$

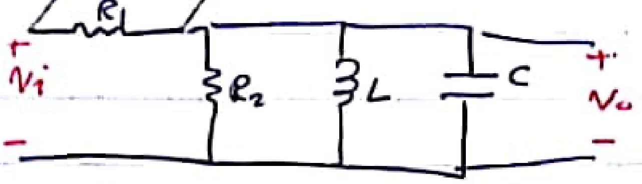


$\left|\frac{V_o}{V_{in}}\right| = \frac{1}{\sqrt{2}} \rightarrow V_o = \frac{V_{in}}{\sqrt{2}}$

الرسم بال (Bode plot)

B.S.F

For parallel RLC



$Z_{eq} = R_1 + R_2 \;//\; \frac{1}{j\omega C} \;//\; j\omega L$

- at $(f = f_0)$ resonat frequency → Z_{eq} = Real → Imgn = صفر

- $\omega_0 = \frac{1}{\sqrt{LC}}$ - $f_0 = \frac{1}{2\pi\sqrt{LC}}$

BPF مختبر الفلتر

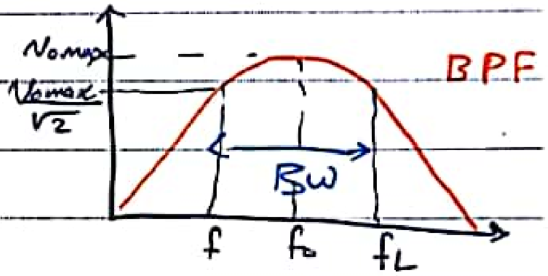
- $\underline{\omega = 0} \rightarrow C \rightarrow o.c$, $\hookrightarrow L \rightarrow s.c$ $\}$ $V_o = 0$
- $\underline{\omega = \infty} \rightarrow C \rightarrow s.c$, $\hookrightarrow L \rightarrow o.c$ $\}$ $V_o = 0$

$\frac{R}{X_C}\}$

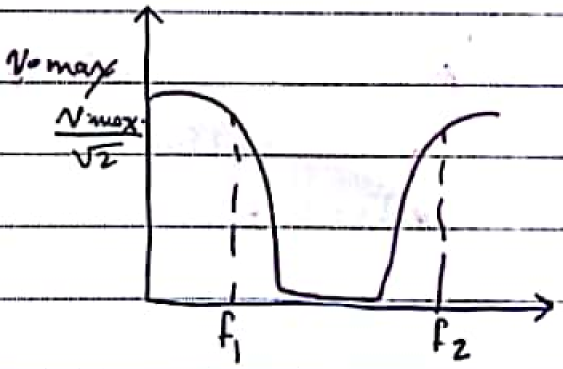
$Q = \omega_0 RC$

$Bw = \frac{\omega_0}{Q} = \frac{1}{RC}$ (rad/s)

$Bw = \frac{f_0}{Q} = \frac{1}{2\pi RC}$ (Hz)



- $f_1 = f_0 - \frac{Bw}{2}$ - $f_2 = f_0 + \frac{Bw}{2}$



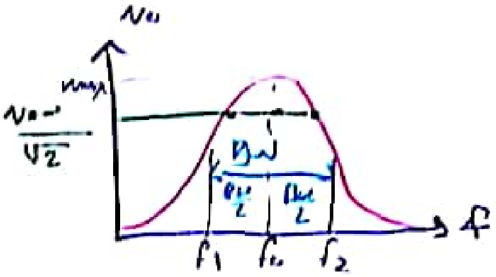
3dB → √2

At $f = f_0$ Resonant

Z_{eq} = pure Resistance / Imag = 0

$$\omega_0 L - \frac{1}{\omega_0 C} = 0 \longrightarrow \boxed{\omega_0 = \frac{1}{\sqrt{LC}}}$$

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$



At $f = f_0$ $\boxed{Z_{eq} = R_1 + R_2}$

$$\boxed{V_{omax} = \frac{R_2}{R_1 + R_2} V_{in}}$$

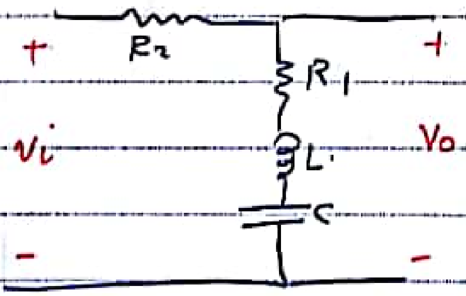
Quality factor (Q)

$$Q = \frac{\omega_0 L}{R_{eq}} = \frac{\omega_0 L}{R_1 + R_2}$$

$$BW = \frac{\omega_0}{Q} = \frac{\cancel{\omega_0}}{\frac{\cancel{\omega_0} L}{R}} = \frac{R}{L} \text{ (rad/s)}$$

$$BW = \frac{f_0}{Q} = \frac{f_0}{\frac{2\pi f_0 L}{R}} = \frac{R}{2\pi L} \text{ (Hz)}$$

- $f_1 = f_0 - \frac{BW}{2}$
- $f_2 = f_0 + \frac{BW}{2}$

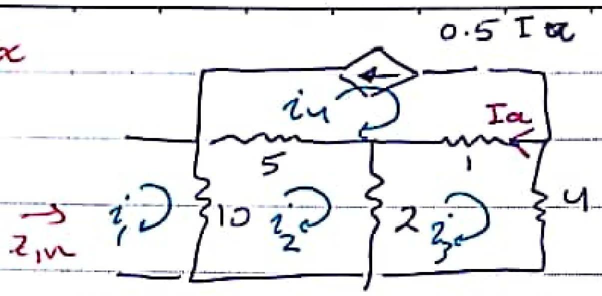


- $\omega = 0 \rightarrow C \rightarrow$ o.c
  $\hookrightarrow L \rightarrow$ s.c $\Big\}$ $V_o = V_{in}$
- $\omega = \infty \rightarrow C \rightarrow$ s.c
  $\hookrightarrow L \rightarrow$ o.c $\Big\}$ $V_o = V_{in}$

$\boxed{BSF}$

- $\omega_0 = \frac{1}{\sqrt{LC}}$
- $Q = \frac{\omega_0 L}{R}$
- $BW = \frac{\omega_0}{Q}$

Ex



$$\Delta Z = \begin{bmatrix} 10 & -10 & 0 & 0 \\ -10 & 17 & -2 & -5 \\ 0 & -2 & 7 & -1 \end{bmatrix}$$

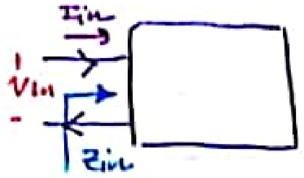
$i_4 = -0.5 I_a = -0.5 (I_4 - I_3)$

$i_4 = -.05 I_4 + 0.5 I_3 \longrightarrow \boxed{1.5 I_4 - 0.5 I_3 = 0}$

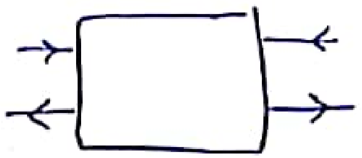
$Z_{in} = 3.7 \ \Omega$

❖ Port network

pair of Input and output terminals.



(One port)



(Two port)

$$R_{in} = \frac{V_i}{I_{in}}$$

▶▶ R input for one port network using determinent methode:

$$a_{11} I_1 + a_{12} I_2 + \cdots + a_{1n} I_N = V_1 \rightarrow \text{Mesh ①.}$$

$$a_{21} I_1 + a_{22} I_2 + \cdots + a_{2n} I_N = V_2 \rightarrow \text{Mesh ②}$$

$$\vdots$$

$$a_{n1} I_1 + a \cdots + a_{NN} I_N = V_N \rightarrow \text{Mesh Ⓝ}$$

$$\underbrace{\begin{bmatrix} a_{11} & a_{12} \cdots & a_{1N} \\ \vdots & & \\ a_{N1} & \text{———} & a_{NN} \end{bmatrix}}_{\Delta a} \begin{bmatrix} I_1 \\ I_2 \\ \vdots \\ I_N \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \\ \vdots \\ V_N \end{bmatrix}$$

$$I_1 = \frac{\begin{bmatrix} V_1 V_2 & a_{12} \text{—} & a_N \\ \vdots & & \\ V_N & & a_N \end{bmatrix}}{\Delta a}$$

▶ To find Rin → Kill sources

- $V_s = 0 \rightarrow (S.C)$
- $I_s = 0 \rightarrow (O.C)$

$\big\}\ V_2 = V_3 \cdots V_N = 0$

$$I_1 = \frac{\begin{bmatrix} V_1 & a_{12} & a_{1N} \\ 0 & a_{22} & \vdots \\ 0 & & \\ 0 & & a_{NN} \end{bmatrix}}{\Delta a} \longrightarrow \frac{\begin{bmatrix} a_{22} & \text{———} & a_{2N} \\ \vdots & & \\ a_{2N} & \text{—} & a_{NV} \end{bmatrix} V_1}{\Delta a}$$

$I_1 = \frac{\Delta_{11}}{\Delta^a}$ V_1

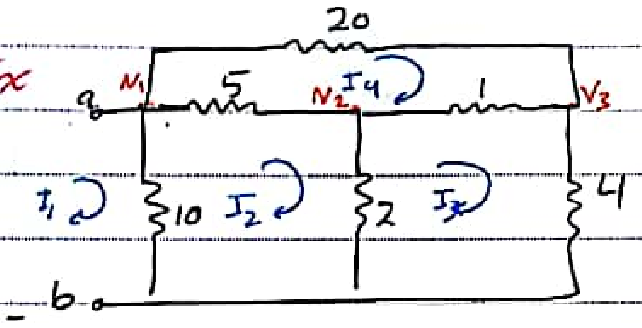
- $\Delta_{11} \rightarrow$ minar m

$$\boxed{\frac{V_1}{I_1} = \frac{\Delta a}{\Delta_{11}}} = R_{in}$$

- $G_{in} = \frac{\Delta_{11}}{\Delta a} \rightarrow = \frac{\Delta Y}{\Delta_{11}}$

- $Z_{in} = \frac{\Delta a}{\Delta_{11}}$
- $Y_{in} = \frac{\Delta Y}{\Delta_{11}}$

Ex



▶ Find Rin ??

$V_1 = 10(i_1 - I_2) = 10i_1 - 10i_2$ Mesh

$10(i_2 - i_1) + 5(i_2 - i_3) + 2(i_2 - i_3) = 0$

Nodel $\rightarrow$ $\frac{V_1}{10} + \frac{V_1 - V_0}{5 \quad 4} + \frac{V_1 - V_3}{20}$

$R_{in} = \frac{\Delta R}{\Delta_{11}}$

$$\Delta R = \begin{bmatrix} 10 & -10 & 0 & 0 \\ -10 & 17 & -2 & -5 \\ 0 & -2 & 7 & -1 \\ 0 & -5 & -1 & 26 \end{bmatrix} = \underline{9680}$$

- $R_{in} = \frac{9680}{2778} = \boxed{3.48\,\Omega}$

$$\Delta_{11} = \begin{bmatrix} 17 & -2 & -5 \\ -2 & 7 & -1 \\ -5 & -1 & 26 \end{bmatrix} = \underline{2778}$$

- $G_{in} = \frac{1}{R_{in}} = \boxed{0.347\,\Omega}$

No.

- $Y_{21} = \frac{I_2}{V_1}\Big|_{V_2=0}$

$Y_{21} = \underline{-V_1/10}$

$Y_{21} = -0.15\,S$

$$\Delta Y = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} = \begin{bmatrix} 0.3 & -0.1 \\ -0.1 & 0.5 \end{bmatrix}$$

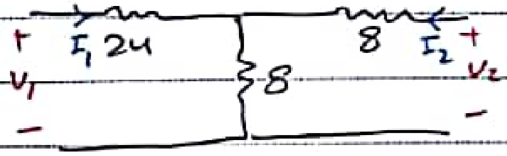
$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 0.3 & -0.1 \\ -0.1 & 0.5 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

$I_1 = 0.3V_1 - 0.1V_2$

$I_2 = -0.1V_1 + 0.5V_2$

- Z - parameter
- Impedance parameter
- open circuit parameter

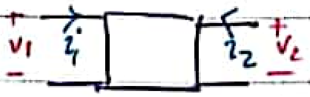
- $Z_{11} = \frac{V_1}{I_1}\Big|_{I_2=0}$
- $Z_{12} = \frac{V_1}{I_2}\Big|_{I_1=0}$
- $Z_{21} = \frac{V_2}{I_1}\Big|_{I_2=0}$
- $Z_{22} = \frac{V_2}{I_2}\Big|_{I_1=0}$



- $Z_{11} = \frac{V_1}{I_1}\Big|_{I_2=0} = 42+8 = 32\,\Omega$
(open circuit)

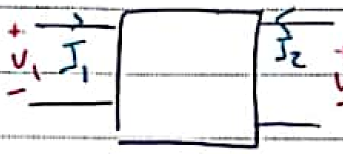
- $Y_{11} = \frac{1}{(8\|8+24)}$ → (parmeter) Z تختلف عن Y وليسوا عكس بعض في ال ⇐
(short circuit)

No.

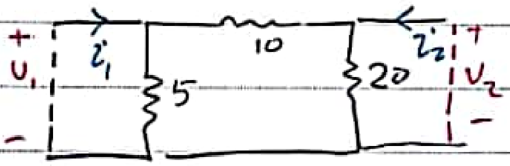


$$Y = \frac{I}{V}$$

- Y - parameter
- Admetance -parameter
- Short circuit



- $Y_{11} = \frac{I_1}{V_1}\Big|_{V_2=0}$
- $Y_{12} = \frac{I_1}{V_2}\Big|_{V_1=0}$
- $Y_{22} = \frac{I_2}{V_2}\Big|_{V_1=0}$
- $Y_{21} = \frac{I_2}{V_1}\Big|_{V_2=0}$



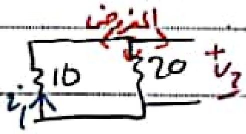
- $Y_{11} = \frac{I_1}{V_1}\Big|_{V_2=0}$

$$Y_{11} = \frac{\cancel{I_1}}{\cancel{I_1}(5//10)} = 0.3 \quad S$$

- $Y_{22} = \frac{I_2}{V_2}\Big|_{V_1=0}$

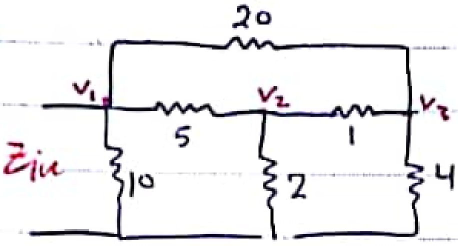
$$Y_{22} = \frac{V_2/(10//20)}{V_2} = \frac{1}{(10//20)} = 0.15 \ S$$

- $Y_{12} = \frac{I_1}{V_2}\Big|_{V_1=0}$



$$Y_{12} = \frac{-V_2/10}{V_2} = -0.15$$

Ex



$$\frac{V_1}{10} + \frac{V_1 - V_2}{5} + \frac{V_1 - V_3}{20}$$

$$\left(\frac{1}{10} + \frac{1}{5} + \frac{1}{20}\right) - \frac{V_2}{5} - \frac{V_3}{20} = 0$$

$$\Delta Y = \begin{array}{ccc} V_1 & V_2 & V_3 \\ \left(\frac{1}{10}+\frac{1}{5}+\frac{1}{20}\right) & \left(-\frac{1}{5}\right) & \left(-\frac{1}{20}\right) \\ \left(-\frac{1}{5}\right) & \left(\frac{1}{2}+\frac{1}{5}+1\right) & -1 \\ \frac{-1}{20} & -1 & \left(\frac{1}{4}+1+\frac{1}{20}\right) \end{array}$$

$$\begin{bmatrix} 0.3 & -0.2 & -0.05 \\ -0.2 & 1.7 & -1 \\ -0.05 & -1 & 1.3 \end{bmatrix} = 0.347 \; \underline{S} \; \mho \text{ semens}$$

$$\Delta_{11} = \begin{bmatrix} 1.7 & -1 \\ -1 & 1.3 \end{bmatrix} = 1.21$$

- $Y = \dfrac{\Delta Y}{\Delta_{11}} = 0.287 \; S$
- $Z = \dfrac{1}{Y} = 3.48$

* هذه الطريقة عندما يكون كل الـ(source) ـ(independent)

- $Z_{22} = \frac{V_2}{I_2}\Big|_{I_1=0} = 8+8 = 16\Omega$

- $Z_{12} = \frac{V_1}{I_2}\Big|_{I_1=0} = \frac{I_2 8}{I_2} = 8\Omega$ لما $I=0$ يعني $V=0$

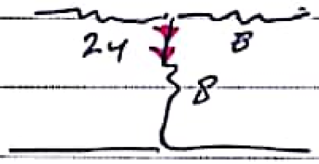
- $Z_{21} = \frac{V_2}{I_1}\Big|_{I_2=0} = \frac{8 I_1}{I_1} = 8\Omega$

$$\Delta Z = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} = \begin{bmatrix} 32 & 8 \\ 8 & 16 \end{bmatrix}$$

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 32 & 8 \\ 8 & 16 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$V_1 = 32 I_1 \textcircled{+} 8 I_2 \rightarrow$ الاشارة موجبة لأن التيارات بنفس الاتجاة

$V_2 = 8 I_1 + 16 I_2$



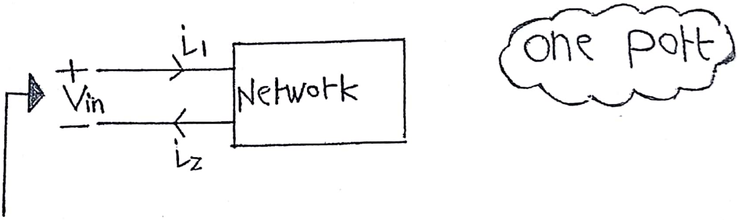
$$Y_{22} = \frac{1}{(24 \parallel 8) + 8} \rightarrow \frac{1}{16}$$

$$Y_{22} \neq \frac{1}{Z_{22}} \neq 16$$

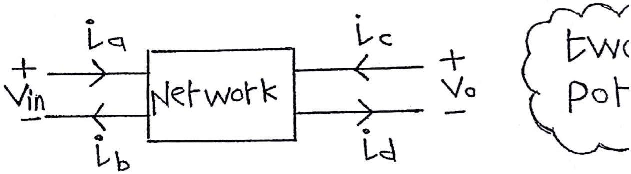
Chapter (17) : Two-Port Network

17.1 : ONE Port Networks :

Port → pair of terminals.



$$\frac{V_{in}}{I_1} = R_{in}$$



*One port network :

$$R_{in} = \frac{V_{in}}{I_{in}}$$

$$V_1 = a_{11} X + a_{12} y + a_{13} Z$$

$$V_2 = a_{21} X + a_{22} y + a_{23} Z$$

$$V_3 = a_{31} X + a_{32} y + a_{33} Z$$

(1)

$$\underbrace{\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}}_{\Delta a} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}$$

$$x = \frac{\begin{vmatrix} V_1 & a_{12} & a_{13} \\ V_2 & a_{22} & a_{23} \\ V_3 & a_{32} & a_{33} \end{vmatrix}}{\Delta a}$$

$$y = \frac{\begin{vmatrix} a_{11} & V_1 & a_{13} \\ a_{21} & V_2 & a_{23} \\ a_{31} & V_3 & a_{33} \end{vmatrix}}{\Delta a}$$

$$= \frac{\begin{vmatrix} a_{11} & a_{12} & V_1 \\ a_{21} & a_{22} & V_2 \\ a_{31} & a_{32} & V_3 \end{vmatrix}}{\Delta a}$$

Mesh Equation :-

$$Z_{11}I_1 + Z_{12}I_2 + \cdots + Z_{1N}I_N = V_1$$

$$Z_{21}I_1 + Z_{22}I_2 + \cdots + Z_{2N}I_N = V_2$$

$$\vdots$$

$$Z_{N1}I_1 + Z_{N2}I_2 + \cdots + Z_{2N}I_N =$$

---

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$$V_2 = V_3 = \cdots V_n = 0$$

$$\underbrace{\begin{bmatrix} Z_{11} & Z_{12} \cdots & Z_{N} \\ Z_{21} & Z_{22} \cdots & Z_{2N} \\ Z_{31} & Z_{32} \cdots & Z_{3N} \\ \vdots & & \\ Z_{N1} & Z_{N2} \cdots & Z_{NN} \end{bmatrix}}_{\Delta Z} \begin{bmatrix} I_1 \\ I_2 \\ \vdots \\ I_N \end{bmatrix} = \begin{bmatrix} V_1 \\ V_2 \\ \vdots \\ V_N \end{bmatrix}$$

(3)

$$= \frac{\begin{bmatrix} V_1 & Z_{12} & \cdots & Z_{1N} \\ V_2 & Z_{22} & & \\ \vdots & \vdots & & \\ V_N & Z_{N2} & \cdots & Z_{NN} \end{bmatrix}}{\Delta Z}$$

$$= \frac{\begin{bmatrix} Z_{12} & Z_{13} & \cdots & Z_{1N} \\ \vdots & & & \\ Z_{N2} & \cdots & & Z_{NN} \end{bmatrix}}{\Delta Z} \Rightarrow \begin{matrix}\text{minor} \\ \Delta_{11}\end{matrix}$$

$$_1 = \frac{V_1 \; \Delta_{11}}{\Delta_z}$$

$$\boxed{\frac{V_1}{I_1} = \frac{\Delta Z}{\Delta_{11}} = Z_{in}}$$

Mesh.

$$Y_{in} = \frac{1}{Z_{in}}$$

$$Y_{in} = \frac{\Delta Y}{\Delta_{11}}$$

For Nodal analysisi:

$$\frac{\Delta Y}{\Delta_{11}} = Y_{in}$$

EXA:

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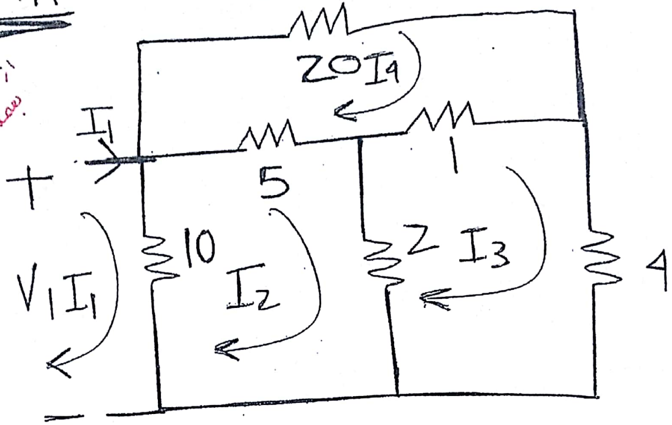
s.c ← Ⓥ
o.c ← Ⓘ
ازاي كان معمول



find Input Resistance for one port using determinant theo

* By mesh:-

Sol. $Z_{in} = \dfrac{\Delta Z}{\Delta_{11}}$

[illegible]

$$\Delta Z = \begin{array}{c} \\ \\ \\ \\ \end{array}\begin{array}{cccc} I_1 & I_2 & I_3 & I_4 \\ \end{array}$$

$$\Delta Z = \begin{vmatrix} 10 & -10 & 0 & 0 \\ -10 & 17 & -2 & -5 \\ 0 & -2 & 7 & -1 \\ 0 & -5 & -1 & 26 \end{vmatrix} = 968\ \Omega$$

→ possi ti

$Z_{ij} \Rightarrow i = j \rightarrow$ possitive

$i \neq j \rightarrow$ negative

(5

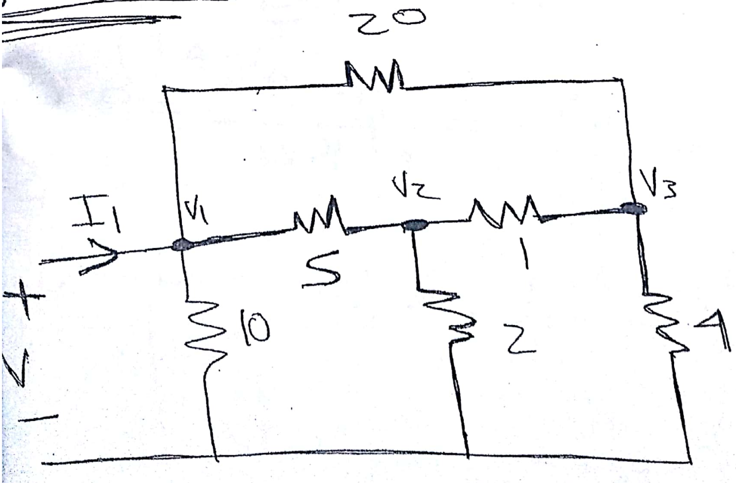
$$= \begin{bmatrix} 17 & -2 & -5 \\ -2 & 7 & -1 \\ -5 & -1 & 26 \end{bmatrix}$$

$$= 2778$$

$$= 3.48\ \Omega.$$

$$\text{in} = 0.287\ \mho.$$

Nodal:



(6)

$$\Delta Y = \begin{array}{c} \\ \\ \\ \end{array}\left[\begin{array}{ccc} V_1 & V_2 & V_3 \\ \frac{1}{10}+\frac{1}{5}+\frac{1}{20} & -\frac{1}{5} & -\frac{1}{20} \\ -\frac{1}{5} & \frac{1}{1}+\frac{1}{5}+\frac{1}{2} & -1 \\ -\frac{1}{20} & -1 & \frac{1}{20}+\frac{1}{4}+1 \end{array}\right]$$

$$= \begin{bmatrix} 0.35 & -0.2 & -0.05 \\ -0.2 & 1.7 & -1 \\ -0.05 & -1 & 1.3 \end{bmatrix}$$

$$= 0.347$$

$$\Delta_{11} = \begin{bmatrix} 1.7 & -1 \\ -1 & 1.3 \end{bmatrix} = 1.2$$

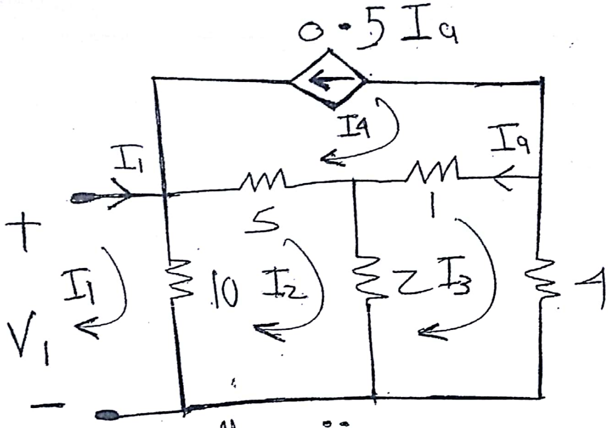
$$Y_{in} = \frac{\Delta Y}{\Delta_{11}} = \frac{0.347}{1.2} = 0.28$$

S

$$Z_{in} = \frac{1}{Y} = 3.48\ \Omega.$$ #

(7

x:



نفس السؤال ?

$$_4 = -0.5 I_a$$

$$_a = (I_4 - I_3)$$

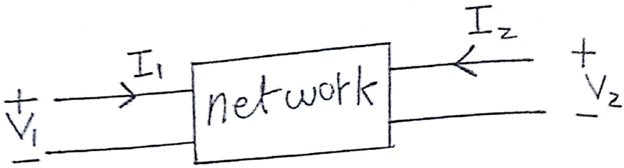
$$.5 I_3 + 1.5 I_4 = 0$$

$$t = \begin{bmatrix} 10 & -10 & 0 & 0 \\ -10 & 17 & -2 & -5 \\ 0 & -2 & 7 & -1 \\ 0 & 0 & -0.5 & 1.5 \end{bmatrix} = 590\,\Omega$$

$$\Delta_{11} = \begin{bmatrix} 17 & -2 & -5 \\ -2 & 7 & -1 \\ 0 & -0.5 & 1.5 \end{bmatrix} = 15$$

$Z_{in} = 3.71\,\Omega$.

17.2) Two port network:



Y-Parameters / Short circuit Parame

/ Admittance.

$$I_1 = Y_{11} V_1 + Y_{12} V_2$$

$$I_2 = Y_{21} V_1 + Y_{22} V_2$$

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix}$$

(10

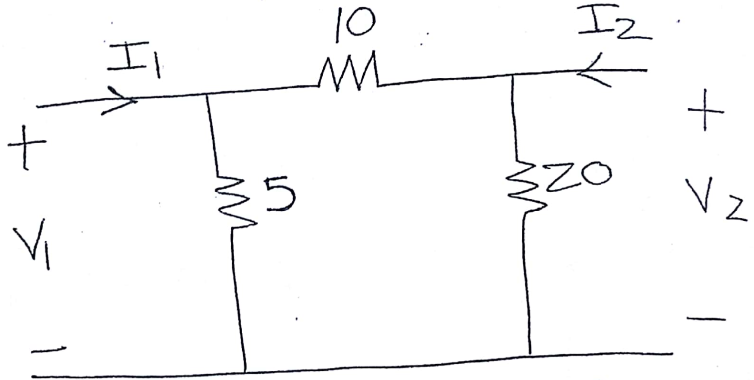
$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0}$$

$$Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0}$$

$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0}$$

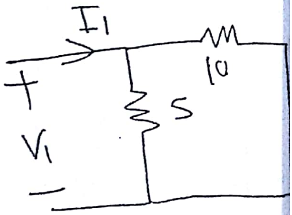
$$Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0}$$

EXA:



find Y-parameters

short circuit parameters



Sol: $Y_{11} = \frac{I_1}{V_1}\Big|_{V_2=0}$

$I_1 = \frac{V_1}{5 // 10}$

$\frac{I_1}{V_1} = Y_{11} = \frac{1}{5//10} = 0.3\ S.$

(12

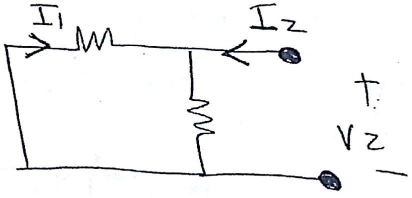
$$_2 = \frac{I_2}{V_2}\Big|_{V_1=0} = \frac{1}{20||10}$$

$$_2 = (20||10) I_2 \rightarrow \frac{I_2}{V_2} = \frac{1}{20||10}$$

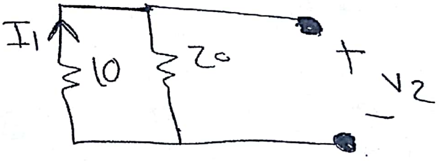
$$= Y_{22}$$

$$= 0{\cdot}15S!.$$

$$_{12} = \frac{I_1}{V_2}\Big|_{V_1=0}$$



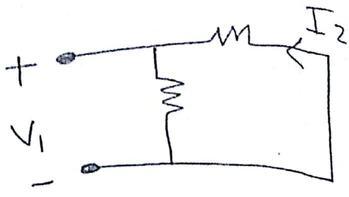
$$= \frac{-V_2}{10}$$



$$_2 = \frac{-1}{10} = Y_{12}$$

$$= -0{\cdot}1$$

$$Y_{21} = \frac{I_2}{V_1}\Big|_{V_2=0}$$



$$I_2 = \frac{-V_1}{10}$$

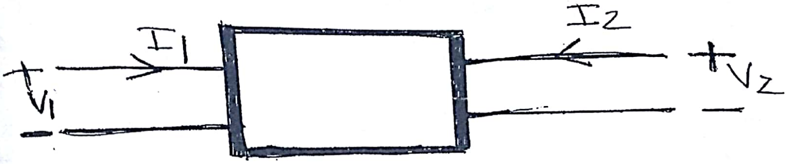
$$\frac{I_2}{V_1} = -\frac{1}{10} = -0.1 = Y_{21}$$ #

$$\therefore\ Y = \begin{bmatrix} 0.3 & -0.1 \\ -0.1 & 0.15 \end{bmatrix}$$

$$I_1 = 0.3V_1 - 0.1V_2$$

$$I_2 = -0.1V_1 + 0.15V_2$$

4) Impedence, Z, open circuit parameters



$$V_1 = Z_{11} I_1 + Z_{12} I_2$$

$$V_2 = Z_{21} I_1 + Z_{22} I_2$$

$$Z_{11} = \frac{V_1}{I_1}\Big|_{I_2=0}$$

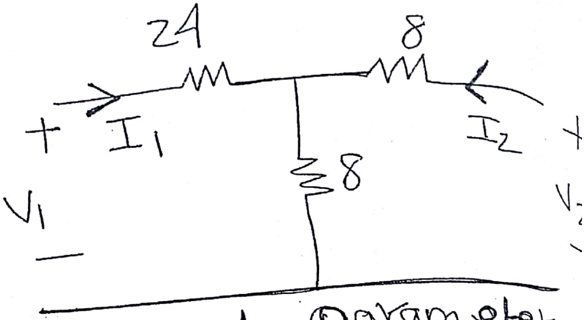
Y ليست عكس ال Z

$$_{12} = \frac{V_1}{I_2}\Big|_{I_1=0}$$

$$_{21} = \frac{V_2}{I_1}\Big|_{I_2=0}$$

$$_{22} = \frac{V_2}{}\Big|_{I}$$

EXA:



find open cct parameter (Z parameter) ? :-

Sol.

$Z_{11} = \frac{V_1}{I_1}\Big|_{I_2=0} = 24+8 = 32$

or:

$V_1 = I_1(24+8)$

$\frac{V_1}{I_1} = Z_{11} = \underline{32\,\Omega}$

$Z_{22} = \frac{V_2}{I_2}\Big|_{I_1=0} = 8+8 = 16\,\Omega$

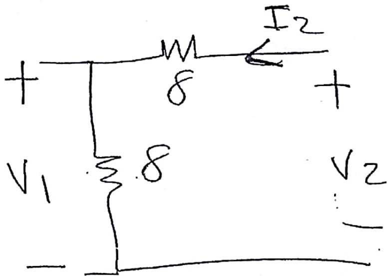
$\frac{V_2}{I_2} = Z_{22} = 16\,\Omega$ (1

$V_2 = I_2(8+8) = 16\Omega$

$12 = \left.\frac{V_1}{I_2}\right|_{I_1=0}$

$V_1 = 8 I_2$

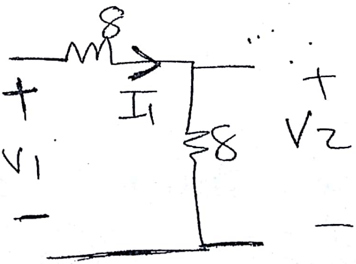
$\frac{V_1}{I_2} = Z_{12} = 8\Omega$



$21 = \left.\frac{V_2}{I}\right|_{I_2=0}$

$=8I_1$

$= Z_{21} = 8\Omega$



$$Z = \begin{bmatrix} 32 & 8 \\ 8 & 16 \end{bmatrix}$$

$$V_1 = 32 I_1 + 8 I_2$$

$$V_2 = 8 I_1 + 16 I_2$$

$$Z_{\text{parameter}} \neq \frac{1}{Y_{\text{parameter}}}$$

* Short cct. → Y parameter.

* Open cct. → Z parameter.

---

z port ✓ filter ✓ 3-phase ✓ S ✓

(1