AC part (03)

AC Circuit Theory Techniques

حل الدوائر الكهربية تحتوي على AC (components → source) باستخدام نظريات:

- Node
- Mesh
- Delta-Y
- Source transformation
- Superposition
- Thevenin's & Norton's

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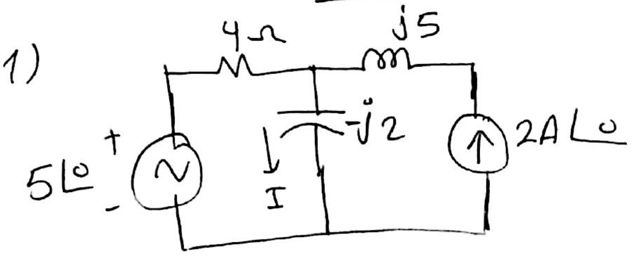
[1] Don't forget $Z = \frac{V}{I}$ = magnitude $\angle$ phase — مهم جداً

Power Factor = Cos [phase]

طب PF خد Z وجيب Cosine الزاوية

EX(1)

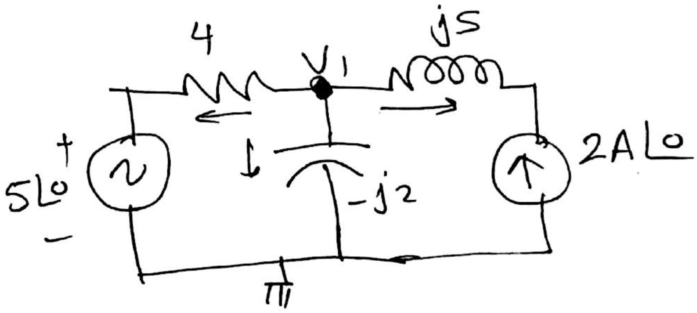


Determine I using

- Node
- Mesh
- Superposition
- Thevenin's
- Source transformation

[1] Node method

هنا مجموع التيارات الخارجة = صفر



$\therefore \frac{V_1 - 5\angle 0}{4} + \frac{V_1}{-j2} - 2A\angle 0 = 0$

$\therefore \frac{V_1}{4} - \frac{5}{4} - \frac{V_1}{2j} - 2 = 0$

$\frac{V_1}{4} - \frac{5}{4} - \frac{V_1}{2j}\cdot\frac{j}{j} - 2 = 0 \longrightarrow \frac{V_1}{4} - \frac{5}{4} + \frac{jV_1}{2} - 2 = 0$

$V_1\left[\frac{1}{4} + \frac{j}{2}\right] = \frac{5}{4} + 2 = \frac{13}{4}$

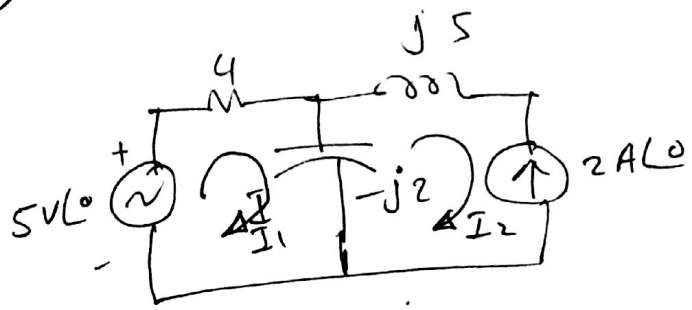
$V_1 = \frac{13/4}{\frac{1}{4} + j/2} = \frac{13}{1+2j} = \frac{13\angle 0}{\sqrt{1+4}\angle \tan^{-1} 2} = \frac{13\angle 0}{2.23\angle 63.43}$

$\boxed{V_1 = 5.81\angle -63.43^\circ}$

$\therefore I = \frac{V_1}{-j2} = \frac{5.81\angle -63.43}{2\angle -90} = 2.9\angle 26.56\ A$

(2)

2- Mesh Loop



loop 1

$5\angle 0 = (4-j2)I_1 - (-j2I_2)$

$\therefore 5\angle 0 = (4-j2)I_1 + 2jI_2 \longrightarrow (1)$

loop 2 $I_2 = -2A\angle 0$ معلوم مقدار معلوم

substitude in (1) $\therefore 5 = (4-j2)I_1 + 2j \times (-2)$

$5 = [4-2j]I_1 - 4j \rightarrow (5+4j) = (4-2j)I_1$

$\therefore I_1 = \frac{5+4j}{4-2j} = \frac{\sqrt{25+16}\ \angle \tan^{-1}\frac{4}{5}}{\sqrt{16+4}\ \angle \tan^{-1}\frac{-2}{4}} = \frac{6.4\angle 38.66}{4.47\angle -26.56}$

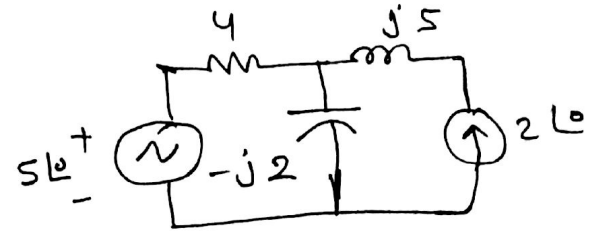
$I_1 = 1.43\angle 65.22$

$\therefore I = I_1 - I_2 = 1.43\angle 65.22 - (-2)$

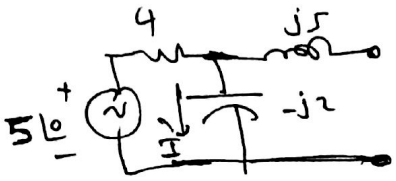
$= (1.43\cos 65.22) + j(1.43\sin 65.22) + 2$

$I = 2.6 + 1.3j = 2.9\angle 26.56^\circ$

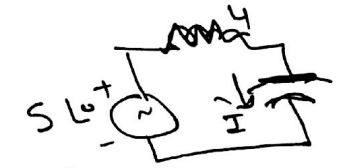
(3) Superposition



[1] 1st step open Circuit Current source



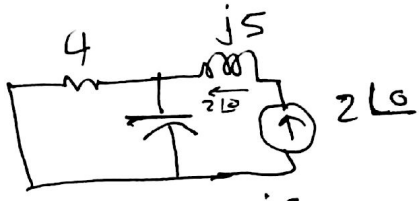
ثم نطبق اى نظرية قديمة لحساب التيار I' ونسميه I' على أن الـ open circuit



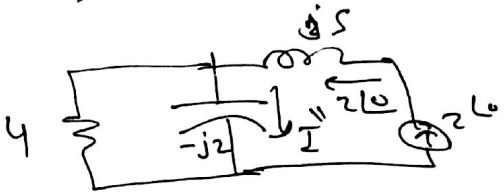
الدائرة تكافئ دائرة مقفرة قصر

$$\therefore I' = \frac{5\angle 0}{4 - 2j} = \frac{5\angle 0}{4.47\angle -26.57} = 1.118\angle 26.57$$

[2] 2nd step S.C voltage source



Using current divider to calc. I''



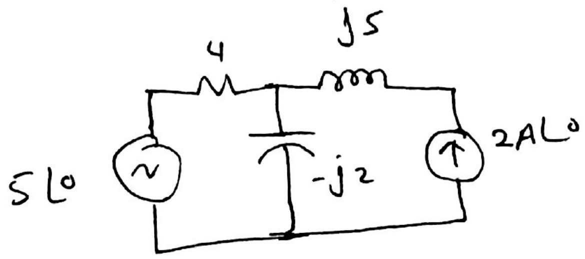
$$I'' = \frac{I_{total} \times 4}{4 - 2j} = \frac{2 \times 4\angle 0}{4 - 2j}$$

$$= \frac{8\angle 0}{4.47\angle -26.57} = 1.789\angle 26.57$$

$$\Rightarrow I = I' + I'' = 1.118\angle 26.57 + 1.789\angle 26.57$$

$$= 2.9\angle 26.56$$

4) Source transformation



1st equivalent circuit

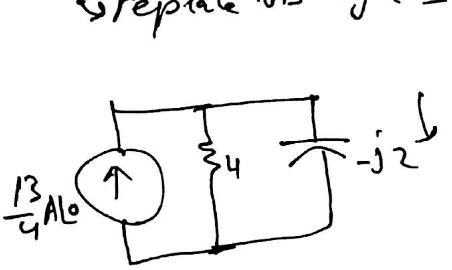
replace V.S by C.S

→ coil removed (has no effect with independent source)

- اتفقنا أن current source لو كان independent ومتوصل معاه مقاومة series أو أي element نهمل الـ element

ولو independent voltage source ومتوصل معاه توازي مقاومة أو أي element نعتبر الـ element o.c

⇒



$$I = \frac{\frac{13}{4}\angle 0 * 4}{4 - j2} = \frac{13\angle 0}{4.47\angle -26.56} = 2.9\angle 26.56^\circ$$

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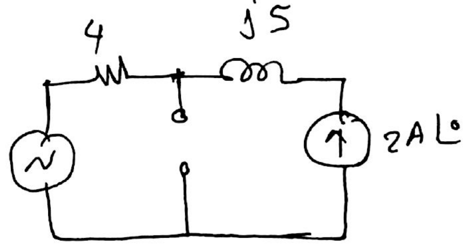
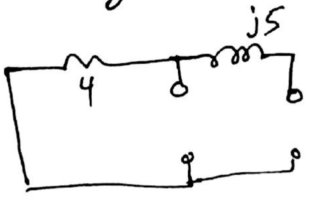
5) Thevenin

1) open circuit the capacitor (اللي اتشال)

2) calc. V_{th}, Z_{th} across cap



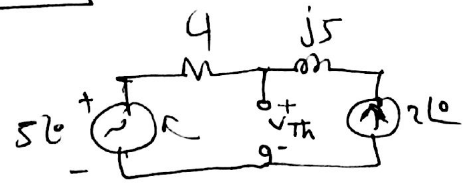
a) to calc Z_{th} (o.c current source, s.c voltage source)



j5 cancelled open ~~c~~

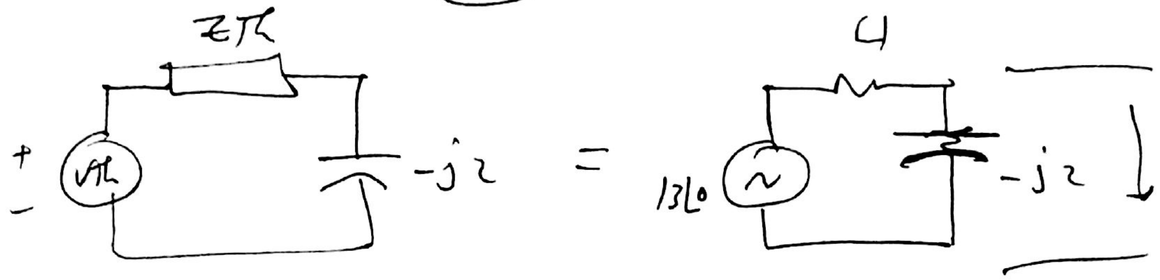
$\therefore Z_{th} = 4\,\Omega$ only

b) calc. V_{th} using KVL



Loop 1: $5 - V_{Th} = 4I$ $\quad\therefore\quad 5 - V_{Th} = 4 \times -2$

~~loop 2 Vth = 2∠0 j5~~ $I = -2\angle 0$ $\quad V_{Th} = 13\angle 0$



$$I = \frac{13\angle 0}{4 - j2} = 2.9\angle 26.56$$

لا عليك استخدم Δ-Y في المسائل السابقة لأنه لو استخدمتها هيفيد فقط وقتية المكثف والمراد حساب التيار فقط

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* مسائل عامة للمراجعة	* المحاضرة القادمة DC & AC

Good Luck!

Quiz

لاحظ لو قابلت معادلتين (Mesh loop) مثلاً

$2\angle 30 = (2+j)I_1 + (3-2j)I_2$ → $2\cos 30 + j2\sin 30$

$4\angle 60 = (5-2j)I_1 + (4)I_2$ → $4\cos 60 + j4\sin 60$

خلي بالك!! الأسهل تستخدم المحددات بعد تحويل الـ complex source

$$\Delta = \begin{vmatrix} 2+j & 3-2j \\ 5-2j & 4 \end{vmatrix} = \text{نفكها} \qquad \Delta_1 = \begin{vmatrix} 2\cos 30 + j2\sin 30 & 3-2j \\ 4\cos 60 + j4\sin 60 & 4 \end{vmatrix} = \text{نفكها}$$

$$\Delta_2 = \begin{vmatrix} 2+j & 2\cos 30 + j2\sin 30 \\ 5-2j & 4\cos 60 + j4\sin 60 \end{vmatrix} = \text{نفكها}$$

$\therefore I_1 = \frac{\Delta_1}{\Delta}$ $\qquad$ $I_2 = \frac{\Delta_2}{\Delta}$