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ELEG2202 Homework3

Q1. 1) Find the phasor corresponding to the following signal:
(a) i(t) = -5 sin (50t +20°) mA

2) Obtain the sinusoidal signal corresponding to the following phasor:
(a) $V_1 = 6 + j8$ V, ω = 20

Q2. A network consisting of an independent current source and a dependent current source is shown in Fig. 1, please find the Thevenin equivalent circuit as seen from node a and b.

Hints: you can use the Method 2 for R_{th} determination.

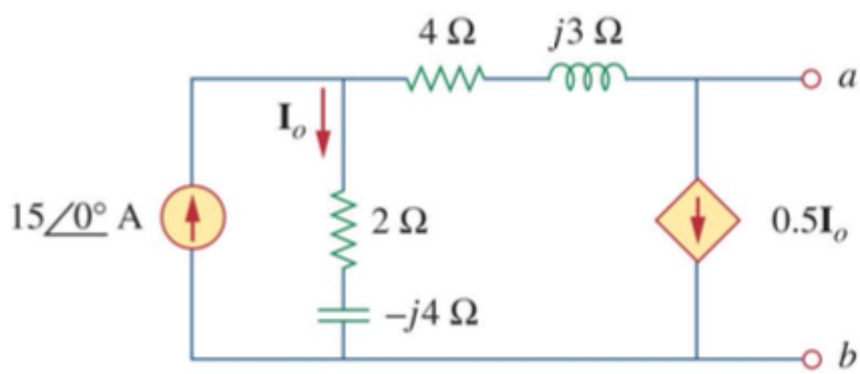


Figure 1

Q3. Find I_o using Norton equivalent circuit seen from node a, b.

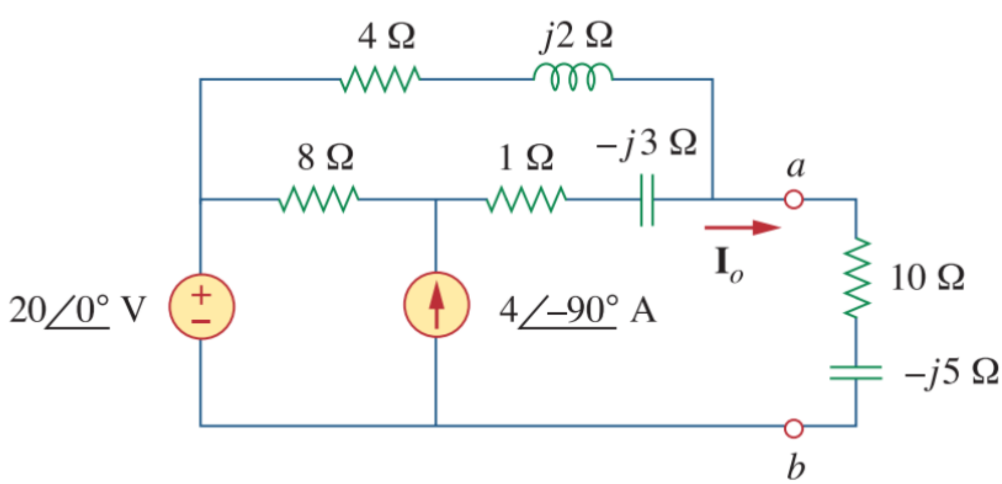


Figure 2

Q4. The voltage across a load is v(t) = 10cos(ωt + 20°)V and the current

through the element in the direction of the voltage drop is
$i(t) = 2\sin(\omega t - 40°)$ A. Find:
(a) the complex and apparent powers,
(b) the average power and the load impedance.

(Q1)

Q1. 1) Find the phasor corresponding to the following signal:

(a) $i(t) = -5 \sin(50t + 20°)$ mA

2) Obtain the sinusoidal signal corresponding to the following phasor:

(a) $V_1 = 6 + j8$ V, $\omega = 20$

a) $i(t) = -5 \sin(50t+20°)$ mA

$= 5 \cos(50t + 20° + 90°) = 5\angle 110°$ mA

2) $V_1 = 6 + j8$ V $= 10 \angle 53.13°$

$\omega = 40$

$\therefore V_1(t) = 10 \cos(\omega t + 53.13°)$

$= 10 \cos(40t + 53.13)$

Q2. A network consisting of an independent current source and a dependent current source is shown in Fig. 1, please find the Thevenin equivalent circuit as seen from node a and b.

Hints: you can use the Method 2 for R_{th} determination.

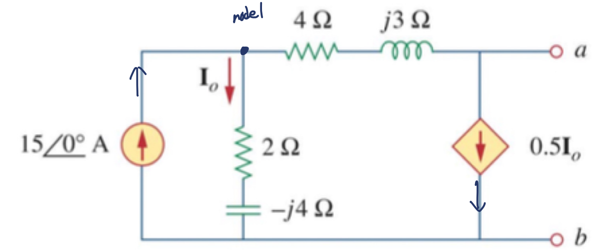


Figure 1

Let node 1 be position in Fig,

By KCL,

$15 = I_o + 0.5 I_o$

$I_o = 10$ A

By KVL

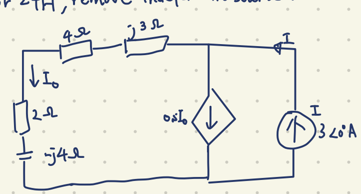
$-I_o(2-j4) + 0.5 I_o(4+j3) + V_{TH} = 0$

$\therefore V_{TH} = 10(2-j4) - 5(4+j3)$

$= -j55$

$= 55\angle -90°$ V

For Z_{TH}, remove independent source and connect 3A constant source



By KCL,

$3 = I_o + 0.5 I_o$

$I_o = 2A$

By KVL

$V_s = I_o(4 + j3 + 2 - j4)$

$= 2(6 - j)$

$\therefore Z_{TH} = \frac{V_s}{I_s} = \frac{2(6-j)}{3} = 4 - j\frac{2}{3}\,\Omega$

Q3. Find I_o using Norton equivalent circuit seen from node a, b.

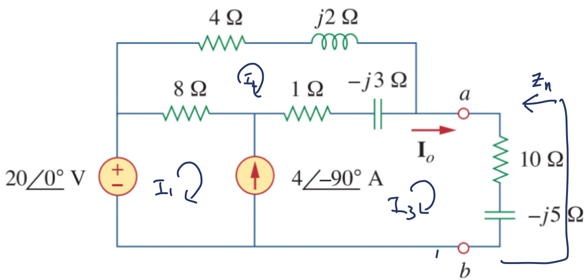


Figure 2

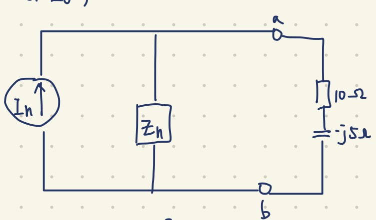
For Z_n, $Z_n = (8+1-j3) \,||\, (4+j2)$

$= (9-j3)(4+j2) / (9-j3+4+j2)$

$= 42+j6 / 13-j1$

$= 3.176 + j0.706$

For I_o, circuit like



$$I_o = I_N \cdot \left(\frac{Z_n}{Z_n + 10 - j5}\right)$$

$$= (4.198\angle -32.68^\circ) \cdot \left(\frac{3.176 + j0.706}{13.176 - j5 + j0.706}\right)$$

$$= (4.198\angle -32.68^\circ)(0.202 + j0.1195)$$

$$= 0.9853\angle -2.1^\circ \text{A} \;//$$

By KVL in mesh 2,

$8(I_2 - I_1) + (4+j2)(I_2) + (1-j3)(i_2 - I_3) = 0$

$-8I_1 + (8+4+j2+1-j3)I_2 - (1-j3)I_3 = 0$

$-8I_1 + (13-j1)I_2 - (1-j3)I_3 = 0 \longrightarrow (1)$

By KCL in Supermesh (mesh 1+mesh 3),

$-I_1 - 4\angle 90^\circ + I_3 = 0$

$I_3 = I_1 + 4\angle 90^\circ$

$-I_1 + 0I_2 + I_3 = -j4 \longrightarrow (2)$

By KVL in Supermesh,

$-20\angle 0^\circ + 8(I_1 - I_2) + (1-j3)(I_3 - I_2) = 0$

$8(I_1) + (-8-1+j3)I_2 + (1-j3)I_3 - 20 = 0$

$8(I_1) + (j3-9)I_2 + (1-j3)I_3 = 20 \longrightarrow (3)$

$$\therefore \begin{bmatrix} -8 & (13-j1) & (j3-1) \\ -1 & 0 & 1 \\ 8 & (j3-9) & (1-j3) \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 0 \\ -j4 \\ 20 \end{bmatrix}$$

$$\Delta = \begin{vmatrix} -8 & (13-j1) & (j3-1) \\ -1 & 0 & 1 \\ 8 & (j3-9) & (1-j3) \end{vmatrix}$$

$$= (-8)\begin{vmatrix} 0 & 1 \\ j3-9 & 1-j3 \end{vmatrix} - (13-j1)\begin{vmatrix} -1 & 1 \\ 8 & 1-j3 \end{vmatrix} + (j3-1)\begin{vmatrix} -1 & 0 \\ 8 & j3-9 \end{vmatrix}$$

$$= -8(9-j3) - (13-j1)(-9+j3) + (j3-1)(9-j3)$$

$$= 42 + j6$$

$$\Delta_3 = \begin{vmatrix} -8 & 13-j1 & 0 \\ -1 & 0 & -j2 \\ 8 & j3-9 & 10 \end{vmatrix}$$

$$= 162 - j74$$

$$i_3 = \frac{162 - j74}{42 + j6} = 3.533 - j2.667 \text{A}$$

$I_n = i_3 = 4.198\angle -32.68^\circ$

+

$10\angle 20^\circ$

Q4. The voltage across a load is v(t) = 10cos(ωt + 20°)V and the current through the element in the direction of the voltage drop is i(t) = 2sin(ωt - 40°) A. Find: $2\cos(\omega t - 130^\circ)$

(a) the complex and apparent powers,

(b) the average power and the load impedance.

a) $v(t) = 10\angle 20^\circ$

$i(t) = 2\sin(\omega t - 40^\circ) = 2\cos(\omega t - 90^\circ - 40^\circ) = 2\angle -130^\circ$

Complex power $= S = VI^*$

$= 10\angle 20^\circ \; 2\angle +130^\circ$

$= 20\angle 150^\circ$

$= 20\cos(150) + j\,20\sin(150)$

$= -17.32 + j10$ //

Apparent Power $= |S| = \sqrt{(-17.32)^2 + (10^2)}$

$= 19.99$ VA //

b) averager power $= VI\cos(\theta_v - \theta_i)$

$= (10)(2)\cos(20 - (-130))$

$= 20\cos(150)$

$= -17.32$ W //

load Impedance

$V = IZ$

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

$= \frac{10\angle 20^\circ}{2\angle -130^\circ}$

$= 5\angle 150^\circ$ //