AIUB COURSE SOLUTION

ELECTRICAL CIRCUITS-02 (AC)
SPRING 16-17

MANNAN SIR’S MID-TERM ASSIGNMENT NUMBER-02 SOLUTION

SRABONI BHUIYAN

AIUB COURSE SOLUTION

A.C.S

TOGETHER WE CAN ACHIEVES MORE

American International University-Bangladesh (AIUB)
Engineering Faculty
EEE 2101: Electrical Circuits-2 (AC)

Assignment 02 [Total 10 Marks]

Submission Date	Marks	Tick on following
With in March 09, 2017	10	
March, 12, 2017 to March 13, 2017	8	
March, 14, 2017 to March 15, 2017	4	
After Feb. 23, 2017	0	

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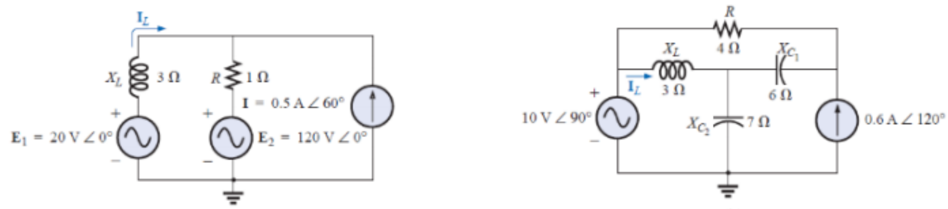
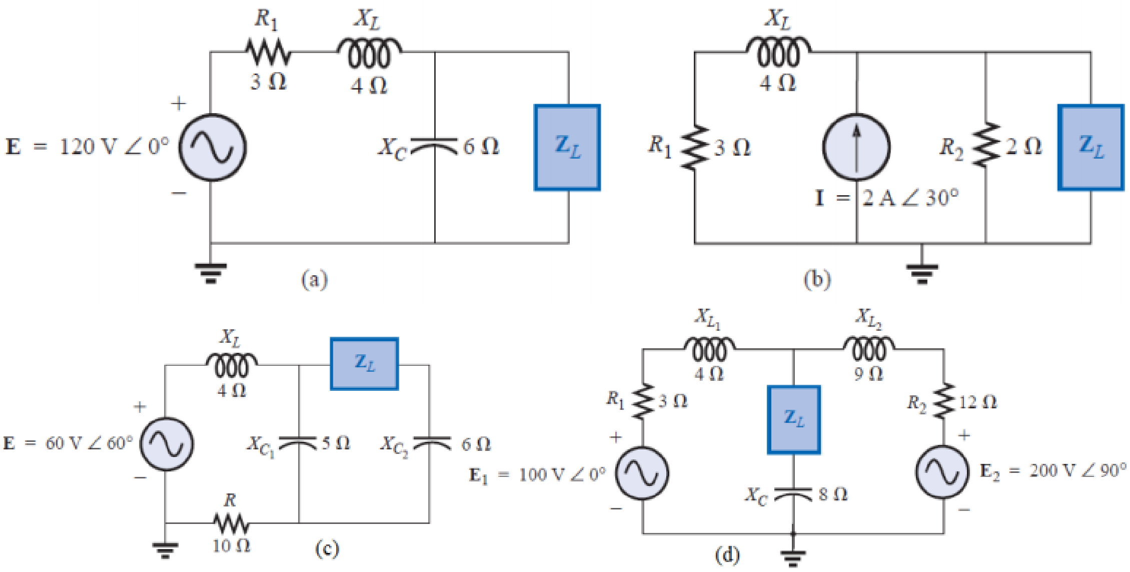
[1] Using superposition, determine the current through the inductance X_L for each network as shown in the following figure.



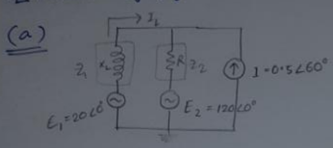
(a) (b)

[2] (***i***) Find the Thévenin equivalent circuit (Z_{TH} and E_{TH}) at the terminal of load impedance Z_L. Draw the Thevenin equivalent circuit.
(***ii***) Find the Norton equivalent circuit (Z_N and E_N) at the terminal of load impedance Z_L. Draw the Thevenin equivalent circuit.
(***iii***) Find the value of load impedance to received maximum power.
(***iv***) Calculate the maximum power consumed by load impedance.



Answer of 1:

(a)

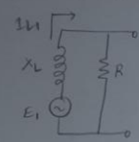


here,

$Z_1 = j3\,\Omega$

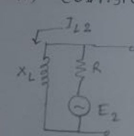
$Z_2 = 1\,\Omega$

i) Consider $E_1 = 20\angle 0°$, $E_2 = 0$ (short) and $I = 0$ (open)



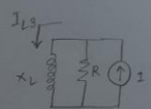
$$Z_{T1} = Z_1 + Z_2 = 1 + j3$$
$$= 3.16\angle 71.57°$$
$$\therefore I_{L1} = \frac{E_1}{Z_{T1}} = \frac{20\angle 0°}{3.16\angle 71.57°}$$
$$= 6.33\angle -71.57$$

ii) consider $E_2 = 120\angle 0°$, $E_1 = 0$ (short) and $I = 0$ (open)



$$Z_{T2} = 3.16\angle 71.57°$$
$$\therefore I_{L2} = \frac{E_2}{Z_{T2}} = \frac{120\angle 0°}{3.16\angle 71.57°}$$
$$= 38\angle -71.57°$$

(iii) consider $I = 0.5\angle 60°$, $E_1 = 0$ (Short) and $E_2 = 0$ (short)



using CDR:

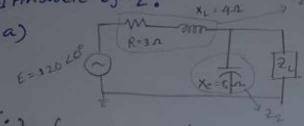
$$I_{L3} = \frac{Z_2}{Z_1 + Z_2} I$$
$$= \frac{0.5\angle 60°}{1 + j3}$$
$$\therefore I_{L3} = 0.16\angle -11.57$$

$$\therefore \text{Total } I_L = I_{L1} - I_{L2} - I_{L3}$$
$$= (6.33\angle -71.57) - (38\angle -71.57) - (0.16\angle -11.57)$$
$$= 31.77\angle 108.73°$$

(Ans.)

Answer of 2:

(a)

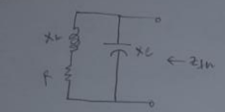


here,

$z_1 = 3 + 4j$

$z_2 = -6j$

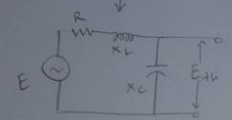
(i) for thevenin's :



$$Z_{th} = Z_1 \parallel Z_2$$

$$= \frac{(3+4j)(-6j)}{3+4j-6j}$$

$$= 8.31 - j0.46$$

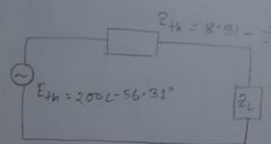


using VDR :

$$E_{th} = \frac{z_2}{z_1 + z_2} \times E$$

$$= \frac{(-6j)}{3+4j-6j} \times (120\angle 0^\circ)$$

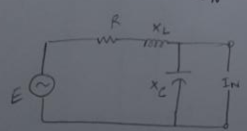
$$\therefore E_{th} = 200\ \angle -56.31^\circ$$



[Thevenin's Equivalent Circuit]

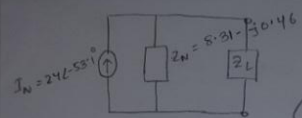
(ii) for Norton's :-

$$Z_N = Z_{th} = 8.31 - j0.46$$



$$I_N = \frac{E}{z_1} = \frac{120\angle 0^\circ}{3+j4}$$

$$= 24\ \angle -53.13$$



(Norton's Equivalent Circuit)

(iii) Value of load Impedence :

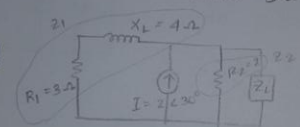
$$Z_{load} = Z_{th}^{*} = 8.31 + j0.46$$

(iv) The maximum power :

$$P_{max} = \frac{E_{th(rms)}^2}{4 \times R_{Load}} = \frac{(200)^2}{4 \times 8.32}$$

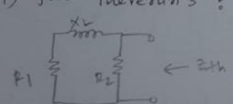
$$= 1201.92 \text{ W (Ans.)}$$

(b)



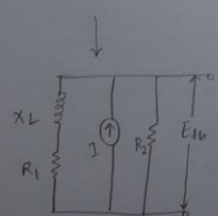
here,
$Z_1 = 3 + j4$
$Z_2 = 2$

(i) for therenin's :



here, $I = 0$ (open)

$$Z_{th} = Z_1 \parallel Z_2 = \frac{(3+j4)(2)}{3+j4+2} = 1.5 + j0.4$$



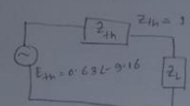
Using CDR :

$$I_{R2} = \frac{\cancel{Z_2}\, Z_1}{Z_1 + Z_2} \times I = \frac{3+j4}{3+j4+2}(2\angle 30°) = 0.31 - j0.05$$

$\therefore\ E_{th} = I_{R2} \times Z_2$

$= (0.31 - j0.05)\,2$

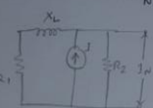
$= 0.63 \angle -9.16$



[Thevenin Equivalent circuit]

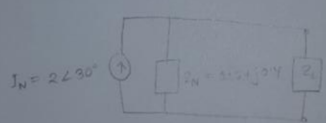
(ii) for Norton's :

$Z_N = 1.5 + j0.4$



here, Z_1 and Z_2 is ~~pal~~ parallel to current source 'I' :

$\therefore\ I_N = I = 2\angle 30^\circ$



[Norton's equivalent circuit]

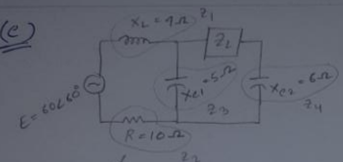
(iii) Value of load Impedence :

$Z_{load} = Z_{th}^{*} = 1.5 - j0.4$

(iv) The maximum power :

$$P_{max} = \frac{E_{th\,(rms)}^{2}}{4 \times R_{load}} = \frac{(0.63)^2}{4 \times 1.5} = 0.1\ W$$

(c)



here,

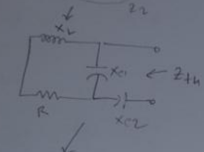
$Z_1 = j4$

$Z_2 = 10$

$Z_3 = -5j$

$Z_4 = -6j$

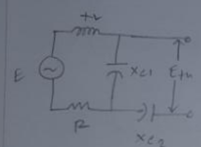
(i)



$$Z_{th} = \frac{(Z_1 + Z_2) Z_3}{Z_1 + Z_2 + Z_3} + Z_4$$

$$= \frac{(10 + 4j)(-5j)}{10 + 4j - 5j} + (-6j)$$

$$\therefore Z_{th} = 2.5 - 4.8j$$

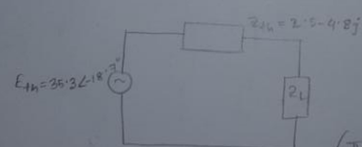


using VDR:

$$E_{th} = \frac{Z_3}{(Z_1 + Z_2) + Z_3} \times E$$

$$= \frac{(-6j)}{10 + 4j - 6j} (60\angle 60^\circ)$$

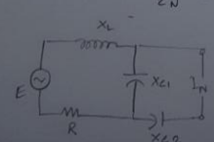
$$\therefore E_{th} = 35.3 \angle 18.7^\circ$$



(Thevenin's Equivalent Circuit)

(ii) for Norton's :

$$Z_N = Z_{th} = 2.5 - j4.8$$



here,

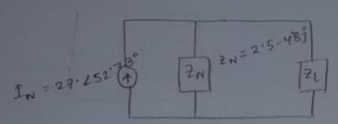
$$Z_T = 10 + 4j + \frac{(-5j)(-6j)}{(-5j - 6j)}$$

$$= 10 + 1.3j$$

$$I_T = \frac{E}{Z_T} = \frac{60\angle 60^\circ}{10 + j11.3} = 3.6 + 4.73j$$

$$\therefore I_N = \frac{(-5j)}{-5j - 6j}(3.6 + 4.73j) \quad \text{[using CDR]}$$

$$\Rightarrow I_N = 1.64 + j2.15 = 2.7\angle 52.73^\circ$$



[Norton's Equivalent circuit]

(iii) Value of load impedence:

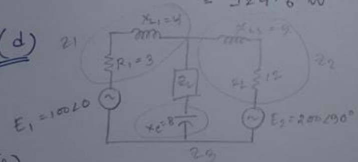
$$Z_{load} = Z_{th}^{*} = 2.5 + j4.8$$

(iv) The maximum power:

$$P_{max} = \frac{E_{th(rms)}^2}{4 \times R_{load}} = \frac{(35.3)^2}{4 \times 2.5}$$

$$= 124.6 \text{ W}$$

(d)



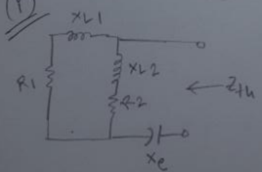
here,

$$Z_1 = 3 + 4j$$

$$Z_2 = 12 + j9$$

$$Z_3 = -8j$$

(i)



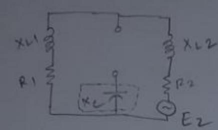
$$Z_{th} = (Z_1 \parallel Z_2) + Z_3$$

$$= \frac{(3+4j)(12+j9)}{3+j4+12+j9} - 8j$$

$$= 2.47 - 5.14j$$

for E_{th} :-

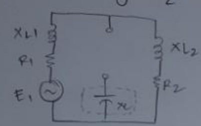
considering $E_1 = 0$



$$E_{th1} = \frac{Z_1}{Z_1+Z_2} \times E_2$$
$$= \frac{3+j4}{3+j4+12+9j} (200\angle 90°)$$

$\therefore E_{th1} = 50.4\angle 102.22°$

considering $E_2 = 0$;

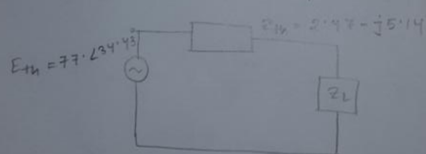


$$E_{th2} = \frac{Z_2}{Z_1+Z_2} \times E_1$$
$$= \frac{12+j9}{3+j4+12+j9} (100\angle 0°)$$

$\therefore E_{th2} = 75\angle -4.04°$

$\therefore E_{th} = E_{th1} + E_{th2} = (50.4\angle 102.22 + 75\angle -4.04°)$

$= 77.77\angle 34.43°$

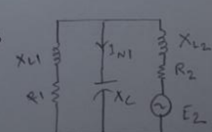


(ii) for Nortons' :-

$$Z_N = Z_{th} = 2.47 - j5.14$$

for I_N :-

considering $E_1 = 0$;



$$R_T = \frac{Z_1 Z_3}{Z_1 + Z_3} + Z_2$$

$$= \frac{(3+4j)(-8j)}{3+4j-8j} + (12+9j)$$

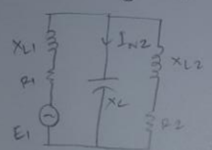
$$= 19.7 + j11.24$$

$$I_T = \frac{E_2}{R_2} = \frac{200\angle 90}{19.7+j11.24} = 4.38 + j7.77$$

$$\therefore I_{N1} = \cancel{4+3j} \; \frac{3+4j}{3+4j-8j}\left(4.38 + j7.7\right)$$

$$= 8.86 \angle 166.63^\circ$$

considering $E_2 = 0$;



here,

$$\therefore Z_T = \frac{Z_3 Z_2}{Z_2 + Z_3} + Z_1$$

$$= \frac{(12+j9)(-8j)}{12+j9-8j} + 3+4j$$

$$= 8.3 - 4.44j$$

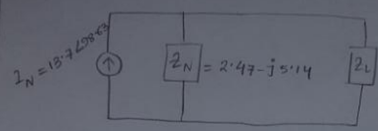
$$I_T = \frac{E_1}{Z_T} = \frac{100\angle 0^\circ}{8.3-4.44j} = 9.37 + 5.02j$$

$$I_{N2} = \frac{12+j9}{12+j9-8j}\left(9.37+5.02j\right)$$

$$= 13.24 \angle 60.28^\circ$$

$$\therefore I_N = I_{N1} + I_{N2} = 8.86\angle 166.63^\circ + 13.24\angle 60.28$$

$$= 13.7 \angle 98.63^\circ$$



[Norton's Equivalent circuit]

(iii) Value of load impedende:

$$Z_{load} = Z_{th}^{*} = 2.47 + j5.14$$

(iv) maximum power:

$$P_{max} = \frac{E_{th(rms)}^2}{4 \times R_{load}} = \frac{(77.77)^2}{4 \times 2.47}$$

$$= 612.16 \text{ W (Ans.)}$$