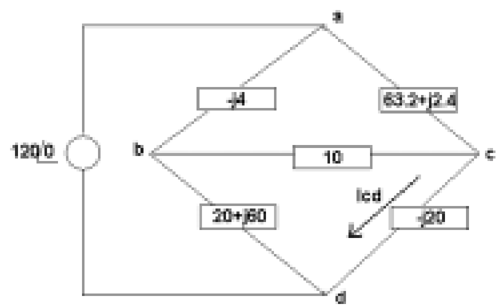
EECE301 Network Analysis II Dr. Charles Kim

Note 11: Phasor Transformation Application Examples

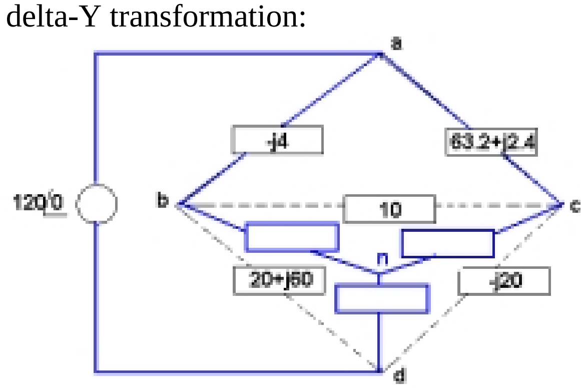
1. Δ-Y Transformation:
   Q: Find current I_{cd} in the circuit below.



Solution:

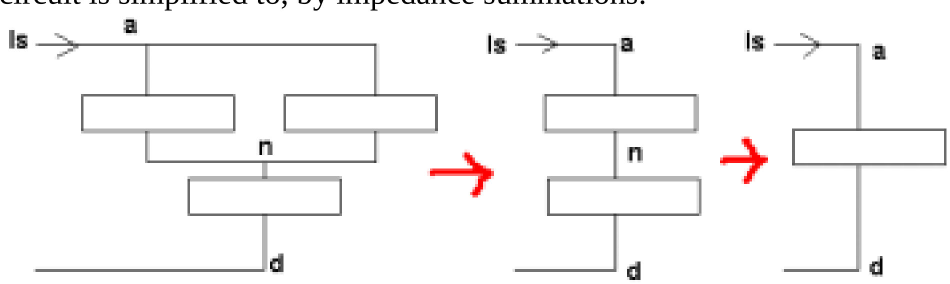
(1) From the circuit above, we see two delta's (top and bottom), and we know that we have to convert one of them to Y-shape. Which delta do you choose to convert to Y-shape? Why?

(2) By the your answer above, we decide to convert the bottom one. Then, Y-impedances are as follows, after applying the delta-Y transformation:



(3) Remember, one more node ("n") is added. But, our target is still the current between the nodes "c" and "d". That means: $I_{cd} = \dfrac{V_{cd}}{-j20}$

The above circuit is simplified to, by impedance summations:



(4) Let’s get some analysis here:
 Since our target is the voltage between node c and node d, we have to derive a few voltage equations.

First, $V_{cd} = (----) + (------)$

Second, $(----) = I_s \cdot (--------)$

Third, $(---) =$

Therefore, $V_{cd} =$

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(5) Finally,

$$I_{cd} = \frac{V_{cd}}{-j20} =$$

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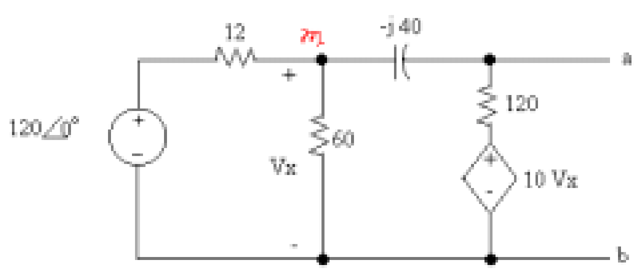
2. Thevenin Equivalent Circuit Problem:

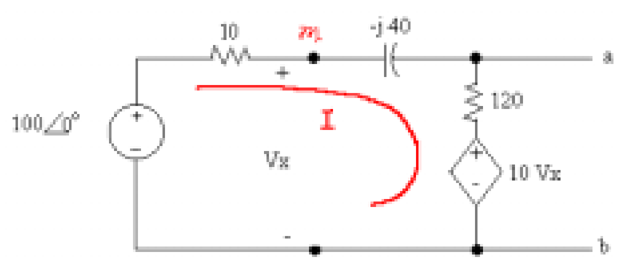
Q.Find the Thevenin equivalent circuit at the terminals *a* and *b* of the circuit below.



SOLUTION

(1) Since there is another node other than *a* and *b*, let’s mark it as *m*.

(2) We can simplify the circuit left of the nodes *m* and *b* by applying a few source transformations, as shown below.



(3) Let's find and express the constraint, Vx.

V_x is the voltage from *m* through *a* to *b*. So the Vx equation is: $V_x =$ ______

(4) Let's express the Thevenin (or terminal *a* and *b*) voltage using the constraint:

$V_{th} = V_{ab} =$ __________

(5) Now, let's apply KVL around.

KVL equation:

____

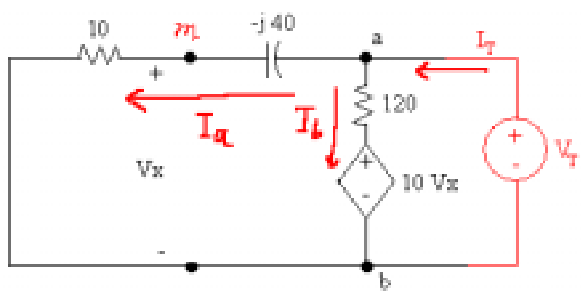
Therefore, the current I: $\bar{I} =$ _________________

(6) From the equation we got at (4) above, we have the following equation for the Thevenin voltage:

$V_{th} = V_{ab} =$ _____________________

Part 2: R_{th}

(1) Let's deactivate the independent source. Also, let's apply a test source. Also, mark two branch currents as I_a and I_b. Then the circuit becomes like this:



(2) Note that the node voltage V_a is same as the test voltage V_T.

Also, the constraint equation around V*x* can be expressed by: $V_x =$ ______

In addition, the current I_a is: $I_a =$ ______

(3) Let's express the test current at node *a*:

$I_T = I_a + I_b =$ ________________

Arranging the above equation, we have:

$$I_T = \underline{\hspace{6cm}}$$

(4) Therefore,

$$Z_{th} = \frac{V_T}{I_T} = \underline{\hspace{5cm}}$$

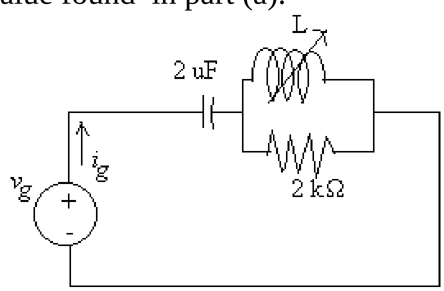
(5) Finally, the Thevenin equivalent circuit is:

3. Phasor Example: In-phase Condition

Q.The circuit shown below is operating in the sinusoidal steady state. The inductor is adjusted until the current i_g is in-phase with the sinusoidal voltage v_g.

(a) Specify the inductance (in Henry) if v_g=100 cos 500t [V].

(b) Find i_g when ***L*** has the value found in part (a).



SOLUTION:

Part (a):

(1) "In-Phase" relationship means that there is no phase shift between the voltage and the current. This happens only when the overall impedance of the circuit behaves like a pure resistor.

(2) So the strategy here is to apply the "in-phase" condition to the total impedance.

(3) The impedance made by the variable inductor and the 2000 ohm resistor is:

Impedance Expression here:

____

(4) Therefore the total impedance is:
Total Impedance Expression Here:

$Z =$ ________________________

(5) Since the total impedance should be purely resistive, the imaginary part of the above impedance must be zero.

L= __________

Part(b):

I= __________