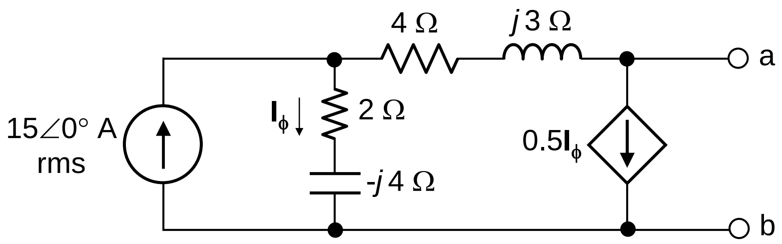
Problem (12 pts)

Consider the circuit shown



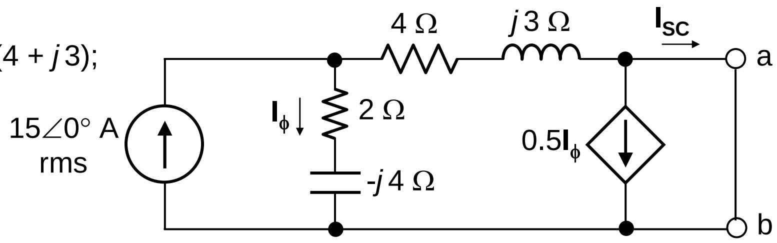
a. Determine the open-circuit voltage at terminals a and b. (3 pts)

$15 = 1.5\mathbf{I}_\phi$; $\mathbf{I}_\phi = 10$ A; $\mathbf{V}_{Th} = 10(2 - j4) - 5(4 - j3) = -j55$ V.

b. Determine the current flowing in the short circuit when there is a short between terminals a and b. (3 pts)

$15 = 1.5\mathbf{I}_\phi + \mathbf{I}_{SC}$;
$\mathbf{I}_\phi(2 - j4) = (0.5\mathbf{I}_\phi + \mathbf{I}_{SC})(4 + j3)$;
solving these two equations gives

$$\mathbf{I}_{SC} = \frac{165}{74}(1 - j6)\ \text{A}$$



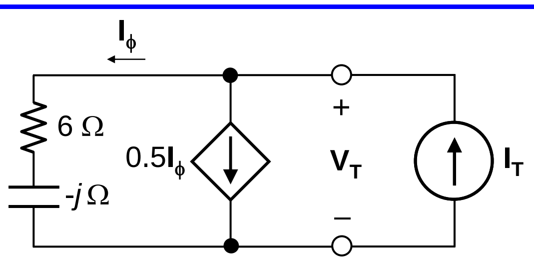
c. Determine the equivalent impedance Z_{Th} as seen by the terminals a and b. (2 pts)

$$Z_{Th} = |\mathbf{V}_{Th}|/|\mathbf{I}_{SC}| = \frac{j55 \times 74}{165(1 - j6)} = 4 - j\frac{2}{3}\Omega$$

d. Evaluate Z_{Th} again using a different method then that employed in part (c). (4 pts)

$\mathbf{I}_T = 1.5\mathbf{I}_\phi$; $\mathbf{V}_T = \mathbf{I}_\phi(6 - j)$
dividing gives:

$$Z_{Th} = \frac{6 - j}{1.5} = 4 - j\frac{2}{3}\ \Omega.$$



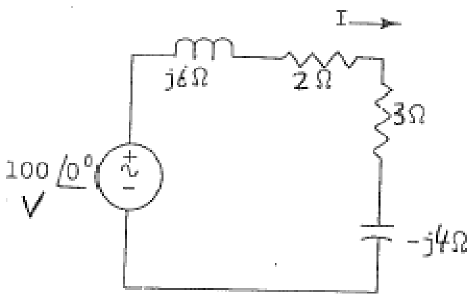


Figure 4.

4. Find the current in the circuit shown in figure 4.

A. 18.6 $\angle -21.8°$ A

B. 22.5 $\angle -35.6°$ A

C. 12.3 $\angle -18.9°$ A

D. 34.7 $\angle -29.7°$ A

E. None of the above

Hint: redraw lattice circuit as a bridge

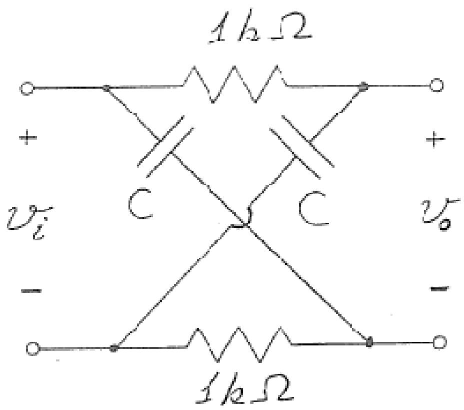


Figure 9.

9. Determine C in the circuit shown in figure 9 so that the output voltage v_o has the same magnitude as the input voltage v_i but lags it by 90°, assuming ω = 200 rad/s.

A. 5 μF
B. 2 μF
C. 6 μF
D. 8 μF
E. None of the above

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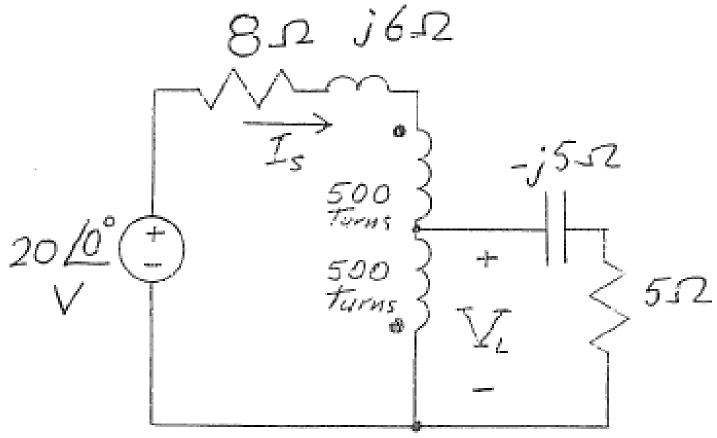


Figure 12.

12. Determine I_s and V_L in the circuit shown in figure 12.

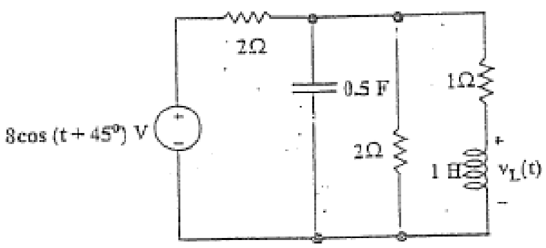
A. $1.4\angle -45.0°$ A, 0 V
B. $0.7\angle -45.0°$ A, $0.3\angle 45.0°$ V
C. $1.4\angle -36.3°$ A, $0.3\angle 14.4°$ V
D. $1.1\angle -45.0°$ A, $0.4\angle 45.0°$ V
E. None of the above

$2\angle -36.9$ A, 0 V

Hint: determine current in (5 - j5) ohms, assuming autotransformer is ideal

4. Find the expression of $v_L(t)$ in the circuit shown in Fig. 3.

A. $v_L(t) = 1.89\cos(t + 90°)$ V
B. $v_L(t) = 1.24\cos(t - 90°)$ V
C. $v_L(t) = 2.58\cos(t + 45°)$ V
D. $v_L(t) = 0.96\cos(t - 45°)$ V
E. None of the above



6. Find v_o in the circuit shown in Fig. 5 if $\omega = 5 \times 10^6$ rad/s.

A. 14.7 /21.8° V
B. 11.6 /15.6° V
C. 12.8 /35.2° V
D. 10.5 /25.9° V
→E. None of the above 10.5@19.8 deg

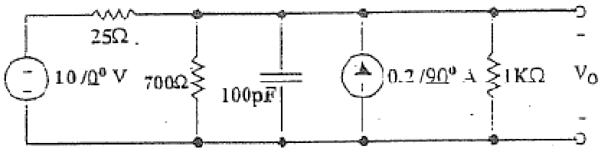
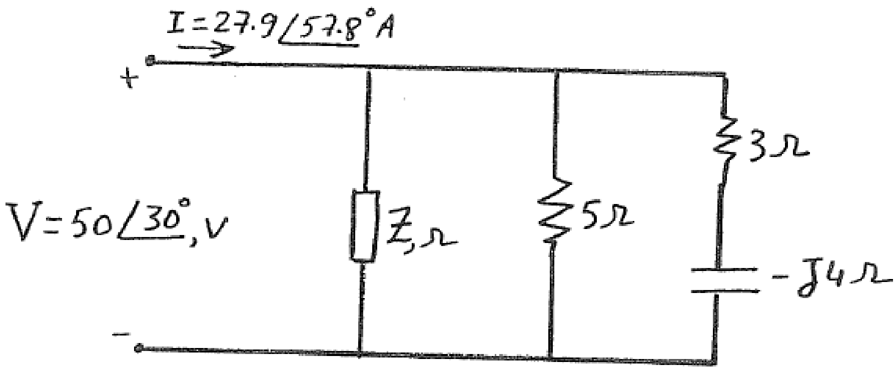


Figure 5.

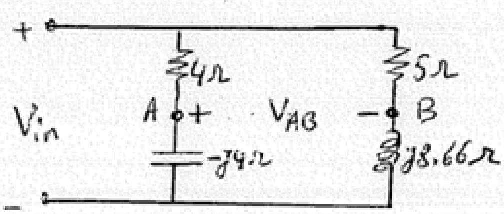
12. Determine Z in the circuit shown below:



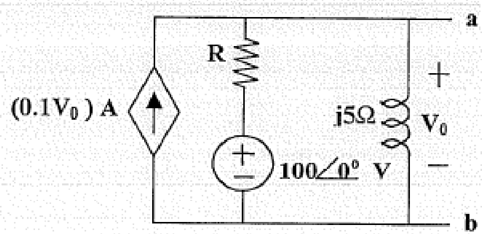
A. 0.2 <29.9°Ω
B. 5Ω
→C. 5<-29.9°Ω
D. 1.8<-27.8°Ω
E. None of the above.

3. In the circuit shown, V_{AB} =48.3<30 V. Find V_{in}

— a. 50<135 V
b. 36<45 V
c. 80<135 V
d. 73<45 V
e. None of the above



11. Considering the circuit below find its Thevenin impedance between a and b.

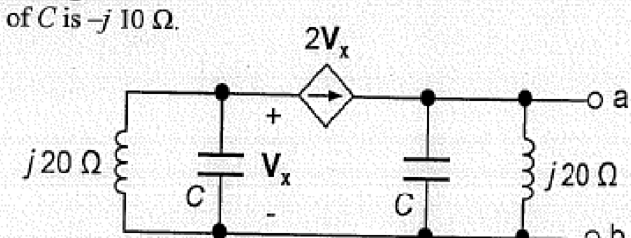


R= 2Ω

a) (2 + j1)Ω
b) (2 + j4)Ω
c) (j5)Ω
d) (j2)Ω
e. None of the above

19. Determine Thevenin's impedance looking into terminals ab, given the reactance of C is $-j$ 10 Ω.

A. $-j$ 20 Ω
B. $+j$ 20 Ω
C. $-j$ 40 Ω
D. $+j$ 40 Ω
E. None of the above



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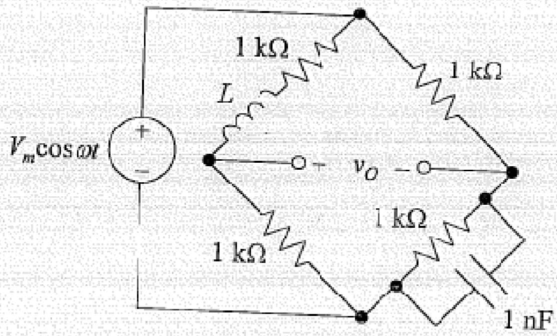
6. Determine L so that the bridge is balanced ($v_O = 0$) at $\omega = 10^6$ rad/s.

A. 1 mH B. 2 μH

C. 4 μH D. 1 H

E. None of the above



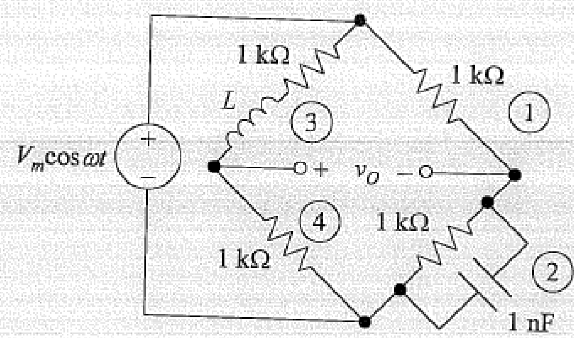
Solution:: At balance, $\frac{Z_1}{Z_2} = \frac{Z_3}{Z_4}$;

$Z_2 = \frac{R / j\omega C}{R + 1/j\omega C} = \frac{R}{1 + j\omega CR}$; Ω.

$\frac{Z_1}{Z_2} = 1 + j\omega CR$. Hence. $\frac{R + j\omega L}{R} =$

$1 + \frac{j\omega L}{R} = 1 + j\omega CR$, or

$L = CR^2 = 10^{-9} \times 10^6 \equiv 1$ mH.



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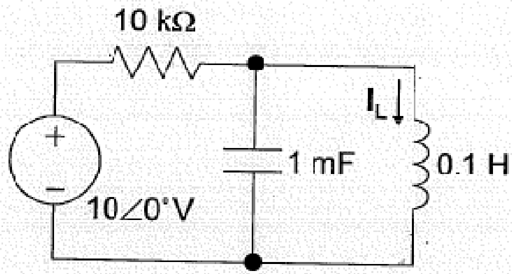
5. Determine $\mathbf{I}_L$, given that $\omega = 100$ rad/s.



A. zero
B. infinite
C. $1\angle 90^\circ$ A
— D. $1\angle -90^\circ$ A
E. None of the above

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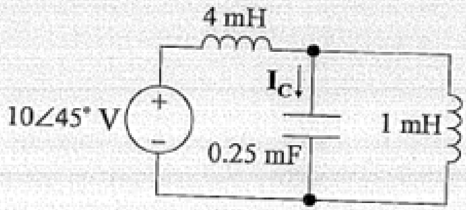
2. Determine $\mathbf{I}_C$, given that $\omega = 2$ krad/s



→ A. $5\angle 135^\circ$ A B. $10\angle 45^\circ$ A

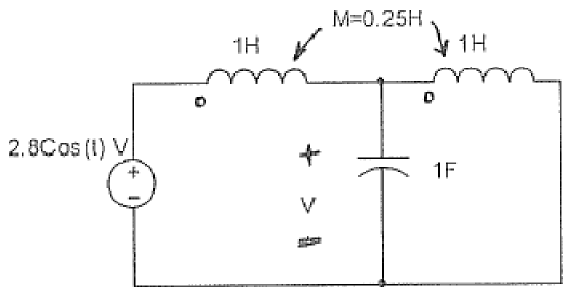
C. $5\angle -45^\circ$ A D. $10\angle 90^\circ$

E. None of the above

Solution: $j\omega L = j2\times 10^{3}\times 10^{-3} = j2\,\Omega$; $\dfrac{1}{j\omega C} = \dfrac{1}{j2\times 10^{3}\times 0.25\times 10^{-3}} = -j2\ \Omega$.

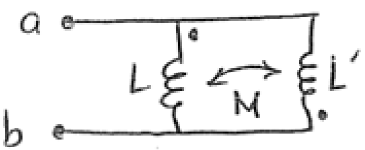
The parallel impedance of $j2\ \Omega$ and $-j2\ \Omega$ is infinite, so that no current flows in the 4 mH inductor. The voltage across the capacitor is $10\angle 45^\circ$ V, and $\mathbf{I}_C = \dfrac{10\angle 45^\circ}{-j2} = 5\angle 135^\circ$ A.

-7- Find the voltage across the capacitor of the circuit shown.



a. Cos(2.26t) b. 0 c. 2.26Cos(t) d. 0.25Cos(t)
f. None of the above

7.Find the equivalent inductance for the following connection , such that: L=60mH, L'=80mH and M=100mH.



a)34.2mH b)86.6mH c)-15.3mH d)134.2mH e)NOA

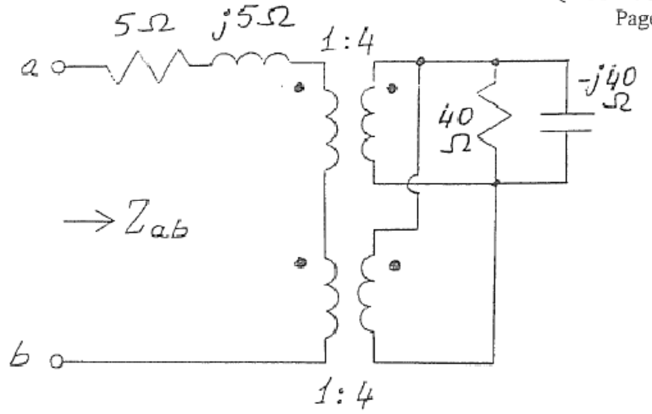


Figure 7.

7. Two identical transformers are connected as shown in figure 7. Determine the impedance Z_{ab}.

— A. 10 Ω
B. 15 Ω
C. 10 +j10 Ω
D. 10 – j10 Ω
E. None of the above

3. Calculate the voltages v_1 and v_2 in the circuit of Fig. 2.

A. v_1 = -10 cost V; v_2 = -9 cost V
B. v_1 = 10 cost V; v_2 = 9 cost V
— C. v_1 = 10 cost V; v_2 = -9 cost V
D. v_1 = 9 cost V; v_2 = -10 cost V
E. None of the above

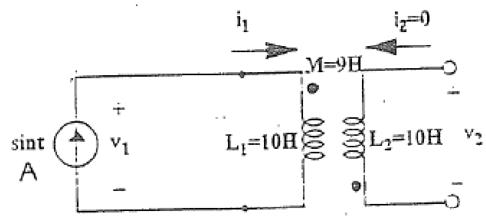


Figure 2.

8. Find the turns ratio for the ideal transformer shown in Fig. 7 required to match the 200 ohms source impedance to the 8 ohms load.

A. n = 3
B. n = 4
— C. n = 5
D. n = 6
E. None of the above

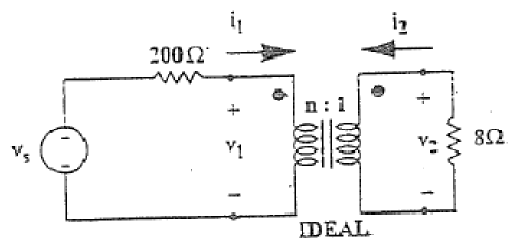


Figure 7.

15. Determine the Thevenin equivalent circuit between terminals a and b in Fig. 13 if $V_s = 10\angle 0^\circ$ V.

A. $V_{Th} = 40$ V; $R_{Th} = 25\ \Omega$
B. $V_{Th} = 20$ V; $R_{Th} = 25\ \Omega$
C. $V_{Th} = 40$ V; $R_{Th} = 50\ \Omega$
D. $V_{Th} = 20$ V; $R_{Th} = 50\ \Omega$
E. None of the above

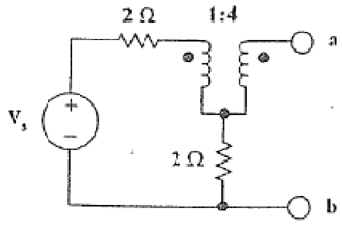


Figure 13

19. Determine L_{eq} in Fig. 16 if $L_3 = 1\ \mu H$.

A. 8 μH
B. 6 μH
C. 4 μH
D. 3 μH
E. None of the above

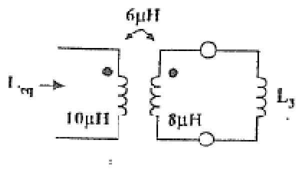


Figure 16

20. If $I_1 = 2$ A in Fig. 17, find the value of I_2 that will minimize the stored energy.

A. 1.33 A
B. 2 A
C. 0
D. 0.67 A
E. None of the above

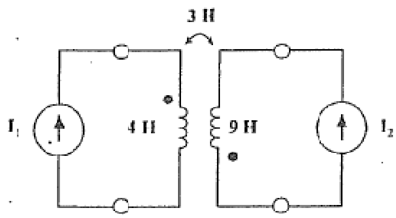
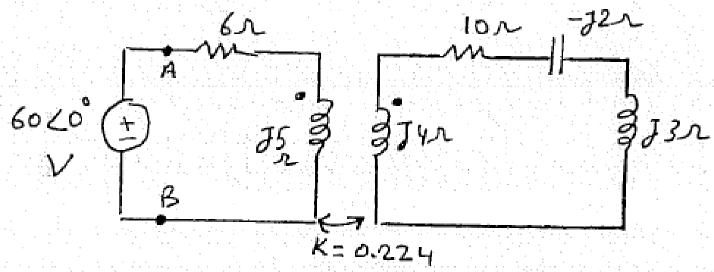


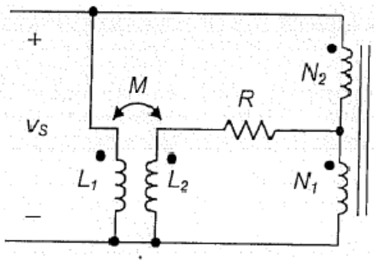
Figure 17

2. Find the input impedance Z_{AB} in the circuit shown below.

A. $6 + j\,5.896\ \Omega$
B. $8.3 + j\,4.7\ \Omega$
→C. $6.1 + J\,5\ \Omega$
D. $3.8 + j\,9.2\ \Omega$
E. None of the above

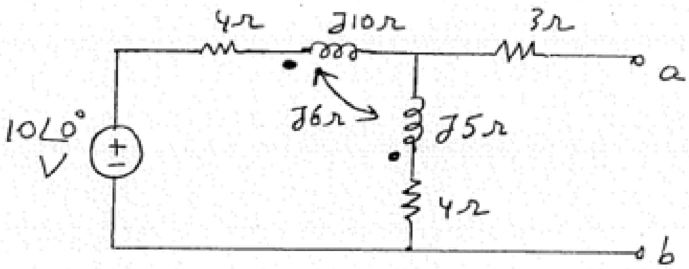


5. In the figure shown, $v_S = 10\cos 100\pi t$ V, $L_1 = 120$ mH, $L_2 = 30$ mH, $R = 100$ ohms, $N_1 = 400$ turns, and $N_2 = 1600$ turns. Determine the coupling coefficient so that no current flows in the 100 ohm resistor.



A. 0.4
B. 0.5
C. 0.6
D. 0.8
E. None of the above

9. In the circuit shown below, find the Thevenin equivalent circuit as seen from terminals a-b.



A. V_{Thev}= 4.82<-34.60, V, Z_{Thev}= 8.62<48.79 Ω
B. V_{Thev}= 4.82< 34.60, V, Z_{Thev}= 8.62<40.38 Ω
C. V_{Thev}= 48.2<-34.60, V, Z_{Thev}= 86.2<48.79 Ω
D. V_{Thev}= 5<-34.60, V, Z_{Thev}= 8.1<48.79 Ω
E. None of the above

12. Consider a source Vs supplying the primary of a transformer. The secondary is connected to a purely capacitive load Zc. The primary impedance is Z1, the secondary impedance is Z2, and the mutual impedance between primary and secondary is Zm. Calculate the currents I1 at primary and I2 at secondary.

Given: Vs = 150 <0° V, Z1=j3600 Ω, Z2=j2500 Ω, Zm=j1200 Ω, Zc= -j2400

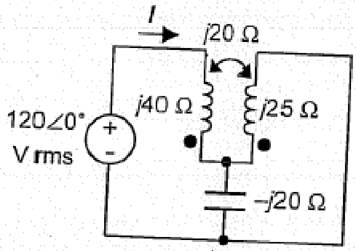
A. I1= 13.9 <-90° mA, I2=166.6<+90° mA
B. I1= 13.9 <0° mA, I2=166.6<+180° mA
C. I1= 33.5 <-90° mA, I2=356.5<+90° mA
D. I1= 33.5 <0° mA, I2=356.5<+180° mA
E. None of the above

Assume dot markings are both up

1. Two magnetically coupled coils have a coefficient of coupling K=0.5. When they are connected in series, their total inductance is 80 mH. When connection of one of the coils is reversed, the total inductance becomes 40 mH. Specify which of the following represents the self-inductance of one of the coils L.

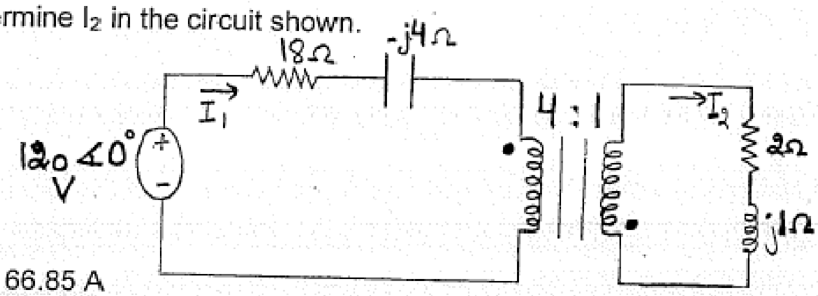
A. 60 mH
B. 52.36 mH
C. 40 mH
D. 5.64 mH
E. None of the above

8. Determine *I*.



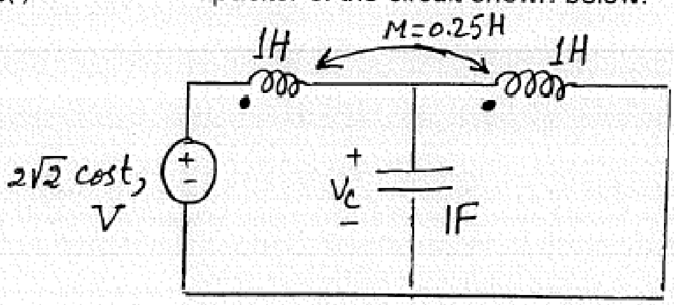
A. +j4 A rms
B. −j6 A rms
C. −j4.8 A rms
D. −j8 A rms
E. None of the above

11. Determine I_2 in the circuit shown.



A. 25.61 <166.85 A
B. 3.56<-166.85 A
C. 16.42<-13.15 A
D. 9.33 <-193.15 A
E. None of the above

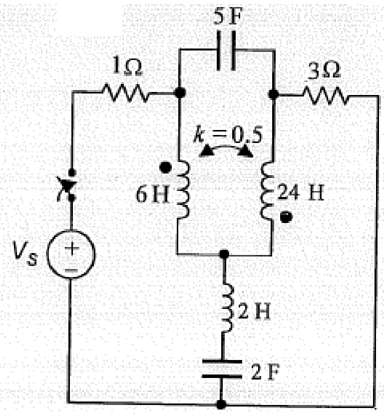
5. Find the voltage $V_c(t)$ across the capacitor of the circuit shown below.



a. 1.6 cost, V
b. 1.41 cost, V
c. 2.26 cos t, V
d. cost, V
e. None of the above

3. Determine the total energy stored in the capacitors and inductors after the switch has been closed for a long time, assuming $V_S = 8$ V.

A. 12 J
B. 30 J
C. 120 J
D. 148 J
E. None of the above



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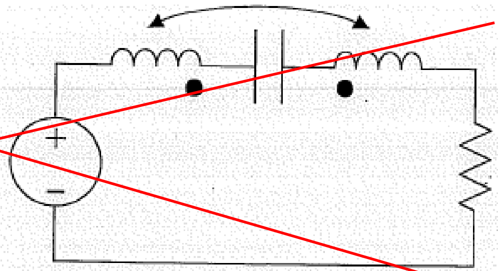
4. If the dot marking on one of the coils is reversed, the damping coefficient α:

A. increases
B. decreases
C. remains the same



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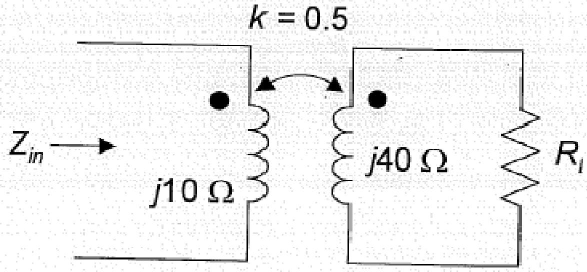
7. Determine the minimum value of Z_{in} as R_L is varied between zero and infinity.

A. $j5\ \Omega$
B. $j7.5\ \Omega$
C. $j10\ \Omega$
D. 0
E. None of the above



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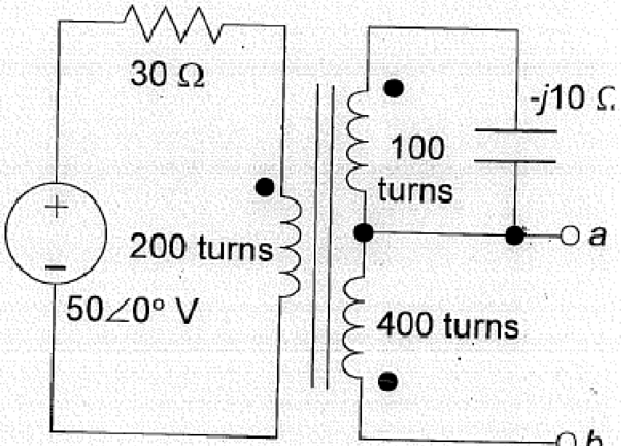
9. Determine Thevenin's equivalent circuit between terminals ab, assuming the transformer is ideal.

$V_{Th} = -64 + j48 \, V$

$Z_{Th} = \frac{96}{5}(4 - j3) \, \Omega$



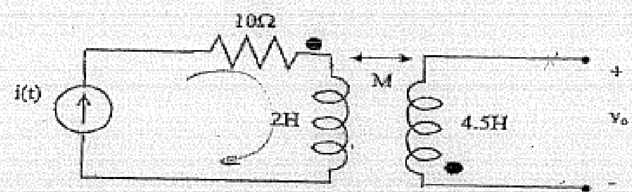
The sinusoidal current source i(t) is given by:

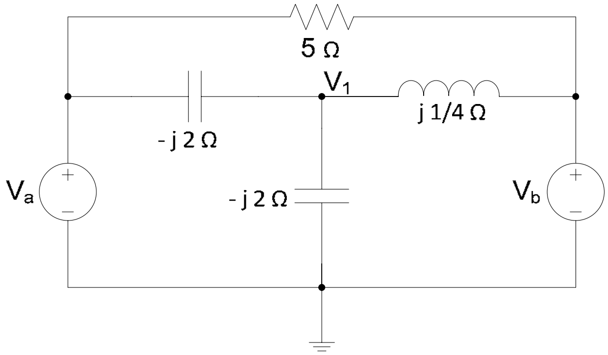
$$i(t) = 10\sin(120\pi t)(\text{Amps})$$
$$t \geq 0$$

This current is applied to the primary coil of a transformer, as shown below. The primary coil (self-inductan 2H) is 100%-coupled to the secondary coil (self-inductance 4.5H).

Find the value of the voltage v_o at $t = 0$.

(a) 15.75 kV
(b) -11.31 kV
(c) -15.75 kV
(d) 11.31kV
(e) None of these





1. Find the correct node-equation for the voltage V_1.

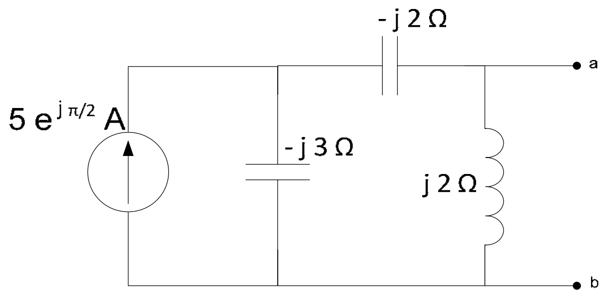
a) $6V_1 + V_a - 8V_b = 0$

b) $2V_1 + V_a - 4V_b = 0$

c) $V_1 - V_a + V_b = 0$

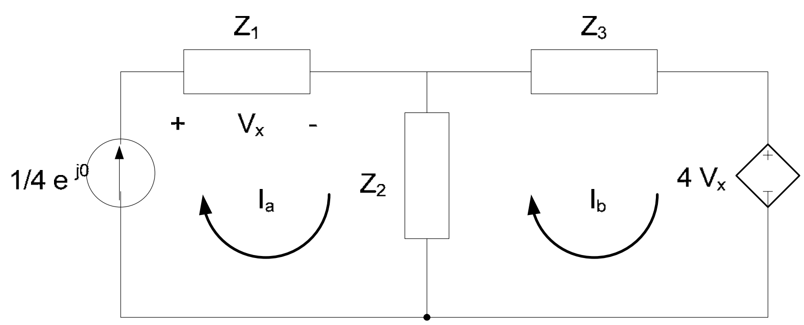
d) $3V_1 - 2V_a + V_b = 0$

e) $7V_1 - 4V_a + V_b = 0$



4. Find the Thevenin equivalent circuit with respect to the terminals a-b. What are the values of V_{Th} in V and Z_{Th} in Ω?

a) V_{Th} =-10 V, Z_{Th} = j10/3 Ω
b) V_{Th} =-8 V, Z_{Th} = j3 Ω
c) V_{Th} =-6 V, Z_{Th} = j14/5 Ω
d) V_{Th} =-4 V, Z_{Th} = j8/3 Ω
e) V_{Th} =-2 V, Z_{Th} = j5/2 Ω



5. What is the expression for V_x?

a) (Z_1+Z_2)
b) $5\ Z_1$
c) $Z_1/4$
d) $2\ Z_1$
e) $Z_1/2$

6. What is the correct set of equations for the mesh currents I_a and I_b?

a) $I_a(-Z_1+4Z_2)-I_b(4Z_2+4Z_3)=0, I_a-5=0$

b) $I_a(-Z_1+2Z_2)-I_b(2Z_2+2Z_3)=0, I_a-2=0$

c) $I_a(-Z_1+Z_2)-I_b(Z_2+Z_3)=0, I_a-1=0$

d) $I_a(-2Z_1+Z_2)-I_b(Z_2+Z_3)=0, I_a-1/2=0$

e) $I_a(-4Z_1+Z_2)-I_b(Z_2+Z_3)=0, I_a-1/4=0$

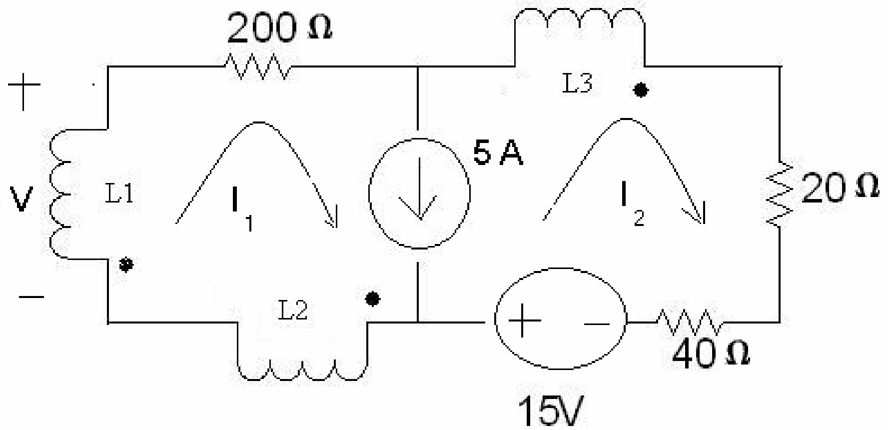
17. If a capacitor with impedance Z_2 is connected in parallel to a load $Z_1 = 300 + j450\ \Omega$. What should be Z_2 in ohms so that the equivalent load is purely resistive?

a) -928.6 j
b) -1112.5 j
c) -650 j
d) -750 j
e) None of the above

22. Assuming that the voltage V across inductance L1 is as shown in figure below and that the mutual inductance between

- L1 and L2 is M12
- L1 and L3 is M13
- L2 and L3 is M23

Use the mesh technique to find the expression of the voltage V.



a) $V = -L_1 dI_1/dt - M_{12} dI_1/dt + M_{13} dI_2/dt$

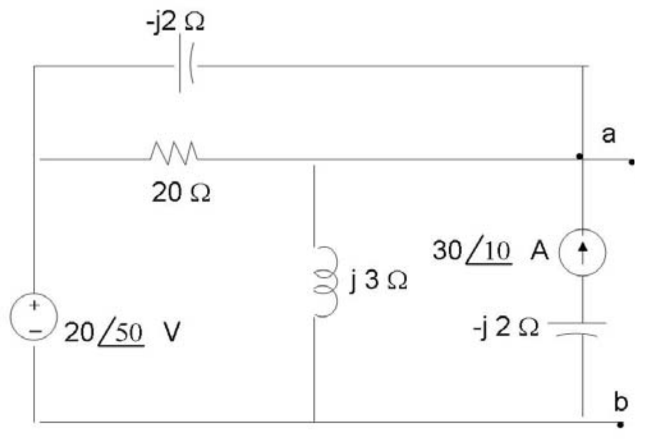
b) $V = -L_1 dI_1/dt + M_{12} dI_1/dt + M_{13} dI_2/dt$

c) $V = -L_1 dI_1/dt + M_{12} dI_1/dt - M_{13} dI_2/dt$

d) $V = -L_1 dI_1/dt + M_{12} dI_1/dt + M_{13} dI_2/dt$

e) None of the above

Problem 1



Find Zth across a and b

A) Z_{th} = 3.85- j 0.77 Ω

B) Z_{th} = 1.65- j 5.50 Ω

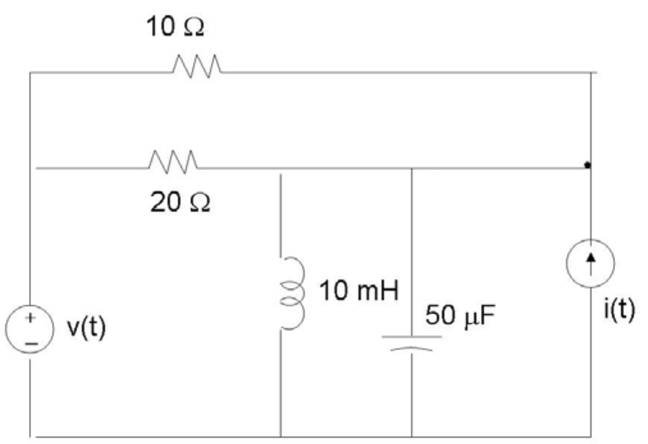
C) Z_{th} = 5.29- j 8.82 Ω

D) Z_{th} = 6.50- j 1.65 Ω

E) None of the above

Problem 2

What are the impedances in this circuit if v(t)=20 cos(10t+50°) Volts and i(t)=50cos(10t+20°) Amperes.



A) 10 Ω, 20 Ω, −j 0.1 Ω, j 0.05 Ω

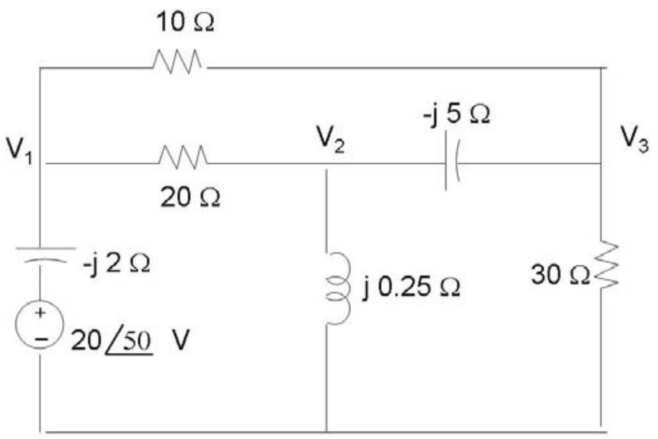
B) 10 Ω, 20 Ω, −j1.0 Ω, j0.05 Ω

C) 10 Ω, 20 Ω, j 0.1 Ω, −j 2000 Ω

D) 10 Ω, 20 Ω, j 10 Ω, −j 20 Ω

E) None of the above

Problem 3
Find the node equations for the following circuit



A)
$$\begin{aligned}&(0.15+j0.5)V_1-0.05\,V_2-0.1V_3+7.66-j6.43=0\\&-0.05\,V_1+(0.05-j3.8)V_2-j0.2V_3=0\\&-0.1V_1-j0.2\,V_2+(0.133+j0.2)V_3=0\end{aligned}$$

B)
$$\begin{aligned}&(0.15+j0.5)V_1-0.1V_2-0.05\,V_3+7.66-j6.43=0\\&-0.1V_1+(0.1-j3.8)V_2-j0.2V_3=0\\&-0.05\,V_1-j0.2\,V_2+(0.0833+j0.2)V_3=0\end{aligned}$$

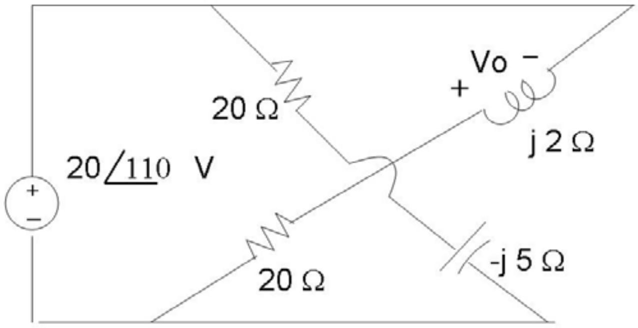
C)
$$\begin{aligned}&(0.15+j0.2)V_1-0.05\,V_2-0.1V_3-12.85-j15.32=0\\&-0.05\,V_1+(0.05-j3.8)V_2-j0.2V_3=0\\&-0.1V_1-j0.2\,V_2+(0.133+j0.2)V_3=0\end{aligned}$$

D)
$$\begin{aligned}&(0.15+j0.2)V_1-0.1V_2-0.05\,V_3-12.85-j15.32=0\\&-0.1V_1+(0.1-j3.8)V_2-j0.2V_3=0\\&-0.05\,V_1-j0.2\,V_2+(0.0833+j0.2)V_3=0\end{aligned}$$

E) None of the above

Problem 4

Find V_0 (t) given ω=120 rad/sec.



A) $V_0 = -0.99 \cos(120t + 94.29.^{o})$ Volts

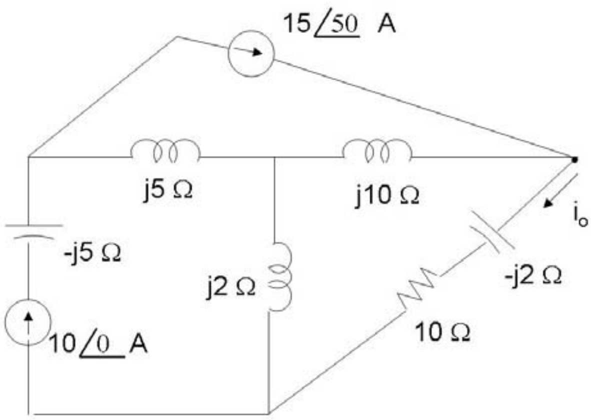
B) $V_0 = -1.99 \cos(120t + 194.29^{o})$ Volts

C) $V_0 = -1.99 \cos(120t - 25.7^{o})$ Volts

D) $V_0 = -0.99 \cos(120t - 115.71^{o})$ Volts

E) None of the above

Problem 5



Find i_o in the circuit above.

A) $8.178\angle 104.62^{0}$

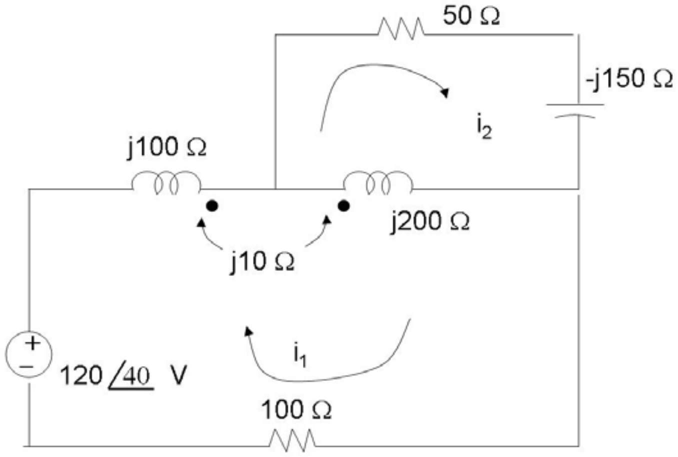
B) $23.14\angle 89.62^{0}$

C) $16.36\angle 104.62^{0}$

D) $11.57\angle 89.62^{0}$

E) None of the above

Problem 6



Given the circuit above, what are the two mesh equations?

A) $-120\angle 40^0 + (100 + j280)\,i_1 - 190\,i_2 = 0; \qquad -j190\,i_1 + (50 + j50)\,i_2 = 0$

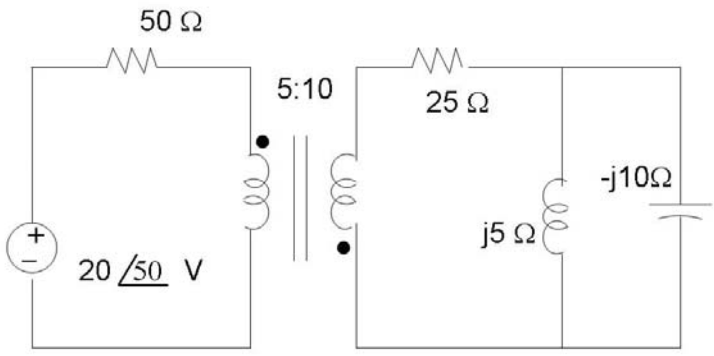
B) $-120\angle 40^0 + (100 + j400)\,i_1 - 250\,i_2 = 0; \qquad -j250\,i_1 + (50 + j50)\,i_2 = 0$

C) $-120\angle 40^0 + (100 + j200)\,i_1 - 150\,i_2 = 0; \qquad -j150\,i_1 + (50 + j50)\,i_2 = 0$

D) $-120\angle 40^0 + (100 + j320)\,i_1 - 210\,i_2 = 0; \qquad -j210\,i_1 + (50 + j50)\,i_2 = 0$

E) None of the above

Problem 7



In the circuit shown above, what is the value of the reflected impedance of the 50 ohms resistor from the primary to the secondary side?

A) 100 Ω

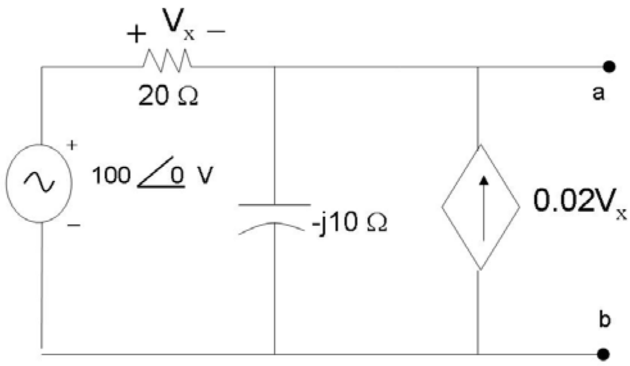
B) 12.5 Ω

C) 25 Ω

D) 200 Ω

E) None of the above

Problem 8



In the circuit shown above, find the Thevenin voltage across a,b

A) $76.82\angle -39.80^0$ V

B) $57.3\angle -55.0^0$ V

C) $28.6\angle -63.0^0$ V

D) $65.99\angle -48.3^0$ V

E) None of the above

Problem 9

For the same circuit of previous problem, find Zth across a,b

A) Zth= 4.9- j4.1 Ω

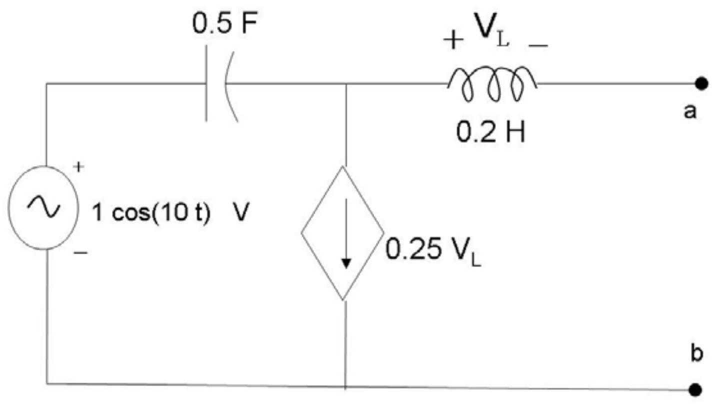
B) Zth= 1.08- j2.12 Ω

C) Zth= 4.7- j6.71 Ω

D) Zth= 3.7- j5.1 Ω

E) None of the above

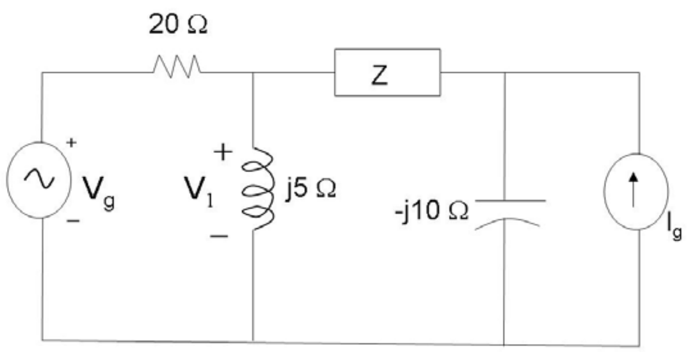
Problem 10



Find the Thevenin equivalent resistance and capacitance/inductance with respect to the terminals a,b in the circuit shown above

A) R = 0.1Ω; L=0.18 Ω
B) R = 0.2Ω; L=0.38 Ω
C) R = 0.25Ω; L=0.43 Ω
D) R = 0.15Ω; L=0.36 Ω
E) None of the above

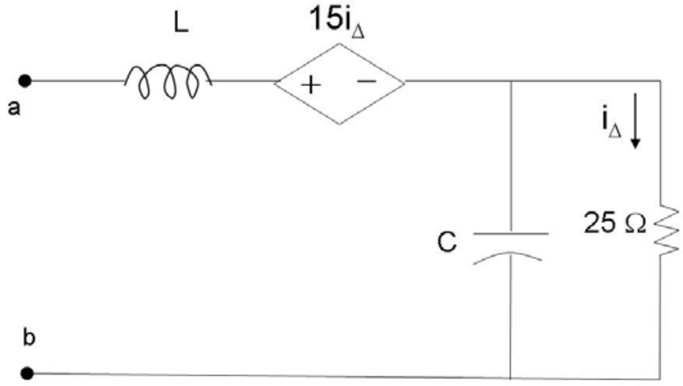
Problem 11



In the circuit shown above, find the value of the impedance Z if
. $V_1 = 40 + j30 \quad V$, $V_g = 100 - j50 \quad V$, and $I_g = 20 + j30 \quad A$

A) 10–j5 Ω
B) 58+j14 Ω
C) 68+j24 Ω
D) 5+j20 Ω
E) None of the above

Problem 12



Find the input impedance Zi   at the terminals a,b in the circuit shown above

A) $Z_i = jL\omega + \dfrac{40}{1 + j25C\omega}$ Ω

B) $Z_i = jL\omega + \dfrac{25}{1 + j40C\omega}$ Ω

C) $Z_i = jL\omega + \dfrac{15}{1 + j40C\omega}$ Ω

D) $Z_i = jL\omega + \dfrac{40}{1 + j15C\omega}$ Ω

E) None of the above

Problem 13

In the circuit of the previous problem, find the frequency ω such that the input impedance Zi is purely resistive.

A) $\omega = \dfrac{1}{40C}\sqrt{1000\dfrac{C}{L} - 1}$ rad/s

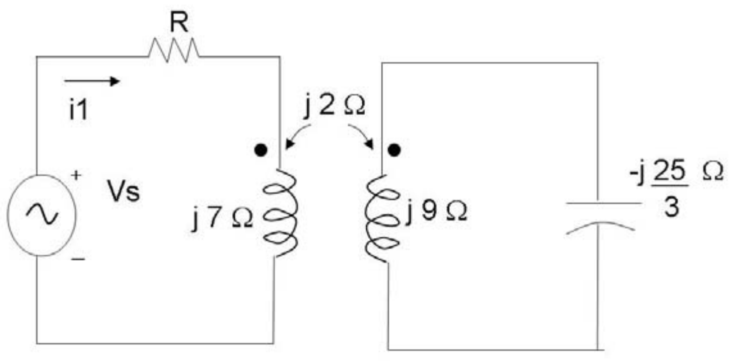
B) $\omega = \dfrac{1}{25C}\sqrt{1000\dfrac{C}{L} - 1}$ rad/s

C) $\omega = \dfrac{1}{40C}\sqrt{600\dfrac{C}{L} - 1}$ rad/s

D) $\omega = \dfrac{1}{15C}\sqrt{600\dfrac{C}{L} - 1}$ rad/s

E) None of the above

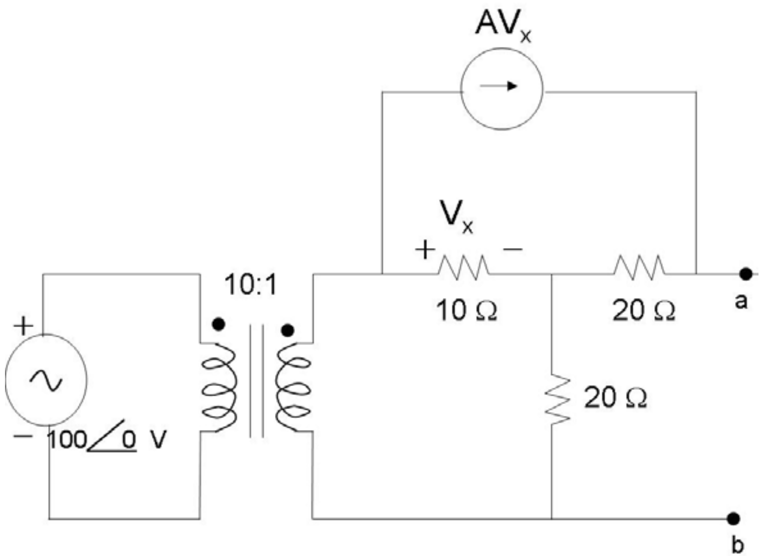
Problem 14



In the circuit shown above, it is given that **R=1 Ω,** and Vs= $10\angle 0$ volts. Find the current i1 as indicated.

A) $8\angle -53.13^0$ A
B) $7.07\angle -53.13^0$ A
C) $7.07\angle -45^0$ A
D) $8\angle -45^0$ A
E) None of the above

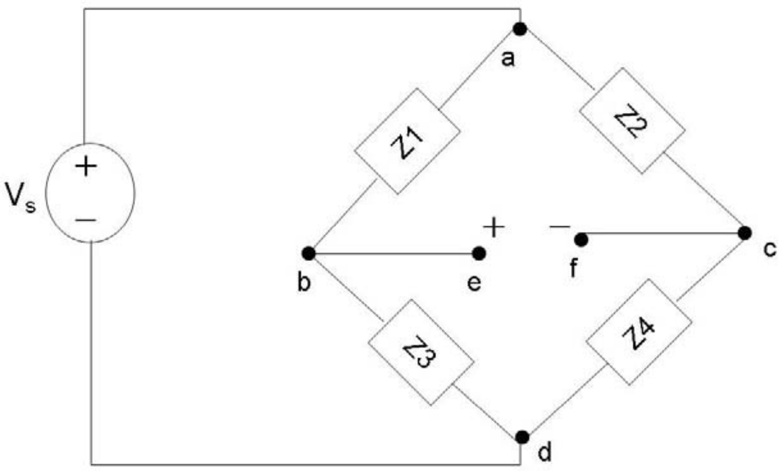
Problem 5



Find the magnitude of the Thevenin Voltage V_{th} across terminals a,b in the circuit above. Given A=1/4.

→ A) 15.0 V
B) 37.5 V
C) 14.29 V
D) 7.15 V
E) None of the above

Problem 7



In the circuit shown above, given $V_s = 48\angle 90^0$ V, $Z_1 = 3 + j4\,\Omega$, $Z_2 = 8 - j6\,\Omega$, $Z_3 = 3 - j4\,\Omega$ and $Z_4 = 8 + j6\,\Omega$. The Thevenin equivalent circuit values for the voltage souce and the internal impedance across terminals e and f are:

A) $14\angle 0^0$ V, $3.5 - j3.5\,\Omega$

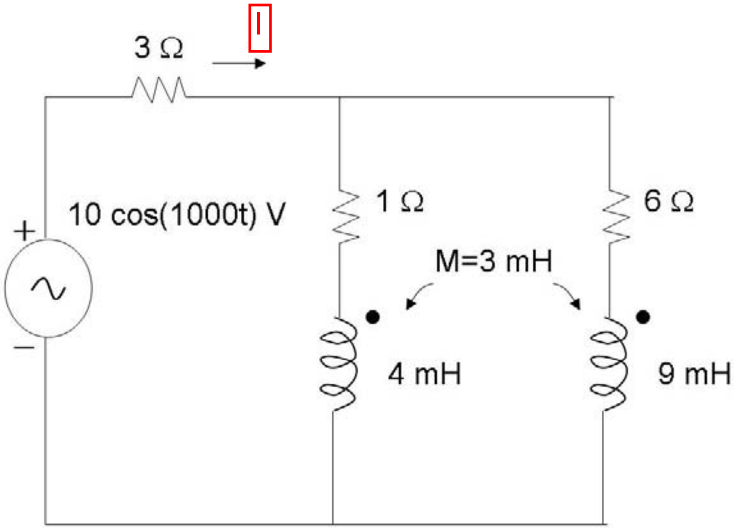
B) $50\angle 0^0$ V, $2.5 + j2.5\,\Omega$,

C) $14\angle 0^0$ V, $7.29\,\Omega$

→D) $50\angle 0^0$ V, $10.42\ \Omega$

E) None of the above

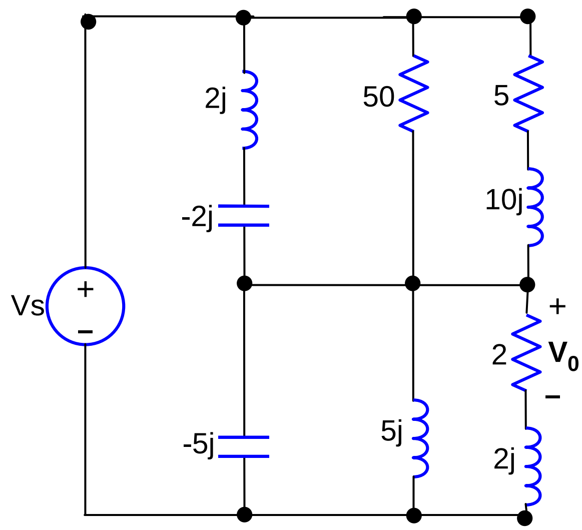
Problem 8



In the circuit shown above, the phasor form of the current I in amperes is:

A) $1.833\angle -45.0^0 \quad V$
B) $0.917\angle -45.0^0 \quad V$
C) $1.5\angle -53.13^0 \quad V$
D) $3.0\angle -53.13^0 \quad V$
E) None of the above

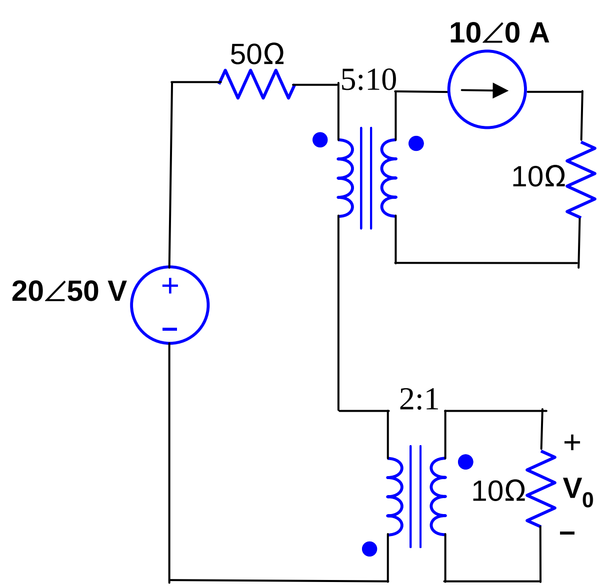
Problem 12



Find V_0 if the source voltage is Vs = $20\angle 60^o$ Volts.

A) $14.14 \angle 15^o$ V
B) $7.07\angle 15^o$ V
C) $20\angle 60^o$ V
D) $10 \angle 60^o$ V
E) None of the above

Problem 13



Find V_0.
A) $400 \angle 0$ V
B) - $400 \angle 0$ V
C) $100 \angle 0$ V
D) - $100 \angle 0$ V
E) None of the above

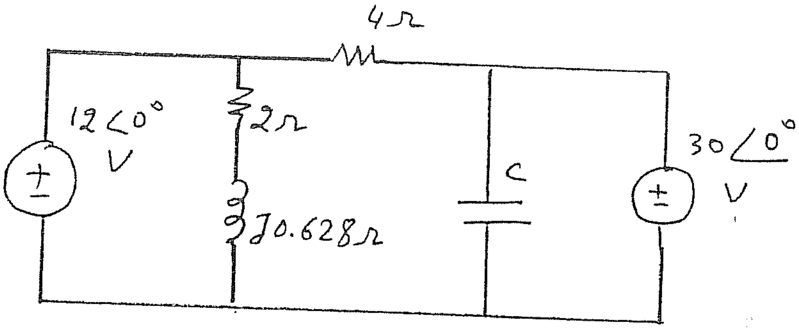
1. An impedance Z1= (4+j4) Ω is connected in parallel with an impedance Z2= (12+j6) Ω. If the input reactive power is 1000 VAR (lagging), what is the total active (average) power ?

A. 1210 W
B. 3025 W
C. 826.39 W
D. 1150 W
E. None of the above

3. The conjugate of the complex power delivered by a current source is $200 - j200$ VA. If the source current is $\frac{10}{\sqrt{2}}\angle 45^\circ$ A peak, determine the rms voltage across the source.

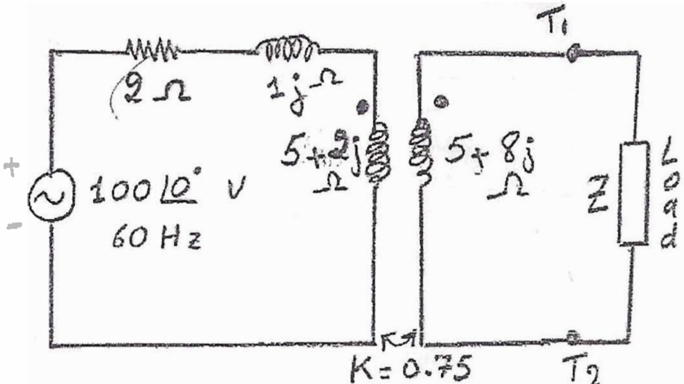
A. 40 V rms
B. $j40$ V rms
C. 80 V rms
D. $-j40$ V rms
E. None of the above $\boxed{\text{j40sqrt(2) rms}}$

11. Determine the value of C in the circuit shown if C takes 5 VAR. The operating frequency is 50 Hz.



A. 12.63 µF
B. 14.74 µF
→C. 17.68 µF
D. 3 µF
E. None of the above

3. Determine the Thevenin impedance to the left of the terminals T1-T2 of the circuit shown in figure.



a. $15\angle 50^{0}\ \Omega$

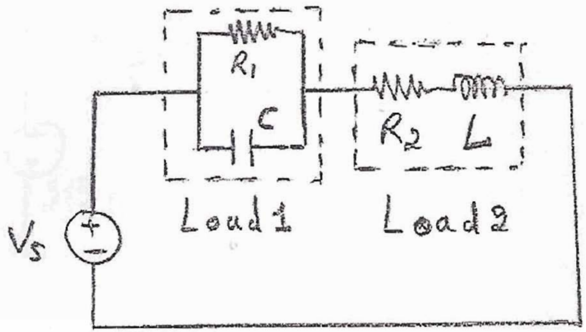
b. $5+5j\ \Omega$

c. $1.086+2.535j\ \Omega$

d. $9.69\angle 51.07^{0}\ \Omega$

e. None of the above.

1. The values of R_1, R_2, C and L are unknown. Load 1 absorbs a complex power of $50\angle -45^0$ VA and load 2 absorbs a complex power of $100\angle 45^0$ VA. Determine R_2 if $V_s = 250\angle 0^0$ V rms.



a. $250\sqrt{2}\ \Omega$.

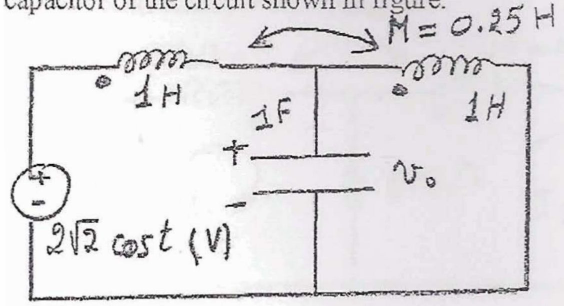
b. $125\sqrt{2}\ \Omega$.

c. $125\ \Omega$.

d. $125/\sqrt{2}\ \Omega$.

e. None of the above.

5. Find the voltage $v_0(t)$ across the capacitor of the circuit shown in figure.

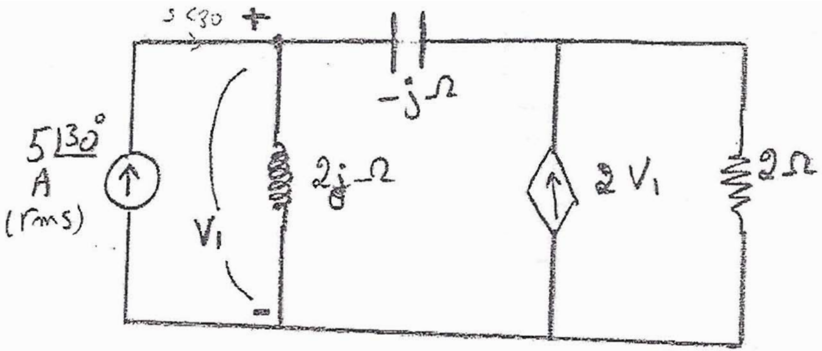


a. $1.60\cos(2t)$ V.
b. $1.60\sin(t)$ V.
c. $3.2\cos(t)$ V.
→ d. $2.26\cos(t)$ V.
e. None of the above.

6. Two impedances $Z_1 = 9.8\angle -78^0\ \Omega$ and $Z_2 = 18.5\angle 21.8^0\ \Omega$ are connected in parallel and the combination in series with an impedance $Z_3 = 5\angle 53^0\ \Omega$. If this circuit is connected across a 100-V source (rms), how much average power will be supplied by the source.

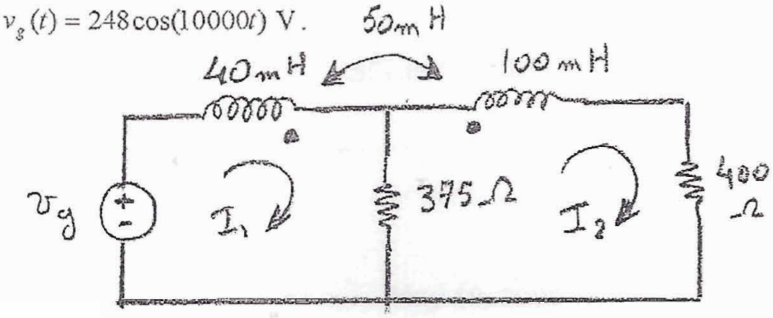
→ a. 980.8 W.
b. 490 W.
c. 1960 W.
d. 1391.6 W.
e. None of the above.

4. How much complex power is delivered by the $5\angle 30^0$ A (rms) current source to the circuit shown in figure.



a. $7.5\angle 137.48^0$ VA.
b. 0 VA.
c. 100 VA.
d. $15.35\angle 137.48^0$ VA.
e. None of the above.

9. Find I_1 in the figure shown if $v_g(t) = 248\cos(10000t)$ V.

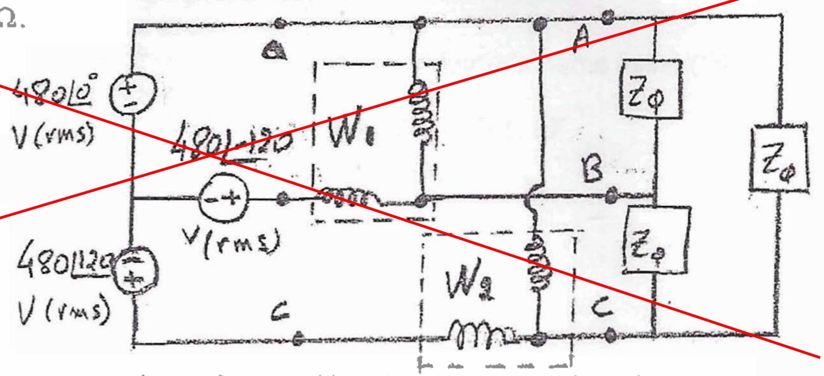


a. $0.8 - 0.62j$ A.
b. $0.4 - 0.3j$ A.
c. $0.6 - 0.6j$ A.
d. $0.9 - 0.31j$ A.
e. None of the above.

10. In problem 9, find the average power delivered to the 375 Ω resistor.

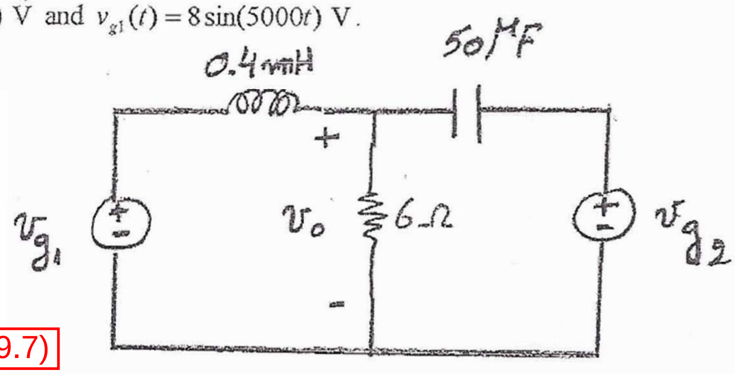
a. 99.2 W.
b. 50.3 W.
c. 49.2 W.
d. 62.7 W.
e. None of the above.

11. Calculate the reading of the two wattmeters ($W_1 + W_2$) in the circuit shown in figure. The value of $Z_\phi = 60\angle 30^0$ Ω.



a. ~10 kW.
b. ~29.9 kW.
c. ~33.2 kW.
d. ~15.4 kW.
e. None of the above.

12. Find the steady-state expression for $v_o(t)$ in the circuit shown if $v_{g1}(t) = 10\cos(5000t + 53.13^0)$ V and $v_{g1}(t) = 8\sin(5000t)$ V.

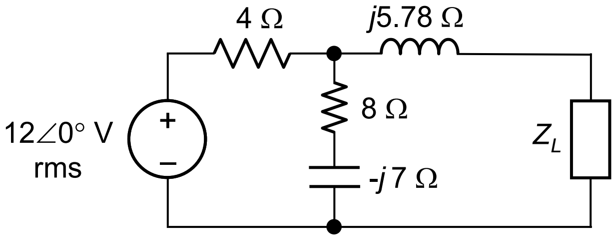


a. $4\cos(5000t)$ V.
b. $8\cos(5000t)$ V.
c. $16\cos(5000t)$ V.
d. $12\cos(5000t)$ V.
e. None of the above.

22.3cos(5,000t + 29.7)

Problem 8 (14 pts)

Consider the circuit shown



a. For $Z_L = 3 - j5.2\ \Omega$,determine the average power developed by the voltage source and the average power absorbed by the load. (4 pts)

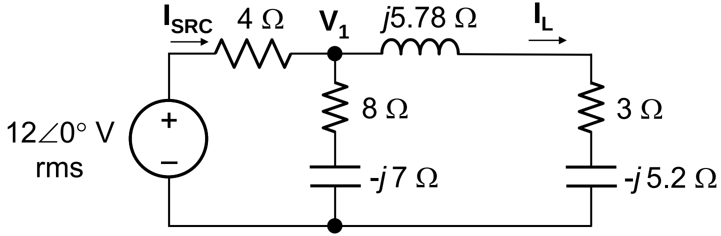
$$\mathbf{V_{Th}} = 12\frac{8 - j7}{12 - j7} = 9 - j1.74\text{ V};$$

$$|\mathbf{V_{Th}}| = 9.18\text{ V};$$

$$\mathbf{I_L} = \mathbf{V_{Th}}/6 = 1.5 - j0.29\text{ A};$$

$$\mathbf{V_1} = (3 - j0.58)I_L = 4.68 + j0\text{ V}$$

$$\mathbf{I_{SRC}} = \frac{12 - 4.68}{4} = 1.83 + j0\text{ A}$$



$$P_{SRC} = V_1 I_{SRC} = 12\times1.83 \cong 22\text{ W};\ P_L = \frac{(9.18)^2}{4\times3} \cong 7\text{ W}.$$

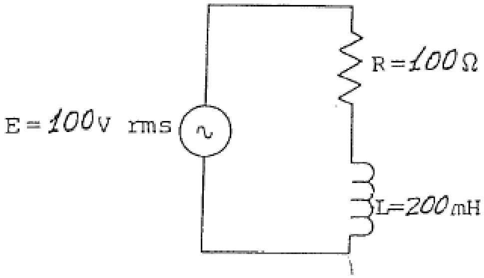
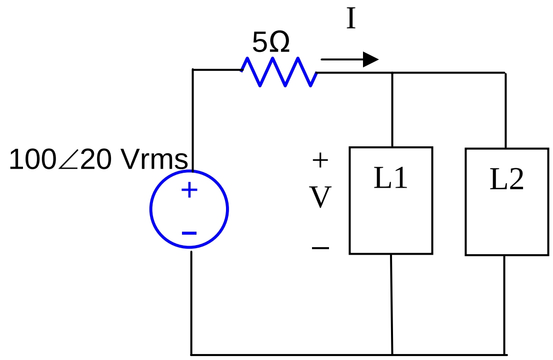


Figure 3.

3. Determine the power dissipated in the load in the circuit shown in figure 3. f= 60 Hz.

A. 38.8 W
— B. 63.8 W
C. 52.5 W
D. 45.3 W
E. None of the above

Problem 14



It is given that the complex power of L1 is 5+j10 VA. It is also given that L2 absorbs 20W at lagging power factor of 0.8. What is the phase difference between I and V as shown in figure?

A) 45.00^o
B) 39.81^o
C) 63.33^o
D) 60.00^o
E) None of the above.

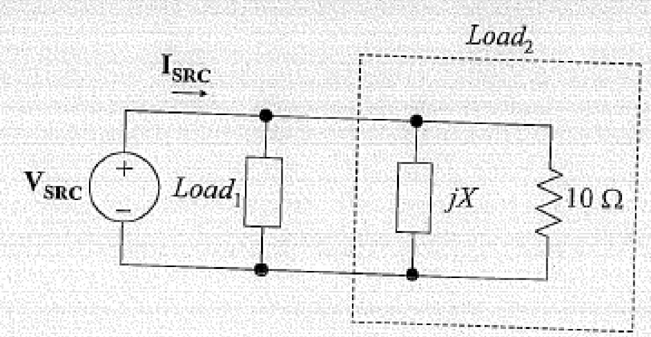
Problem 15

What is the impedance of a load if it absorbs 20KVAR at lagging power factor of 0.6 when a current of magnitude 50 A rms flows through it?

A) 6 + 8j ohms
B) 3 + 4j ohms
C) 4+ j3 ohms
D) 8+ j6 ohms
E) None of the above.

8%

5. The complex powers absorbed by L_1 and L_2 are $1 + j0.2$ kVA and $1 - j0.2$ kVA. Determine $\mathbf{I}_{SRC}$, assuming that the phase angle of $\mathbf{V}_{SRC}$ is zero. Note that X need not be given.



A. $20\angle 90^\circ$ A

B. $10\angle 90^\circ$ A

C. $10\angle 0^\circ$ A

→ D. $20\angle 0^\circ$ A

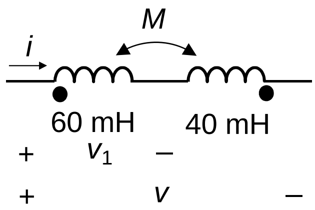
E. None of the above

Solution: The complex power delivered by the source is 2 kVA. The real power absorbed by L_2 is in the 10 Ω resistor. If $\mathbf{V}_{SRC} = V_m\angle 0$ V, then $\frac{|V_m|^2}{10} = 1000$, or $V_m = 100$ V. It follows that $I_m = \frac{2000}{100} = 20$ A, and $\mathbf{I}_{SCR} = 20\angle 0$ A.

1. A coil (R and L) has a resistance of 10Ω and draws a current of 5A (RMS) when connected across a 100V (RMS), 60 Hz source. Determine the inductance of the coil.

a. 17.32 mH
b. 32.48 mH
— c. 45.94 mH
d. 102.73 mH
e. None of the above

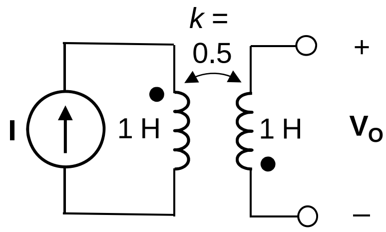
1. If M = 5 mH, determine the ratio v_1/v.



Solution: $L_{eq} = L_1 + L_2 - 2M$; $v = L_{eq}\dfrac{di}{dt}$; $v_1 = L_1\dfrac{di}{dt} - M\dfrac{di}{dt}$;

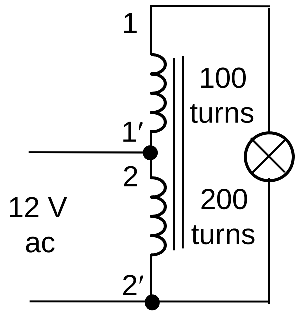
hence, $\dfrac{v_1}{v} = \dfrac{L_1 - M}{L_1 + L_2 - 2M} = \dfrac{60 - M}{100 - 2M}$

2. Determine $\mathbf{V_O}$, given that $\mathbf{I} = 1\angle 0°$ A and ω = 10 rad/s.



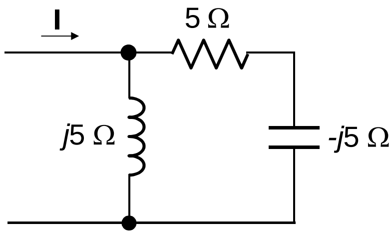
Solution: $M = k\sqrt{L_1L_2} = 0.5$ H; secondary voltage is $j\omega M\mathbf{I}$, with the dotted terminal positive with respect to the undotted terminal. Hence, $\mathbf{V_O} = -j\omega M\mathbf{I} = -j10\times 0.5\mathbf{I} = -j5\mathbf{I}$.

3. The lamp glows brighter when the dots are at coil terminals



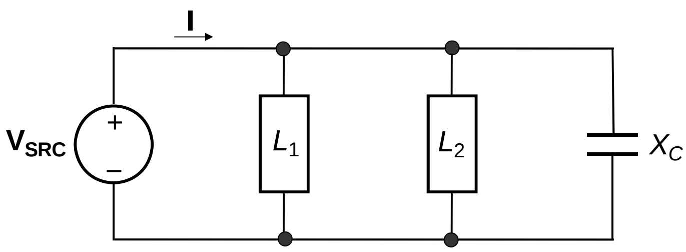
Solution: The lamp glows brighter when the voltage across it is largest. This occurs when the voltages across the windings are additive, that is, when the dots are at terminals 1 and 2 or 1′ and 2′.

4. Determine the reactive power absorbed in the circuit, given that $\mathbf{I} = 1\angle 0°$ A rms.



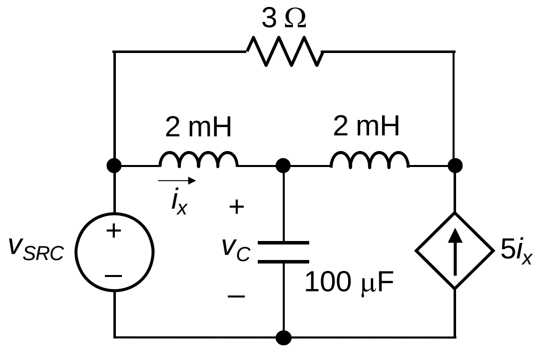
Solution: The equivalent series impedance is $\dfrac{j5(5-j5)}{j5+5-j5} = 5 + j5$. The reactive power is $5|I|^2$ VAR. As a check, the current in the capacitive branch is $\dfrac{j5}{j5+5-j5}\mathbf{I} = j\mathbf{I}$; the reactive power absorbed by the capacitor is $-5|j\mathbf{I}|^2 = -5|I|^2$ VAR. The current in the inductive branch is $\dfrac{5-j5}{j5+5-j5}\mathbf{I} = (1 - j)\mathbf{I} = \sqrt{2}\angle -45°\mathbf{I}$; the reactive power absorbed by the inductor is $5|\sqrt{2}\,I|^2 = 10|I|^2$ VAR. The total reactive power absorbed is $10|I|^2 - 5|I|^2 = 5|I|^2$ VAR.

5. In the circuit shown, L_1 consumes 160 W at 0.8 p.f. lagging and L_2 consumes 320 VAR at 0.6 p.f. lagging. Determine $\mathbf{I}$ when X_C is chosen for unity power factor, assuming $\mathbf{V_{SRC}} = 200\angle 0°$ V rms.



Solution: Ay unity p.f. the total reactance seen by the source is zero and the source applies only real power. The real power consumed by L_2 is $\frac{320}{0.8}\times 0.6 = 240$ W. The total real power supplied by the load is 160 + 240 = 400 W. The current is $\frac{400}{V_{SRC}\angle 0^\circ} = \frac{400}{V_{SRC}}\angle 0^\circ$ A rms.

6. Derive the time-domain expression for v_C, given that $v_{SRC} = 10\sin(2{,}000t)$ V.



Solution: $\omega L = 2\times10^3\times2\times10^{-3} = 4\ \Omega$;

$\frac{1}{\omega C} = \frac{1}{2\times10^3\times100\times10^{-6}} = 5\ \Omega$; $\mathbf{V_{SRC}} = 10\angle 0^\circ$.

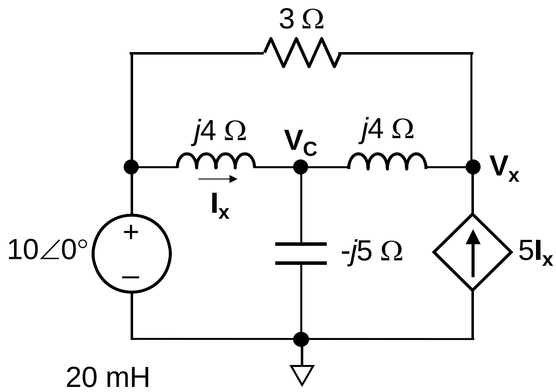
The node-voltage method can be applied, the circuit being as shown. At the middle node:

$\mathbf{V_C}/{-j5} + (\mathbf{V_C} - \mathbf{V_x})/j4 + (\mathbf{V_C} - 10)/j4 = 0$

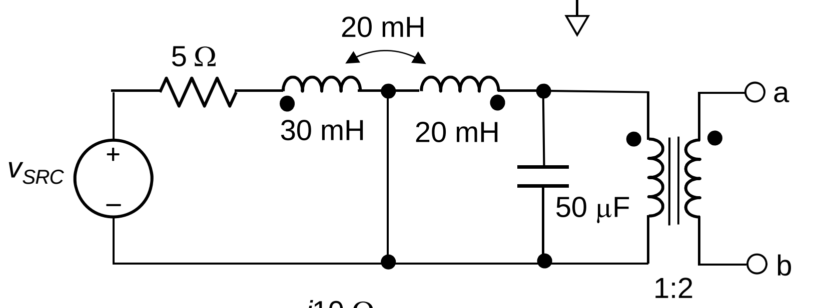
At the right-hand node:

$(\mathbf{V_x} - \mathbf{V_C})/j4 + (\mathbf{V_x} - 10)/3 = 5\mathbf{I_x} = 5(10 - \mathbf{V_C})/j4$

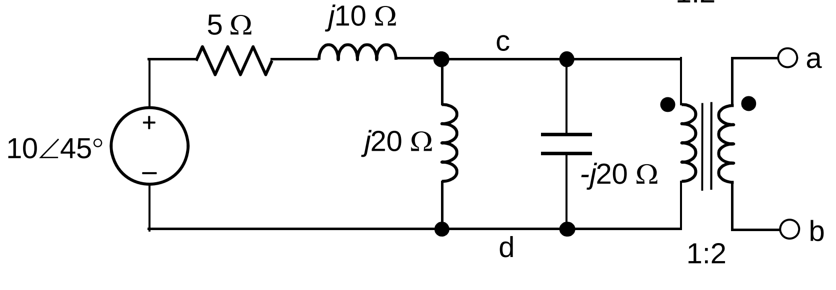
Solving, $\mathbf{V_C} = 11.98 + j1.44 = 12.1\angle 6.86^\circ$, so that $v_C = 12.1\sin(2{,}000t + 6.86^\circ)$ V.



7. Derive $\mathbf{V_{Th}}$ and Z_{Th} as seen between terminals ab, given that $v_{SRC} = 10\cos(1{,}000t + 45^\circ)$ V.

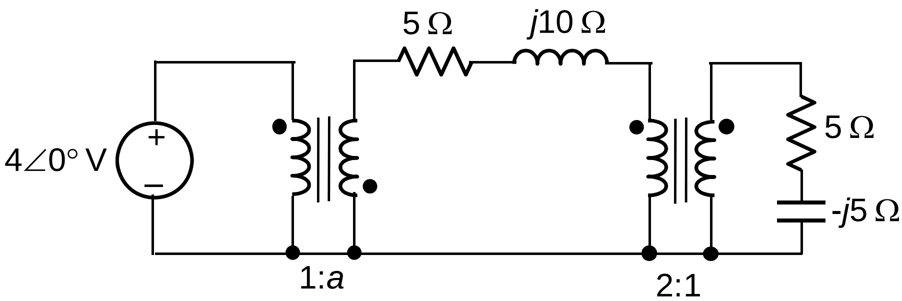


Solution: $\omega L_1 = 10^3\times30\times10^{-3} = 30\ \Omega$; $\omega L_2 = \omega M = 10^3\times20\times10^{-3} = 20\ \Omega$; $\frac{1}{\omega C} = \frac{1}{10^3\times50\times10^{-6}} = 20\ \Omega$; $\mathbf{V_{SRC}} = 10\angle 45^\circ$. The circuit in the frequency domain will be as shown, where $\omega(L_1 - M) = 10\ \Omega$; $\omega(L_2 - M) = 0\ \Omega$ and is omitted. The $j20\ \Omega$ in parallel with $-j20\ \Omega$ is effectively an open circuit. The current in the $(5 + j10)\ \Omega$ impedance is zero, $\mathbf{V_{cd}} = 10\angle 45^\circ$, and $\mathbf{V_{ab}} = \mathbf{V_{Th}} = 20\angle 45^\circ$.



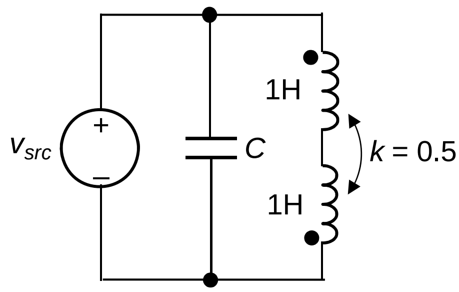
If the independent voltage source is replaced by a short circuit, the impedance on the primary side is (5 + *j*10) Ω and Z_{Th} = 4(5 + *j*10) = 20 + *j*40 Ω.

3. Determine the impedance seen by the source, assuming *a* = 2.



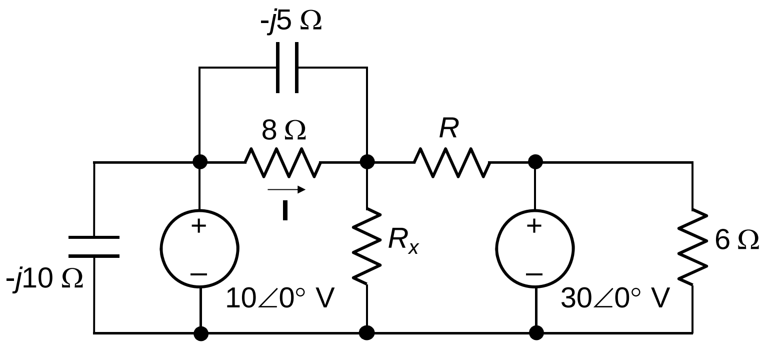
Solution: Reflection of the (5 – *j*5) Ω through the RH transformer gives (20 – *j*20) Ω. The impedance on the secondary side of the LH transformer is (25 – *j*10) Ω. Reflected to the primary side, this becomes (25 – *j*10)/a^2 Ω.

4. If v_{src} = 10cos(1,000*t*) V, determine the energy stored in the circuit in the sinusoidal steady state at *t* = 0, assuming *C* = 1 μF.



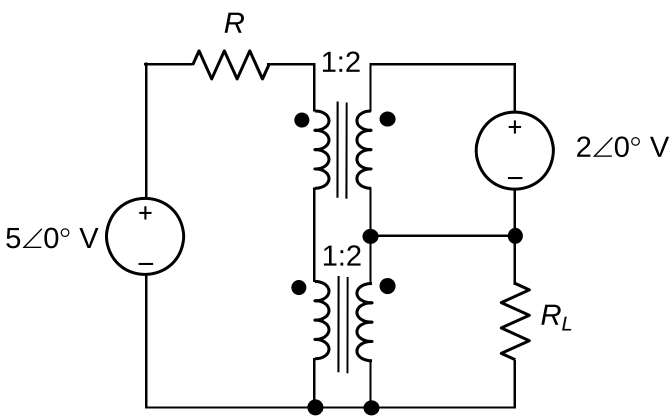
Solution: At *t* = 0, the voltage across *C* is 10 V and the current through the inductors is zero, being proportional to the integral of v_{src}. The energy stored is $W = \frac{1}{2}Cv^2 = 50C$.

5. Determine R_x given that **I** = 0 and *R* = 2 Ω.



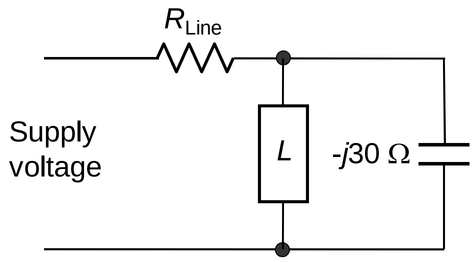
Solution: Since **I** = 0, the voltage across R_x is 10 V, and the same current $\frac{30\angle 0^\circ - 10\angle 0^\circ}{R}$ flows through *R* and R_x. It follows that $\frac{20}{R}R_x = 10$, or $R_x = \frac{R}{2}$.

7. Determine the maximum power that can be delivered to R_L, assuming *R* = 0.5 Ω.



Solution: The primary voltage of the upper transformer is always 1 V. On open circuit, the source current is zero, the primary voltage is 5 – 1 = 4 V, and V_{Th} = 8 V. On short circuit, the primary voltage of the lower transformer is zero, the source current is (5 – 1)/R and the short circuit current is 2/R. This gives, $R_{Th} = 4R$. The maximum power delivered is $(8)^2/(4\times 4R) = 4/R$.

8. Given that the load L consumes 1200 W at 0.8 p.f. lagging and the magnitude of the voltage across L is 300 V rms. Determine the power dissipated in the resistance R_{line}, if $R_{\text{line}} = 0.5\ \Omega$.



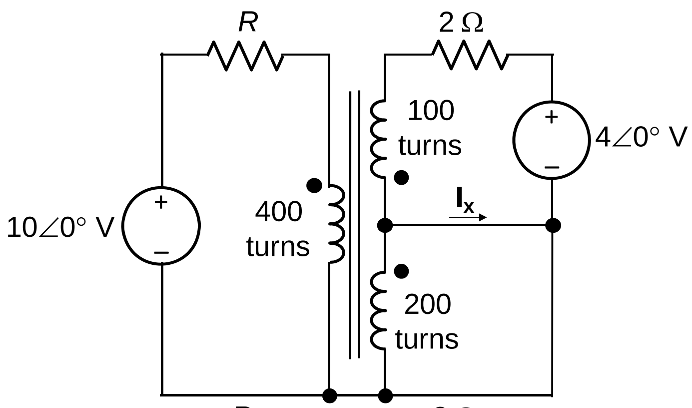
Solution: The reactive power absorbed by the load is $\frac{1200}{0.8}\times 0.6 = 900$ VAR. The reactive power absorbed by the capacitor is $\frac{V^2}{-30} = -3000$ VAR. The total complex power is 1200 + j(900 – 3000) = 1200 – j2100 VA. The magnitude of the line current $\frac{\sqrt{(1200)^2+(2100)^2}}{300} = \sqrt{65}$ A. The power dissipated in R_{line} is $65R_{\text{line}}$.

9. Two identical coils, each having an inductance of 10 mH, are connected in series. When the connections to one of the coils are reversed, the total inductance is multiplied by a factor a. Determine the coupling coefficient of the coils.

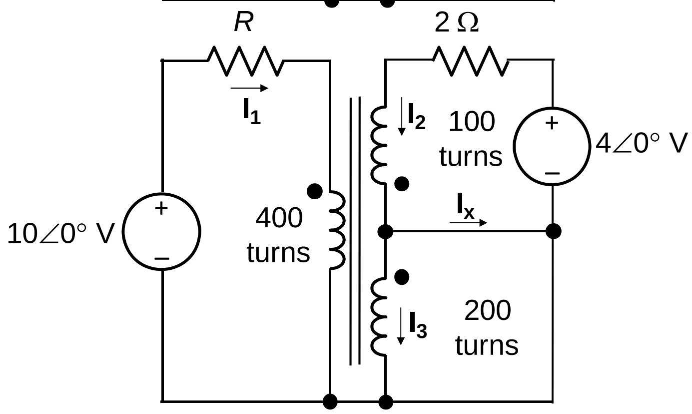
Solution: (10 + 10 + 2M) = a(10 + 10 – 2M); 2M(a + 1) = 20(a – 1);

$$M = \frac{10(a-1)}{a+1};\ k = \frac{M}{10} = \frac{(a-1)}{a+1}$$

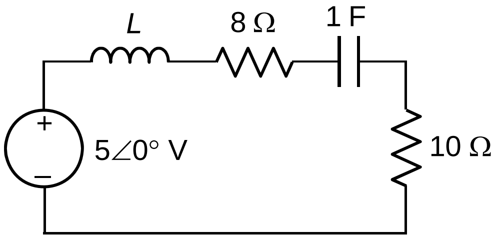
10. Determine $\mathbf{I_x}$, assuming $R = 4\ \Omega$.



Solution: The voltage across all windings is zero. Hence, $\mathbf{I_1} = \frac{10}{R}$ A, and $\mathbf{I_2} = \frac{4}{2} = 2$ A. Setting the net mmf to zero, $400\mathbf{I_1} - 100\mathbf{I_2} + 200\mathbf{I_3} = 0$, or $\frac{4\times 10}{R} - 2 + 2\mathbf{I_3} = 0$, which gives $\mathbf{I_3} = 1 - \frac{20}{R}$; $\mathbf{I_X} = \mathbf{I_2} - \mathbf{I_3} = 1 + \frac{20}{R}$.

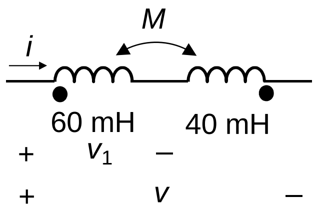


11. Determine the frequency at which maximum power is dissipated in the 10 Ω resistor, assuming L = 1 H.



Solution: $\frac{1}{\omega C} = \frac{1}{\omega}$ Ω. Maximum power is dissipated in the 10 Ω resistor when $X_L = -X_C$, which gives $\omega L = \frac{1}{\omega}$, or $\omega = \frac{1}{\sqrt{L}}$ rad/s.

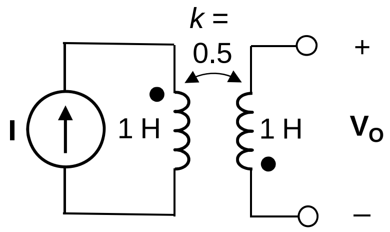
1. If M = 5 mH, determine the ratio v_1/v.



Solution: $L_{eq} = L_1 + L_2 - 2M$; $v = L_{eq}\dfrac{di}{dt}$; $v_1 = L_1\dfrac{di}{dt} - M\dfrac{di}{dt}$;

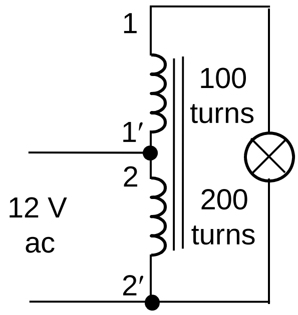
hence, $\dfrac{v_1}{v} = \dfrac{L_1 - M}{L_1 + L_2 - 2M} = \dfrac{60 - M}{100 - 2M}$

2. Determine $\mathbf{V_O}$, given that $\mathbf{I} = 1\angle 0°$ A and ω = 10 rad/s.



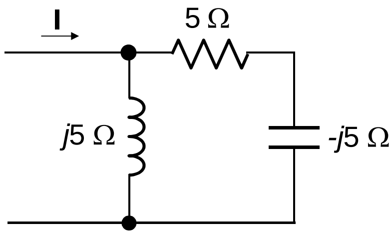
Solution: $M = k\sqrt{L_1L_2} = 0.5$ H; secondary voltage is $j\omega M\mathbf{I}$, with the dotted terminal positive with respect to the undotted terminal. Hence, $\mathbf{V_O} = -j\omega M\mathbf{I} = -j10\times0.5\mathbf{I} = -j5\mathbf{I}$.

3. The lamp glows brighter when the dots are at coil terminals



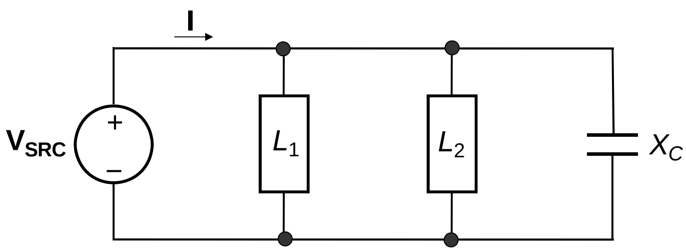
Solution: The lamp glows brighter when the voltage across it is largest. This occurs when the voltages across the windings are additive, that is, when the dots are at terminals 1 and 2 or 1′ and 2′.

4. Determine the reactive power absorbed in the circuit, given that $\mathbf{I} = 1\angle 0°$ A rms.

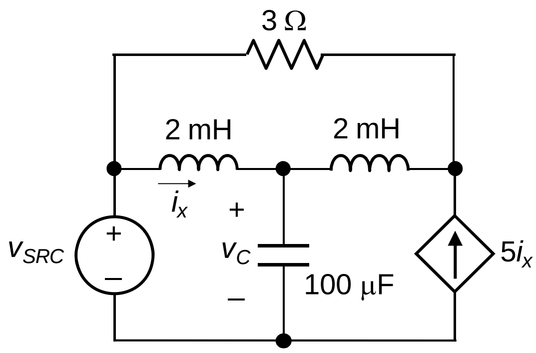


Solution: The equivalent series impedance is $\dfrac{j5(5 - j5)}{j5 + 5 - j5} = 5 + j5$. The reactive power is $5|I|^2$ VAR. As a check, the current in the capacitive branch is $\dfrac{j5}{j5 + 5 - j5}\mathbf{I} = j\mathbf{I}$; the reactive power absorbed by the capacitor is $-5|j\mathbf{I}|^2 = -5|I|^2$ VAR. The current in the inductive branch is $\dfrac{5 - j5}{j5 + 5 - j5}\mathbf{I} = (1 - j)\mathbf{I} = \sqrt{2}\angle{-45°}\mathbf{I}$; the reactive power absorbed by the inductor is $5|\sqrt{2}\,I|^2 = 10|I|^2$ VAR. The total reactive power absorbed is $10|I|^2 - 5|I|^2 = 5|I|^2$ VAR.

5. In the circuit shown, L_1 consumes 160 W at 0.8 p.f. lagging and L_2 consumes 320 VAR at 0.6 p.f. lagging. Determine $\mathbf{I}$ when X_C is chosen for unity power factor, assuming $\mathbf{V_{SRC}} = 200\angle 0°$ V rms.



Solution: Ay unity p.f. the total reactance seen by the source is zero and the source applies only real power. The real power consumed by L_2 is $\frac{320}{0.8}\times 0.6 = 240$ W. The total real power supplied by the load is 160 + 240 = 400 W. The current is $\frac{400}{V_{SRC}\angle 0^\circ} = \frac{400}{V_{SRC}}\angle 0^\circ$ A rms.



6. Derive the time-domain expression for v_C, given that $v_{SRC} = 10\sin(2{,}000t)$ V.

Solution: $\omega L = 2\times10^3\times2\times10^{-3} = 4\ \Omega$; $\frac{1}{\omega C} = \frac{1}{2\times10^3\times100\times10^{-6}} = 5\ \Omega$; $\mathbf{V_{SRC}} = 10\angle 0°$.

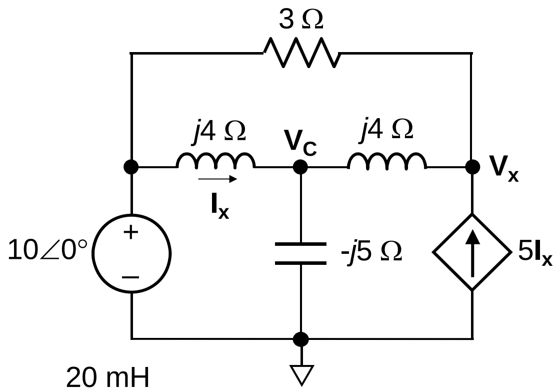
The node-voltage method can be applied, the circuit being as shown. At the middle node:

$\mathbf{V_C}/-j5 + (\mathbf{V_C} - \mathbf{V_x})/j4 + (\mathbf{V_C} - 10)/j4 = 0$

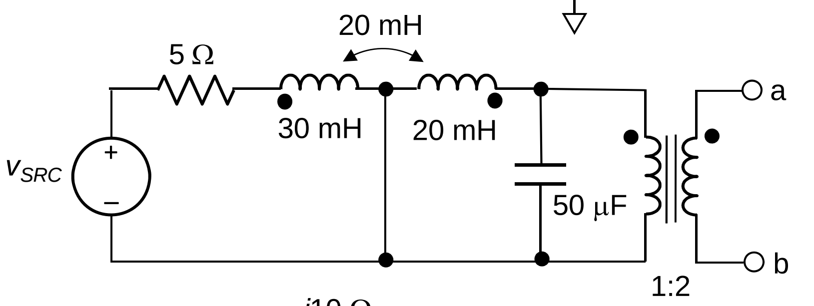
At the right-hand node:

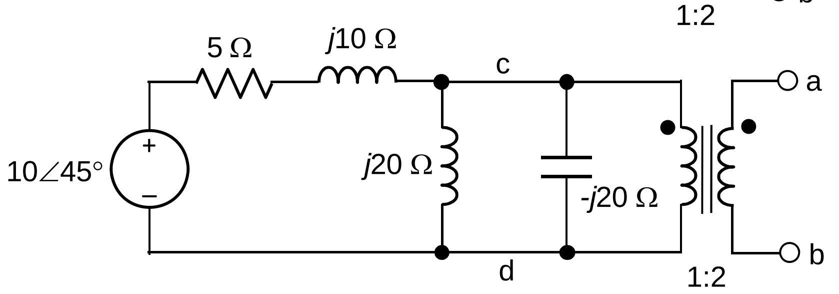
$(\mathbf{V_x} - \mathbf{V_C})/j4 + (\mathbf{V_x} - 10)/3 = 5\mathbf{I_x} = 5(10 - \mathbf{V_C})/j4$

Solving, $\mathbf{V_C} = 11.98 + j1.44 = 12.1\angle 6.86°$, so that $v_C = 12.1\sin(2{,}000t + 6.86°)$ V.



7. Derive $\mathbf{V_{Th}}$ and Z_{Th} as seen between terminals ab, given that $v_{SRC} = 10\cos(1{,}000t + 45°)$ V.

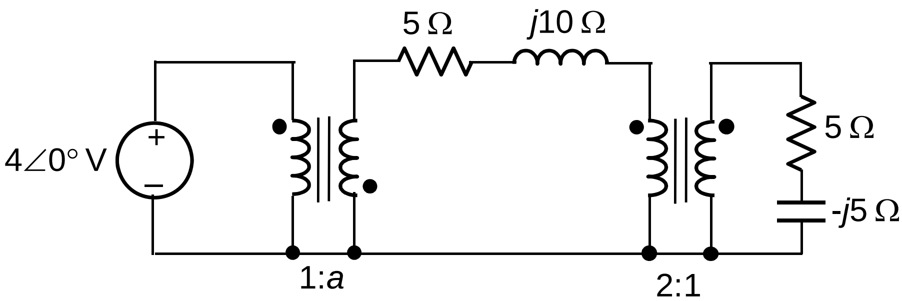




Solution: $\omega L_1 = 10^3\times30\times10^{-3} = 30\ \Omega$; $\omega L_2 = \omega M = 10^3\times20\times10^{-3} = 20\ \Omega$; $\frac{1}{\omega C} = \frac{1}{10^3\times50\times10^{-6}} = 20\ \Omega$; $\mathbf{V_{SRC}} = 10\angle 45°$. The circuit in the frequency domain will be as shown, where $\omega(L_1 - M) = 10\ \Omega$; $\omega(L_2 - M) = 0\ \Omega$ and is omitted. The $j20\ \Omega$ in parallel with $-j20\ \Omega$ is effectively an open circuit. The current in the $(5 + j10)\ \Omega$ impedance is zero, $\mathbf{V_{cd}} = 10\angle 45°$, and $\mathbf{V_{ab}} = \mathbf{V_{Th}} = 20\angle 45°$.

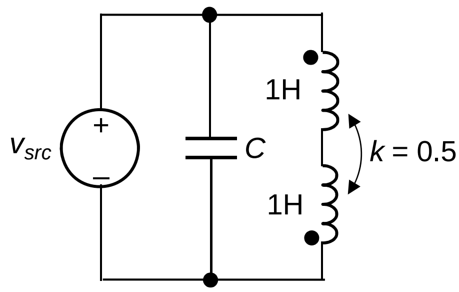
If the independent voltage source is replaced by a short circuit, the impedance on the primary side is (5 + j10) Ω and Z_{Th} = 4(5 + j10) = 20 + j40 Ω.

3. Determine the impedance seen by the source, assuming a = 2.



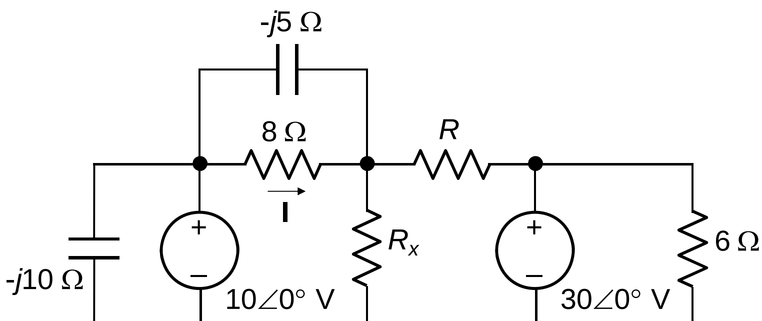
Solution: Reflection of the (5 – j5) Ω through the RH transformer gives (20 – j20) Ω. The impedance on the secondary side of the LH transformer is (25 – j10) Ω. Reflected to the primary side, this becomes (25 – j10)/a^2 Ω.

4. If v_{src} = 10cos(1,000t) V, determine the energy stored in the circuit in the sinusoidal steady state at t = 0, assuming C = 1 μF.



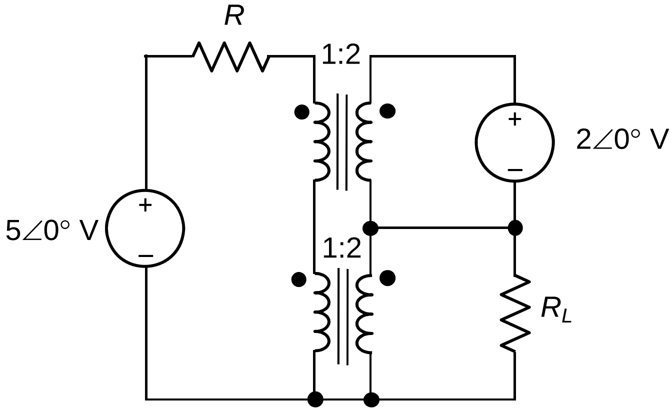
Solution: At t = 0, the voltage across C is 10 V and the current through the inductors is zero, being proportional to the integral of v_{src}. The energy stored is $W = \frac{1}{2}Cv^2 = 50C$.

5. Determine R_x given that **I** = 0 and R = 2 Ω.



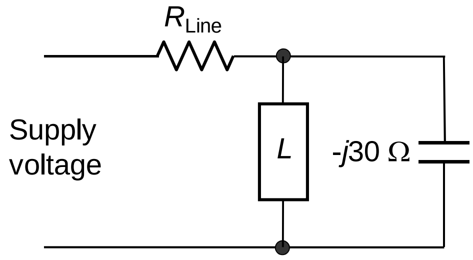
Solution: Since **I** = 0, the voltage across R_x is 10 V, and the same current $\frac{30\angle 0^\circ - 10\angle 0^\circ}{R}$ flows through R and R_x. It follows that $\frac{20}{R}R_x = 10$, or $R_x = \frac{R}{2}$.

7. Determine the maximum power that can be delivered to R_L, assuming R = 0.5 Ω.



Solution: The primary voltage of the upper transformer is always 1 V. On open circuit, the source current is zero, the primary voltage is 5 – 1 = 4 V, and V_{Th} = 8 V. On short circuit, the primary voltage of the lower transformer is zero, the source current is (5 – 1)/R and the short circuit current is 2/R. This gives, $R_{Th} = 4R$. The maximum power delivered is $(8)^2/(4\times 4R) = 4/R$.

8. Given that the load L consumes 1200 W at 0.8 p.f. lagging and the magnitude of the voltage across L is 300 V rms. Determine the power dissipated in the resistance R_{line}, if $R_{\text{line}} = 0.5\ \Omega$.



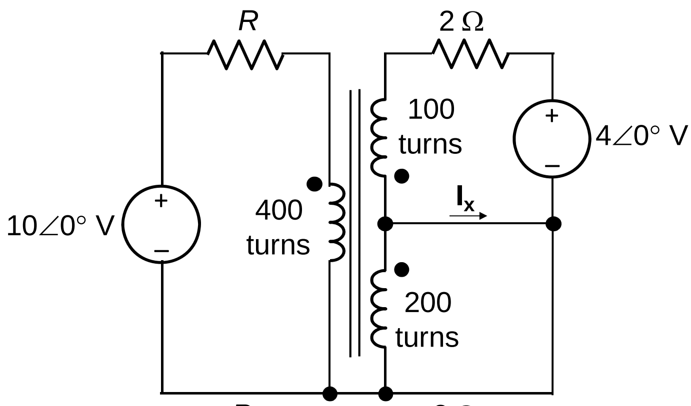
Solution: The reactive power absorbed by the load is $\dfrac{1200}{0.8}\times 0.6 = 900$ VAR. The reactive power absorbed by the capacitor is $\dfrac{V^2}{-30} = -3000$ VAR. The total complex power is 1200 + j(900 – 3000) = 1200 – j2100 VA. The magnitude of the line current $\dfrac{\sqrt{(1200)^2+(2100)^2}}{300} = \sqrt{65}$ A. The power dissipated in R_{line} is $65R_{\text{line}}$.

9. Two identical coils, each having an inductance of 10 mH, are connected in series. When the connections to one of the coils are reversed, the total inductance is multiplied by a factor a. Determine the coupling coefficient of the coils.

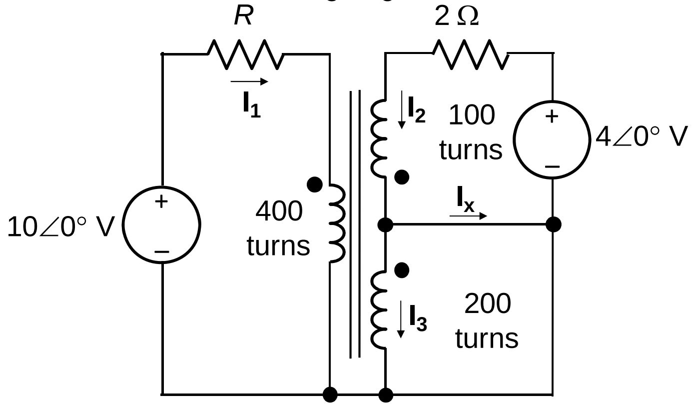
Solution: $(10 + 10 + 2M) = a(10 + 10 - 2M)$; $2M(a + 1) = 20(a - 1)$;

$$M = \frac{10(a-1)}{a+1};\ k = \frac{M}{10} = \frac{(a-1)}{a+1}$$

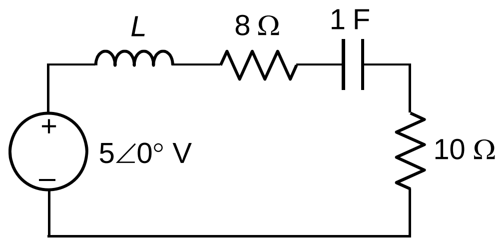
10. Determine $\mathbf{I_x}$, assuming $R = 4\ \Omega$.



Solution: The voltage across all windings is zero. Hence, $\mathbf{I_1} = \dfrac{10}{R}$ A, and $\mathbf{I_2} = \dfrac{4}{2} = 2$ A. Setting the net mmf to zero, $400\mathbf{I_1} - 100\mathbf{I_2} + 200\mathbf{I_3} = 0$, or $\dfrac{4\times 10}{R} - 2 + 2\mathbf{I_3} = 0$, which gives $\mathbf{I_3} = 1 - \dfrac{20}{R}$; $\mathbf{I_x} = \mathbf{I_2} - \mathbf{I_3} = 1 + \dfrac{20}{R}$.

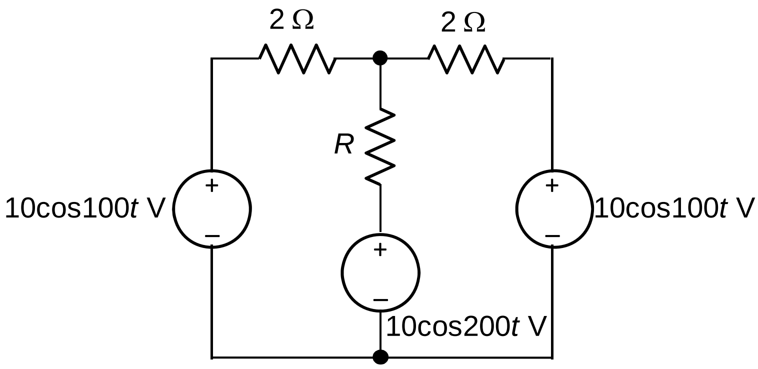


11. Determine the frequency at which maximum power is dissipated in the 10 Ω resistor, assuming L = 1 H.



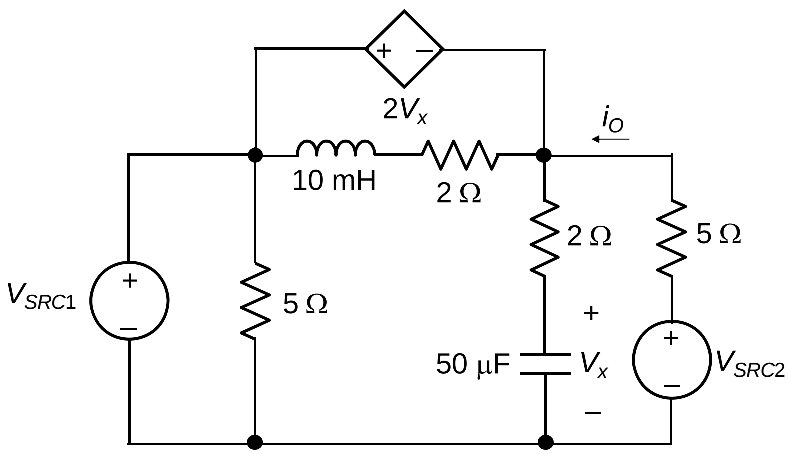
Solution: $\frac{1}{\omega C} = \frac{1}{\omega}$ Ω. Maximum power is dissipated in the 10 Ω resistor when $X_L = -X_C$, which gives $\omega L = \frac{1}{\omega}$, or $\omega = \frac{1}{\sqrt{L}}$ rad/s.

15. Determine the total power dissipated in R if R = 1 Ω.

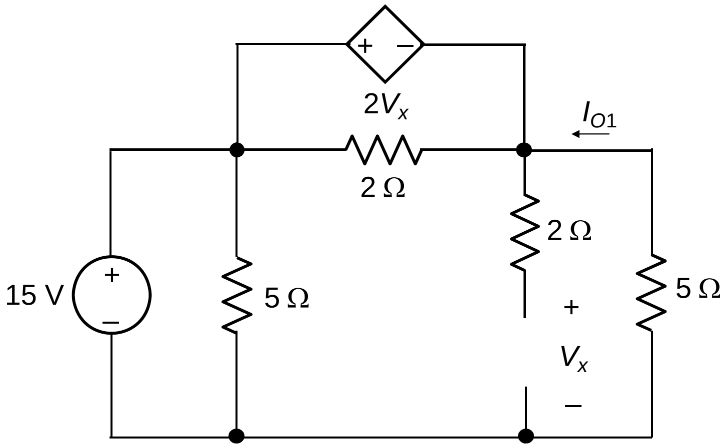


Solution: With either of the 10cos100t V acting alone, i_{R1} = $\frac{10}{2+\frac{2R}{R+2}} \times \frac{2}{R+2} = \frac{5}{R+1}$. The current due to both 10cos100t V sources, with the 10cos200t V source set to zero, is $\frac{10}{R+1}$ and the power dissipated in R is $\frac{100R}{2(R+1)^2} = \frac{50R}{(R+1)^2}$. With the 10cos200$t$ V source acting alone, $i_{R3} = \frac{10}{R+1}$, and the power dissipated in R is $\frac{100R}{2(R+1)^2} = \frac{50R}{(R+1)^2}$. The total power dissipated in R is $\frac{100R}{(R+1)^2}$.

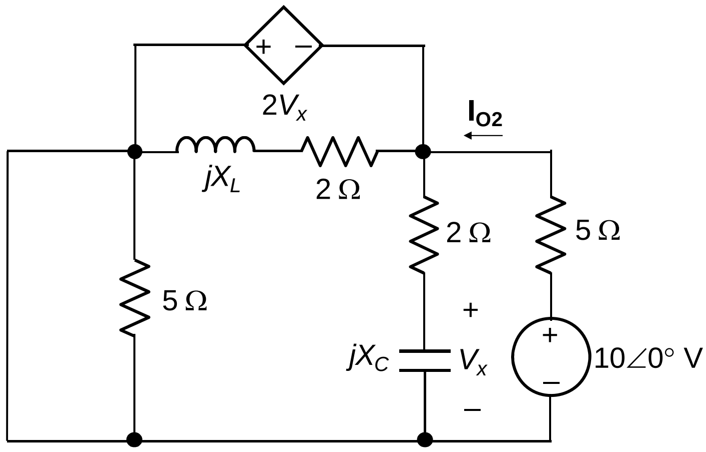
16. Determine i_O, given that V_{SRC1} is 15 V dc and V_{SRC2} = 10cos(3,000t) V.



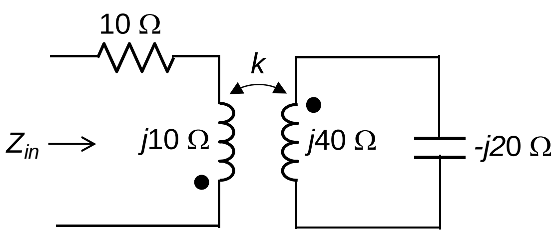
Solution: With V_{SRC1} applied and V_{SRC2} set to zero, the circuit becomes as shown. 15 = 3V_x, so that V_x = 5 V and $I_{O1} = \dfrac{-V_x}{5} = -1$ A.



With V_{SRC2} applied and V_{SRC1} set to zero, the circuit becomes as shown. It follows that: -2V_x = V_x + $\dfrac{2V_x}{jX_C}$, or $V_x\left(3+\dfrac{2}{jX_C}\right)=0$, which gives V_x = 0. Hence, $\mathbf{I_{O2}}$ $= \dfrac{10\angle 0^\circ}{5} = 2\angle 0^\circ$ A. Thus, i_O = -1 + 2cos(3,000t) A.



17. Determine k so that the input resistance is purely resistive.

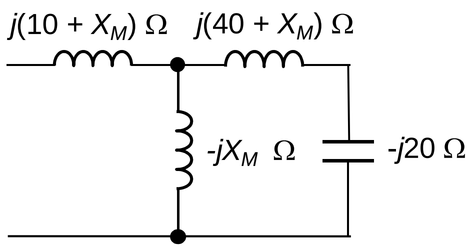


Solution: Disregarding the 10 Ω resistance and replacing the linear transformer by its T-equivalent circuit, the circuit becomes as shown. The input reactance is

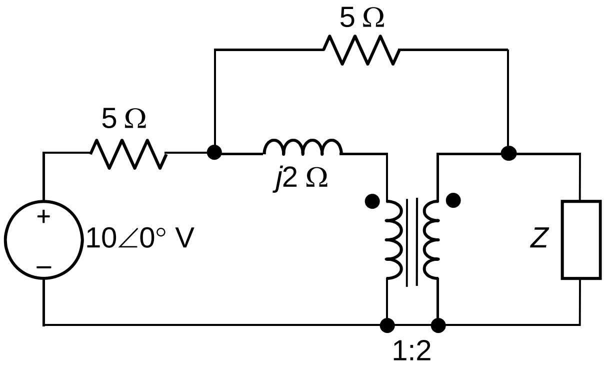
$$j10 + jX_M - \frac{jX_M\left(j20 + jX_M\right)}{j20} = 0, \text{ or}$$

$$10 + X_M - X_M - \frac{X_M^2}{20} = 0, \text{ which gives}$$

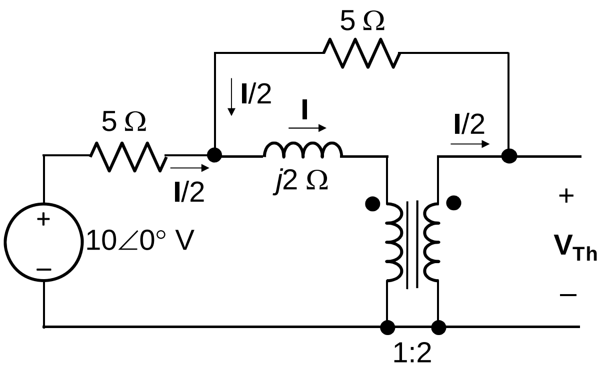
$$X_M = \sqrt{200} = 10\sqrt{2}. \text{ Hence, } k = \frac{10\sqrt{2}}{\sqrt{400}} = \frac{1}{\sqrt{2}} = 0.71.$$



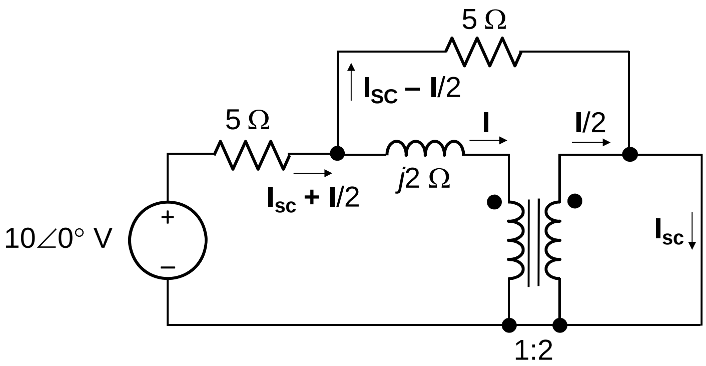
18. Determine Z so that maximum power is transferred to it and calculate this power given that the source voltage is 10 V peak value.



Solution: We will determine TEC as seen by Z. On open circuit, the currents are as shown. From KVL: $10\angle 0^\circ - 5\mathbf{I}/2 + 5\mathbf{I}/2 = \mathbf{V}_{\mathbf{Th}}$. In This particular problem, the voltages across the 5 Ω resistors cancel out. Hence, $\mathbf{V}_{\mathbf{Th}} = 10\angle 0^\circ$ V peak value



When Z is replaced by a short circuit, the currents are as shown. From KVL: $10\angle 0^\circ - 5(\mathbf{I}_{\mathbf{sc}} + \mathbf{I}/2) - 5(\mathbf{I}_{\mathbf{sc}} - \mathbf{I}/2) = \mathbf{0}$. Again, the terms involving I cancel out. Hence, $\mathbf{I}_{\mathbf{sc}} = 1\angle 0^\circ$ A, and $Z_{Th} = \dfrac{10\angle 0^\circ}{1\angle 0^\circ} = 10\ \Omega$. It follows that for maximum power transfer, $Z = 10\ \Omega$. The power dissipated in the load is $\left(\dfrac{V_{Th}}{\sqrt{2}}\right)^2 \dfrac{1}{4\times 10} = 1.25$ W.



Problem 1

Given 3 elements $R = 10K\Omega$, $L = 10mH$ and $C = 625nF$ powered by a source $v = 90sin(10,000t + \frac{\pi}{4})$ (V). Find the impedance of each element Z_R, Z_L and Z_C.

A) $Z_R = 10K\Omega$, $Z_L = 100j\Omega$, $Z_C = -160j\Omega$

B) $Z_R = 10K\Omega$, $Z_L = 10j\Omega$, $Z_C = -16j\Omega$

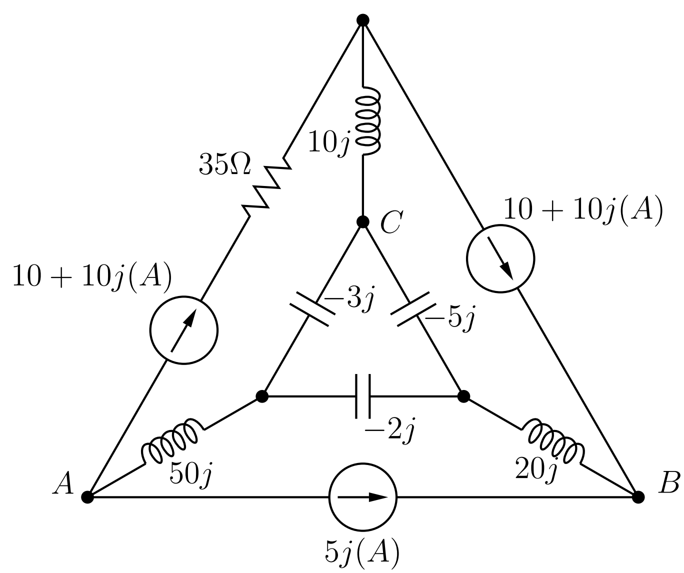
C) $Z_R = 10jK\Omega$, $Z_L = 10j\Omega$, $Z_C = -1600j\Omega$

D) $Z_R = 10K\Omega$, $Z_L = 10j\Omega$, $Z_C = -160j\Omega$

E) None of the above

Problem 2

Find the Thevenin equivalent voltage between A and C. (Impedances are in Ω)



A) 285-190j V

→ B) -741+494j V

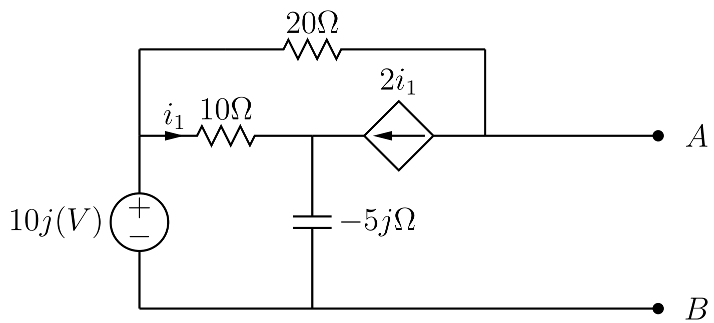
C) -741-494j V

D) 285+190j V

E) None of the above

Problem 3

Find the Thevenin equivalent voltage between A and B.



A) $39.7V\angle 21.6^o$

B) $18.6V\angle 7.1^o$

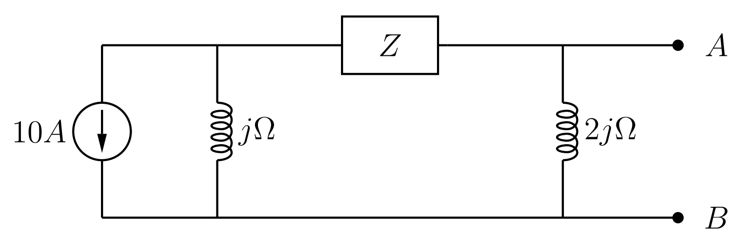
C) $18.6V\angle -7.1^o$

D) $39.7V\angle -21.6^o$

E) None of the above

Problem 4

Find the nature of Z such that the Thevenin equivalent impedance between A and B is 1Ω.



A) $0.8 - 1.4j\Omega$

B) $0.8 + 1.4j\Omega$

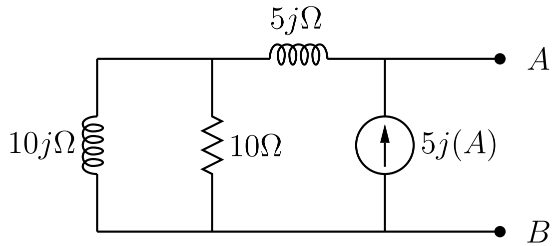
C) $0.5 - 2.5j\Omega$

D) $0.5 + 2.5j\Omega$

E) None of the above

Problem 5

Find the Thevenin voltage between A and B.



A) 50+25j V

B) -100+50j V

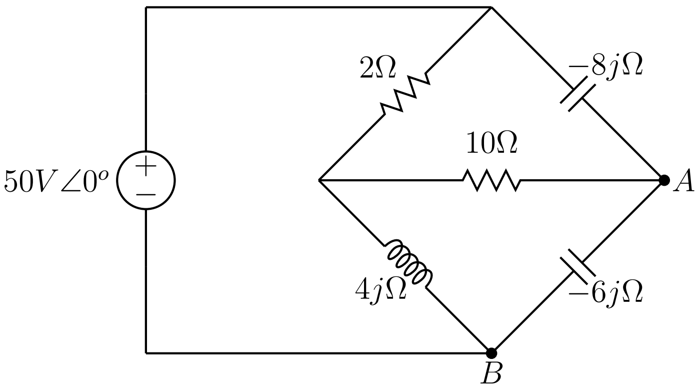
C) 100+50j V

D) -50+25j V

E) None of the above

Problem 6

Find the Thevenin impedance between A and B.



A) 1.49-0.55j Ω

B) 0.96+3.21j Ω

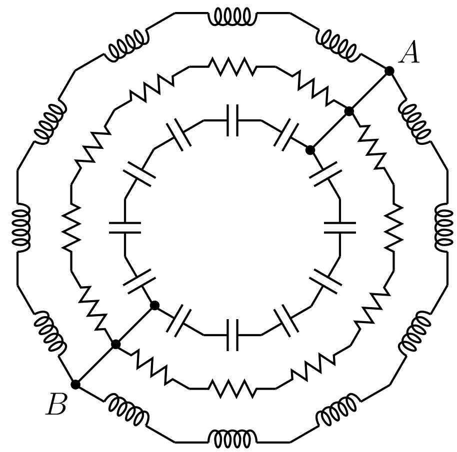
C) 0.96-3.21j Ω

D) 1.49+0.55j Ω

E) None of the above

Problem 7

All the inductors are equal to $5j\Omega$, all the capacitors are equal to $-6j\Omega$, all the resistances are equal to 10Ω. Find Z_{AB}.



A) 30.56+16.98j Ω

B) 30.56-16.98j Ω

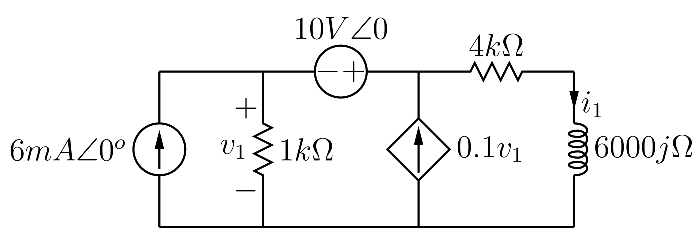
C) 27-9j Ω

→D) 27+9j Ω

E) None of the above

Problem 8

Find i_1.



A) 0.76-1.14j mA

B) -0.26+1.6j mA

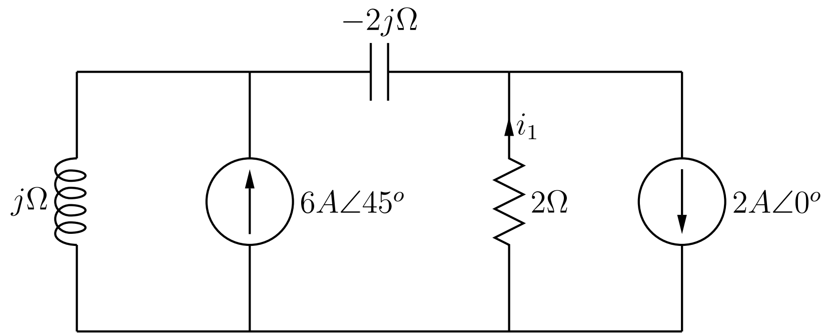
C) 0.26-1.6j mA

D) -0.76+1.14j mA

E) None of the above

Problem 9

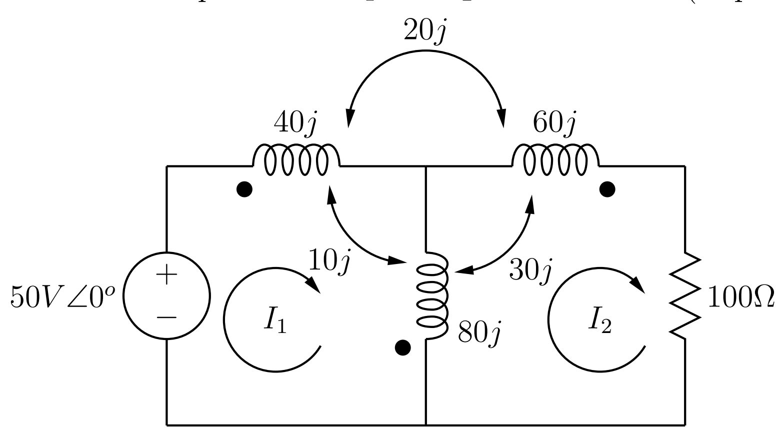
Find i_1.



A) $3.38\angle - 29.2^o$ (A)
B) $7.55\angle - 82.4^o$ (A)
C) $7.55\angle 82.4^o$ (A)
D) $3.38\angle 29.2^o$ (A)
E) None of the above

Problem 10

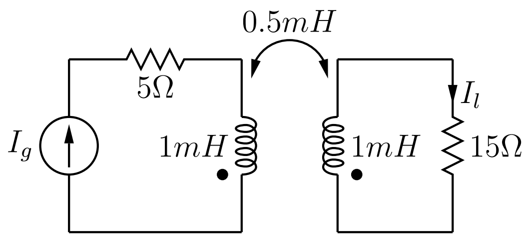
Write the two mesh current equation for I_1 and I_2 **Don't solve**. (Impedances are in Ω).



A) $100jI_1 + 60jI_2 = 50$ $\quad 60jI_1 + (100 + 80j)I_2 = 0$
B) $120jI_1 - 80jI_2 = 50$ $\quad -80jI_1 + (100 + 80j)I_2 = 0$
C) $100jI_1 - 80jI_2 = 50$ $\quad -80jI_1 + (100 + 80j)I_2 = 0$
D) $100jI_1 - 60jI_2 = 50$ $\quad -60jI_1 + (100 + 80j)I_2 = 0$
E) None of the above

Problem 11

If $I_g = 20cos(10,000t + \frac{\pi}{3})(A)$ find the energy associated with the 2 coils at the time $t = 100\pi\mu s$.



A) 65.3mJ

B) 261.3mJ

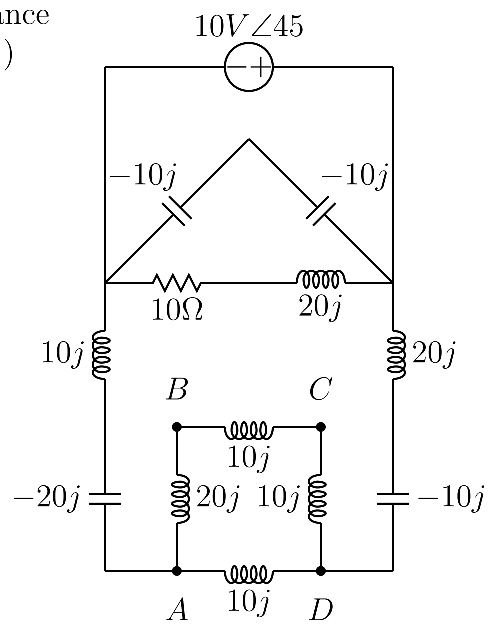
C) 40.7mJ

D) 163mJ

E) None of the above

Problem 12

Find the Thevenin equivalent impedance between A and B. (Impedances are in Ω.)



A) 10j Ω

B) 8j Ω

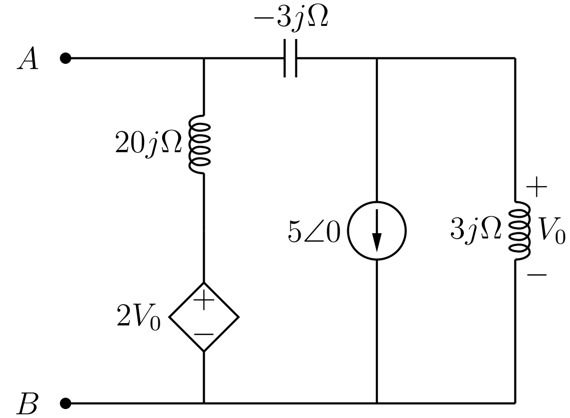
C) 7.5j Ω

D) 12j Ω

E) None of the above

Problem 1

Find the Thevenin equivalent voltage between A and B (V_{AB}).



A) 15j V

B) -20j V

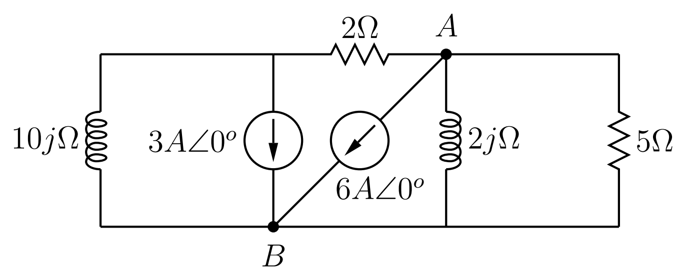
C) 20j V

D) -15j V

E) None of the above

Problem 2

Find the average power associated with the 6A current source between A and B.



A) -23.86W

B) 23.86W

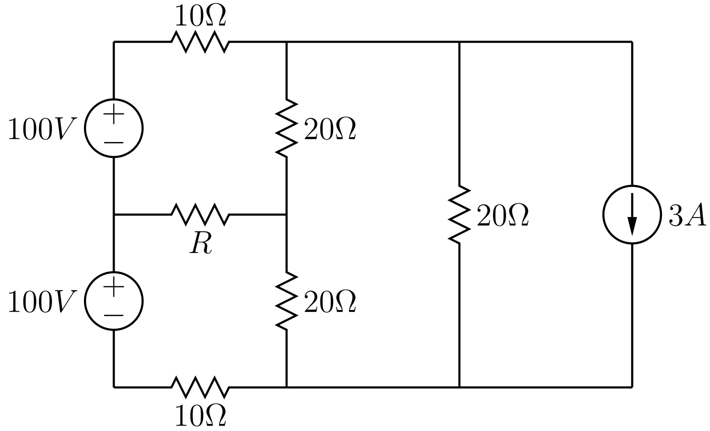
C) 28.71W

D) -28.71W

E) None of the above

Problem 3

Find R that satisfies the maximum power transfer constraint.



A) 14Ω

B) 15Ω

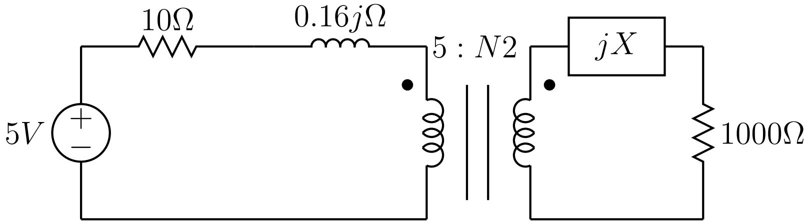
C) 16.33Ω

D) 17.46Ω

E) None of the above

Problem 8

Find N_2 and X such that maximum power is delivered to the 1000Ω resistor.



A) $N_2 = 50,\ X = -16$

B) $N_2 = 10,\ X = -16$

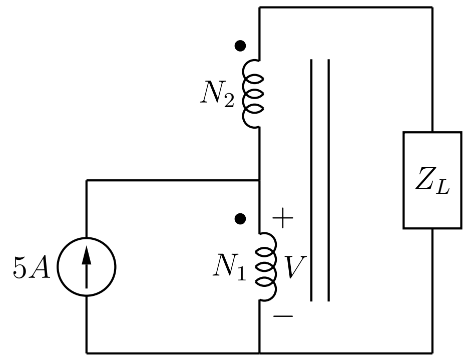
C) $N_2 = 10,\ X = -0.64$

D) $N_2 = 2,\ X = -0.64$

E) None of the above

Problem 9

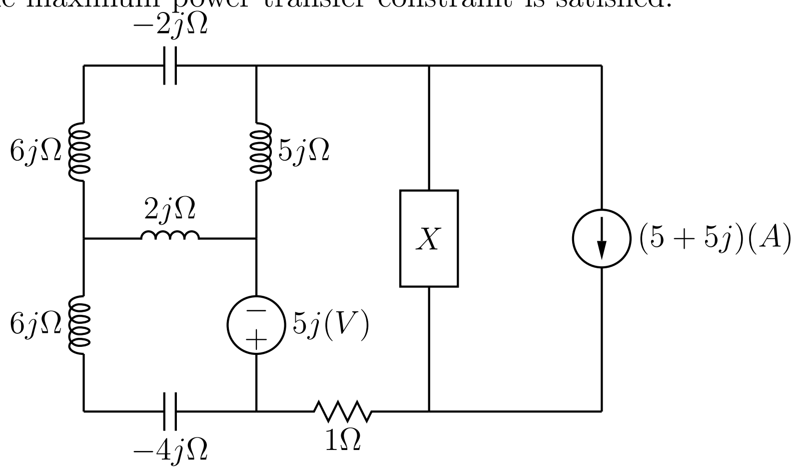
Given $Z_L = 100 + 100j$, N_2=90, N_1=10, find V.



A) $7.07V\angle -135^o$
B) $63.64V\angle 45^o$
C) $63.64V\angle -135^o$
D) $7.07V\angle 45^o$
E) None of the above

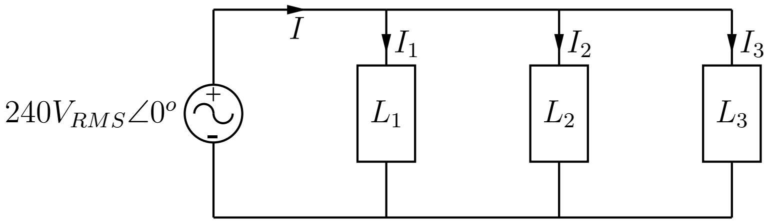
Problem 10

Find X such that the maximum power transfer constraint is satisfied.



A) $1 - 2.5j\Omega$
B) $1 + 2.5j\Omega$
C) $2 - 2.5j\Omega$
D) $2 + 2.5j\Omega$
E) None of the above

The following given is used in the next 5 problems. 3 electrical elements are powered by a $240V_{RMS}$, 60Hz source:



The following is given for the three elements:

L1: 240W, PF=0.6 Lag

L2: 200VARS, PF=0.5 Lag

L3: 100VA, PF=0 Lead

Problem 11

Find the total apparent power.

A) 725.67VA

B) 626.33VA

C) 550.2VA

D) 888.8VA

E) None of the above

Problem 12

Find the total power factor.

A) 0.567 Lag

B) 0.646 Lag

C) 0.808 Lag

D) 0.747 Lag

E) None of the above

Problem 13

Find the magnitude of the total current I.

A) 5.21A

B) 3.02A

C) 2.292A

D) 7.40A

E) None of the above

Problem 14

Find the capacitor that needs to be placed in parallel with the loads to adjust the power factor to 0.9 Lag.

A) 62.7μF

B) 147μF

C) 49μF

D) 11.4μF

E) None of the above

Problem 15

Find the magnitude of I again after the power factor is adjusted as in the previous problem.

A) 1.64A

B) 3.29A

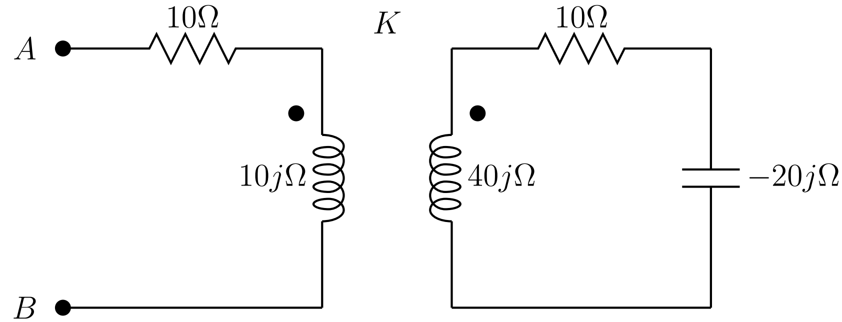
C) 0.91A

D) 2.13A

E) None of the above

Problem 16

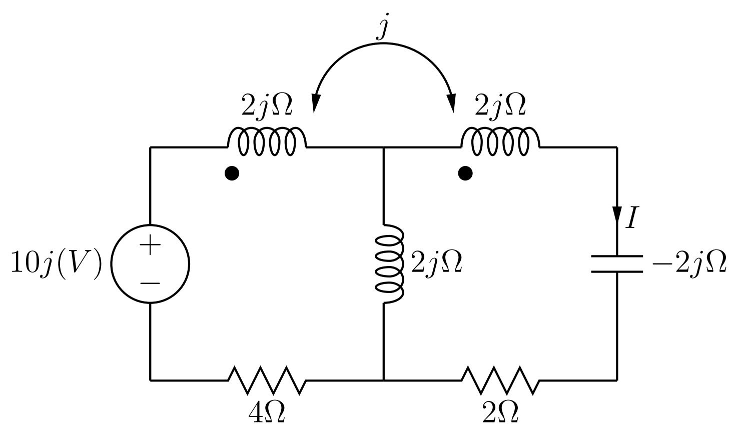
Consider the linear transformer of the figure below, given $\omega = 1 rad/s$, find the coupling coefficient K, such that the Thevenin impedance between A and B is purely resistive.



A) 0.79
B) 0.82
C) 0.85
D) 0.88
E) None of the above

Problem 17

Find I.



A) 0.0389 - 0.6226j A
B) -0.0778 + 1.2452j A
C) -0.0389 + 0.6226j A
D) 0.0778 - 1.2452j A
E) None of the above