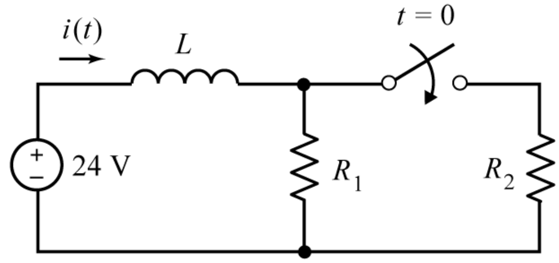
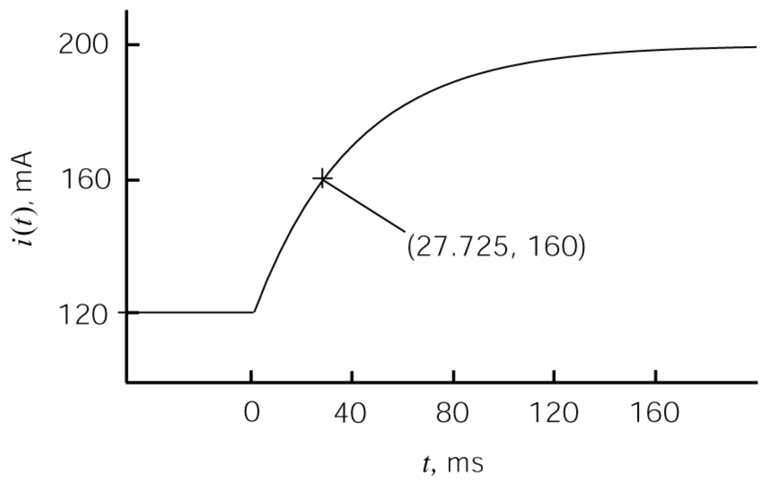
EE221 - Practice for the Midterm Exam

1. Consider this circuit and corresponding plot of the inductor current:



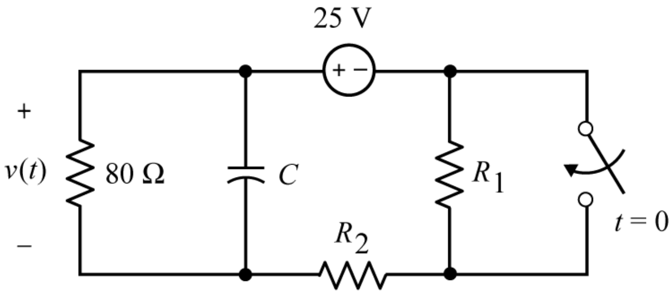


Determine the values of L, R_1 and R_2: $L =$ ________ H, $R_1 =$ ________ Ω and $R_2 =$ ________ Ω.

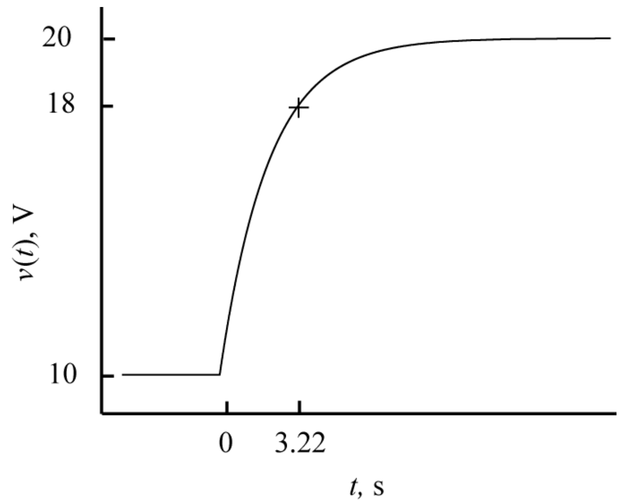
Hint: Use the plot to determine values of D, E, F and a such that the inductor current can be represented as

$$i(t) = \begin{cases} D & \text{for } t \le 0 \\ E + F\,e^{-at} & \text{for } t \ge 0 \end{cases}$$

2.



(a)

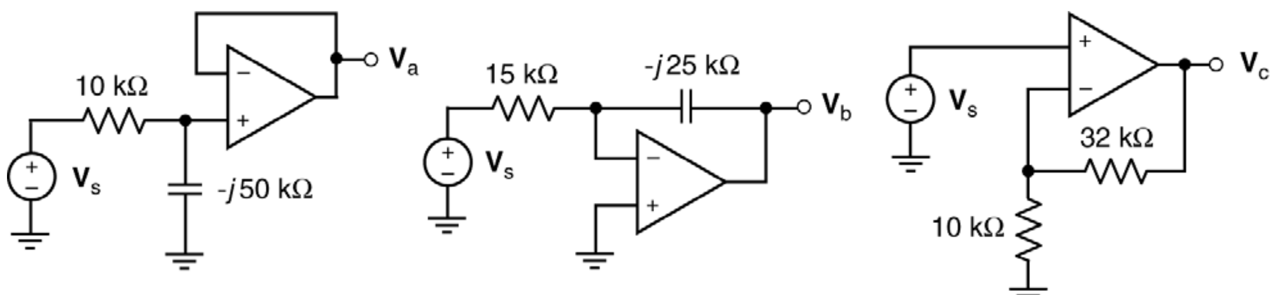


(b)

Design the circuit in (*a*) to have the response in (*b*) by specifying the values of *C*, R_1 and R_2.

C = _______ F, R_1 = _______ Ω and R_2 = _______ Ω.

3.



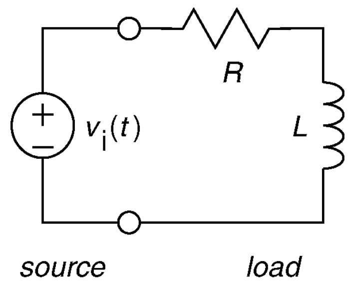
Here are three ac circuits, each represented in the frequency domain. The input to each of these circuits is the phasor voltage $\mathbf{V}_s = 2.5\angle -75°$ V. Let P_a, P_b and P_c denote the average power supplied by the source in circuit (*a*), (*b*) and (*c*) respectively. Determine the values of P_a, P_b and P_c:

P_a = _______mW, P_b = _______mW and P_c = _______mW

4. Given that

$$v_i(t) = 24\cos(3t + 75°) \quad \text{V}$$

answer the following questions:



a) Suppose $R = 9\,\Omega$ and $L = 5$ H. What are the average, complex and reactive powers delivered by the source to the load?

$P =$ _______ W, $\mathbf{S} =$ _______ VA and $Q =$ _______ VAR

b) Suppose the source delivers 8.47 + *j* 14.12 VA to the load. What are the values of the resistance, *R*, and the inductance, *L*?

$R =$ _______ Ω and $L =$ _______ H

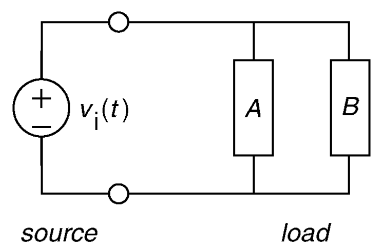
c) Suppose the source delivers 14.12 W to the load at a power factor of 0.857 lagging. What are the values of the resistance, *R*, and the inductance, *L*?

$R =$ _______ Ω and $L =$ _______ H

5. Given that

$$v_i(t) = 24\cos(3t + 75°) \quad \text{V}$$

Determine the impedance of the load and the complex power delivered by the source to the load under each of the following conditions:



a) The source delivers 14.12 + *j* 8.47 VA to load *A* and 8.47 + *j* 14.12 VA to load *B*.

$\mathbf{Z} =$ _____________ Ω, $\mathbf{S} =$ _____________ VA

b) The source delivers 8.47 + *j* 14.12 VA to load *A* and the impedance of load *B* is $15 + j9\,\Omega$.

$\mathbf{Z} =$ _____________ Ω, $\mathbf{S} =$ _____________ VA

c) The source delivers 14.12 W to load *A* at a power factor of 0.857 lagging and the impedance of load *B* is $9 + j15\,\Omega$.

$\mathbf{Z} =$ _____________ Ω, $\mathbf{S} =$ _____________ VA

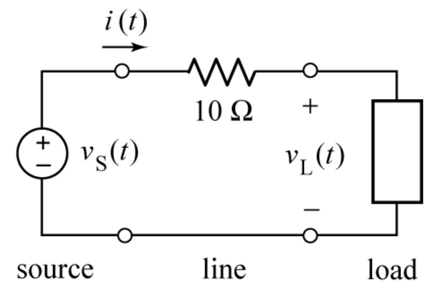
d) The impedance of load *A* is $15 + j9\,\Omega$ and the impedance of load *B* is $9 + j15\,\Omega$.

$\mathbf{Z} =$ _____________ Ω, $\mathbf{S} =$ _____________ VA

6. In this circuit an ac source is connected to a load by the line. The load voltage is $\mathbf{V}_L = 120\angle 0°$ Vrms and the load receives 50 W at a power factor of 0.8 lagging. The line current is

$$\mathbf{I} = 1.042\angle -36.87° \text{ Arms}$$

Determine the RMS value of required source voltage, $v_s(t)$, and the average power supplied by the source, P_s.

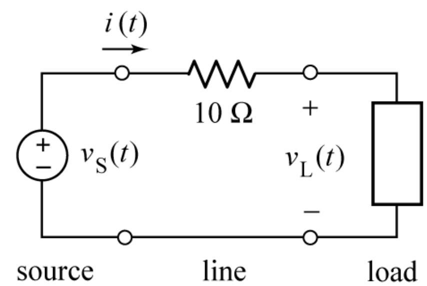


$|\mathbf{V}s|$ = _______ Vrms and P_s = _______ W

7. In this circuit an ac source is connected to a load by the line. The load voltage is $\mathbf{V}_L = 120\angle 0°$ Vrms and the load receives 50 W at a power factor of 0.8 lagging. The line current is

$$\mathbf{I} = B\angle\phi \text{ Arms}$$

Determine the values of B and ϕ.



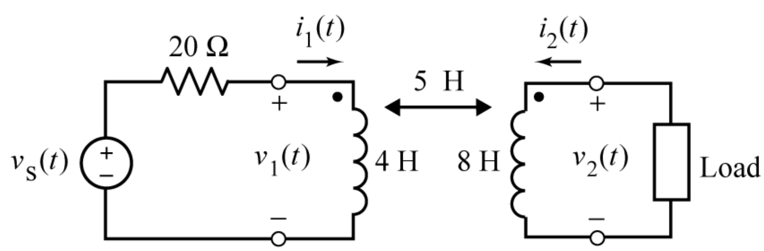
B = _______ Arms and ϕ = _______ °

8. The input to this circuit shown is

$$v_s(t) = 12\cos(5t) \text{ V}$$

The impedance of the load is 20 + j 15 Ω.

Noticing that $i_1(t)$ and $i_2(t)$ are mesh currents, we can represent this circuit by the mesh equations



$$\begin{bmatrix} 20 + ja & jb \\ jc & 20 + jd \end{bmatrix}\begin{bmatrix} \mathbf{I}_1 \\ \mathbf{I}_2 \end{bmatrix} = \begin{bmatrix} 12\angle 0° \\ 0 \end{bmatrix}$$

where a, b, c, and d are real constants. Determine the values of a, b, c, and d.

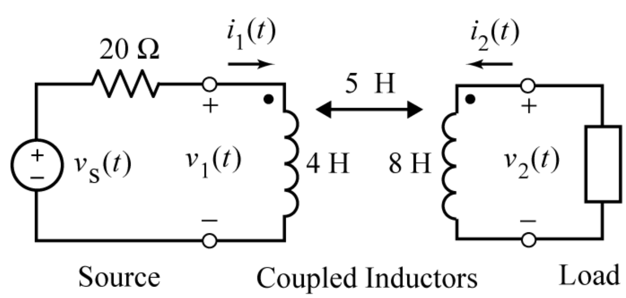
a = _______ Ω, b = _______ Ω, c = _______ Ω, and d = _______ Ω

9. This circuit consists of a source connected to a load by coupled coils. The input is

$$v_s(t) = 12\cos(5t) \text{ V}$$

The impedance of the load is 20 + j 15 Ω.

The mesh currents $i_1(t)$ and $i_2(t)$ are

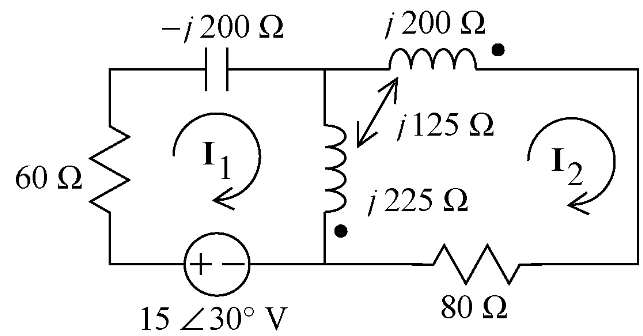


$$i_1(t) = 0.4676\cos(5t - 22.8°) \text{ A} \quad \text{and} \quad i_2(t) = 0.1998\cos(5t - 2.86°) \text{ A}$$

Determine the values of $\mathbf{S}$, the complex power supplied by the source, $\mathbf{S}_c$, the complex power received by the coupled inductors and $\mathbf{S}_L$, the complex power received by the load.

$\mathbf{S}$ = _______ + j _______ VA, $\mathbf{S}_c$ = _______ + j _______ VA and $\mathbf{S}_L$ = _______ + j _______ VA

10. Here is a circuit containing coupled coils, represented in the frequency domain. The currents $\mathbf{I}_1$ and $\mathbf{I}_2$ are mesh currents. The mesh equations representing this circuit can be expressed as



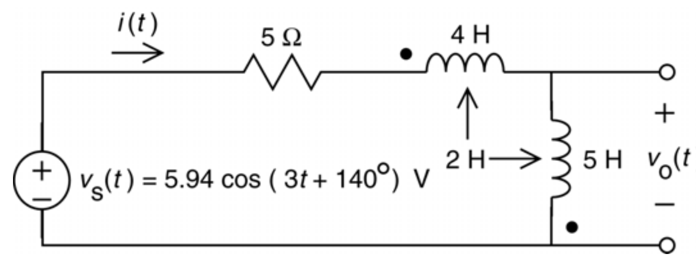
$$(a+jb)\mathbf{I}_1+(c+jd)\mathbf{I}_2=15\angle 30°$$

$$(c+jd)\mathbf{I}_1+(80+jf)\mathbf{I}_2=0$$

where $a+jb$, $c+jd$, and $40+jf$ represent complex numbers in rectangular form. Determine the following:

$a=$_______ , $b=$_______ , $c=$_______ , $d=$_______ , $f=$_______

11. The current $i(t)$ and voltage $v(t)$ labeled on the circuit drawing are

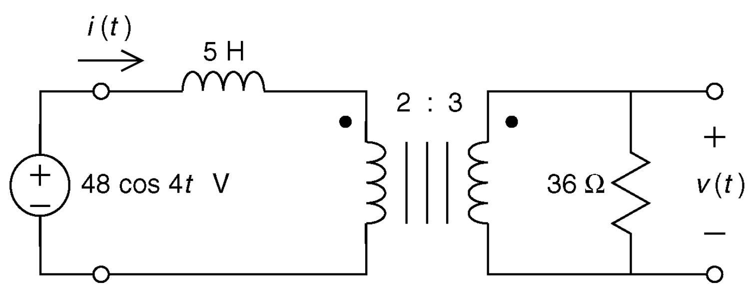


$i(t)=$ ________ $\cos(3t+68.4°)$ A

and

$v(t)=$ _________ $\cos(3t+$ _________ $°)$ V

12. The current $i(t)$ and voltage $v(t)$ labeled on the circuit drawing are

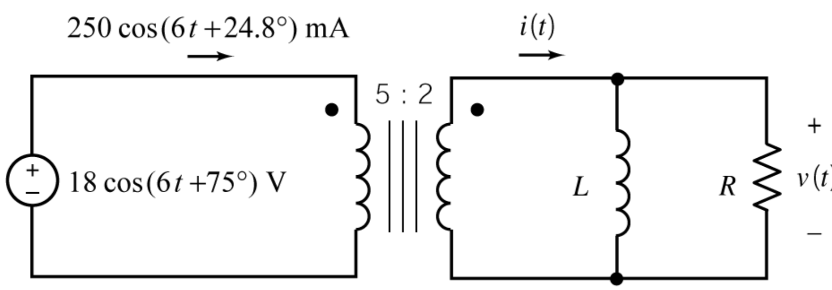


$i(t)=$ ________ $\cos(4t-51.3°)$ A

and

$v(t)=$ ________ $\cos(4t-$ _______ $°)$ V

13.



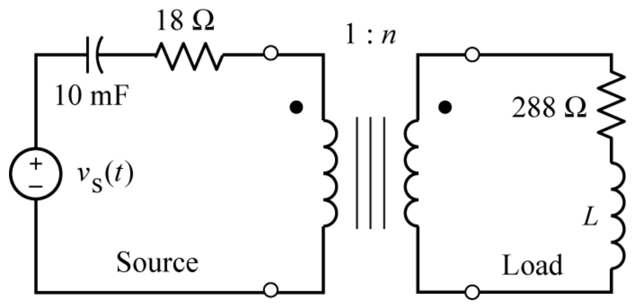
Determine the values of R and L: $R=$ __________ Ω and $L=$ __________ H

14. This circuit consists of a load connected to a source through an ideal transformer. The input to the circuit is

$$v_s(t) = 12\cos(20t) \;\; \text{V}$$

Determine the values of the turns ration, n, and load inductance, L, required for maximum power transfer to the load.

$n =$ ____________ and $L =$ ___________ H



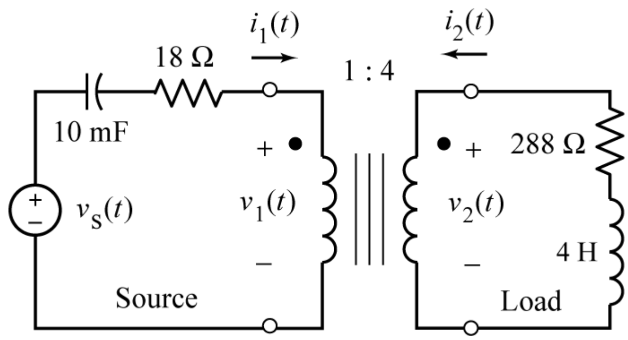
15. This circuit consists of a load connected to a source through an ideal transformer. The input to the circuit is

$$v_s(t) = 12\cos(20t) \;\; \text{V}$$

The coil voltages and currents are

$$v_1(t) = A\cos(20t + 15.5°) \;\; \text{V},$$

$$v_2(t) = B\cos(20t + 15.5°) \;\; \text{V}$$



$$i_1(t) = C\cos(20t) \;\; \text{A} \;\; \text{and} \;\; i_2(t) = D\cos(20t + 180) \;\; \text{A}$$

Determine the values of A, B, C and D.

$A =$ _________ V, $B =$ _________ V, $C =$ _________ A and $D =$ _________ A

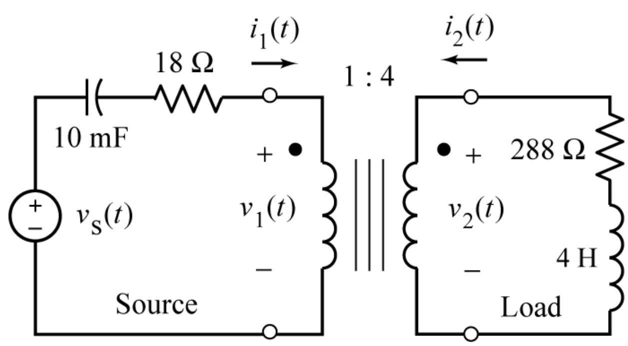
16. This circuit consists of a load connected to a source through an ideal transformer. The input to the circuit is

$$v_s(t) = 12\cos(20t) \;\; \text{V}$$

The coil voltages and currents are

$$v_1(t) = 6.227\cos(20t + 15.5°) \;\; \text{V},$$

$$v_2(t) = 24.91\cos(20t + 15.5°) \;\; \text{V}$$



$$i_1(t) = 0.333\cos(20t) \;\; \text{A} \;\; \text{and} \;\; i_2(t) = 0.0833\cos(20t + 180) \;\; \text{A}$$

Determine the values of $\mathbf{S}_p$, the complex power received by the primary (left) coil of the transformer and $\mathbf{S}_L$, the complex power received by the load.

$\mathbf{S}_p =$ _________ $+\,j$ _________ VA and $\mathbf{S}_L =$ _________ $+\,j$ _________ VA

17. The network function of a circuit is $\mathbf{H}(\omega) = -10\dfrac{j\omega}{1+j\dfrac{\omega}{20}}$. The table below tabulates frequency response data for this circuit. Fill in the blanks in the table:

ω, rad/s	Gain, V/V	Phase Shift, °
10	89.44	________
40	________	−153.4

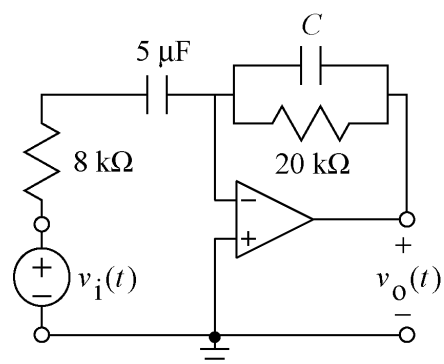
18. The network function of a circuit is $\mathbf{H}(\omega) = \dfrac{k}{1+j\dfrac{\omega}{p}}$. The table below tabulates frequency response data for this circuit.

ω, rad/s	Gain, V/V	Phase Shift, °
10	17.18	−17.4
40	11.25	−51.3

Determine the values of p and k: $p =$ ________ rad/s and $k =$ ________ V/V

19. The input to the circuit is the voltage of the voltage source, $v_i(t)$. The output is the voltage $v_o(t)$. The network function of this circuit is

$$\mathbf{H}(\omega) = \frac{\mathbf{V_o}(\omega)}{\mathbf{V_i}(\omega)} = \frac{(-0.1)\,j\omega}{\left(1+j\dfrac{\omega}{p}\right)\left(1+j\dfrac{\omega}{125}\right)}$$

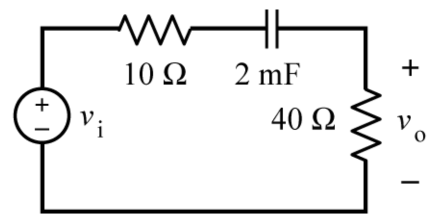


Determine the values of the capacitance, C, and the pole, p.

$C =$ ___________ μF and $p =$ _________ rad/s .

20. The network function of this circuit is:

$$\mathbf{H}(\omega) = \frac{\mathbf{V_o}(\omega)}{\mathbf{V_s}(\omega)} = (k)\frac{j\omega}{1+j\dfrac{\omega}{p}}$$

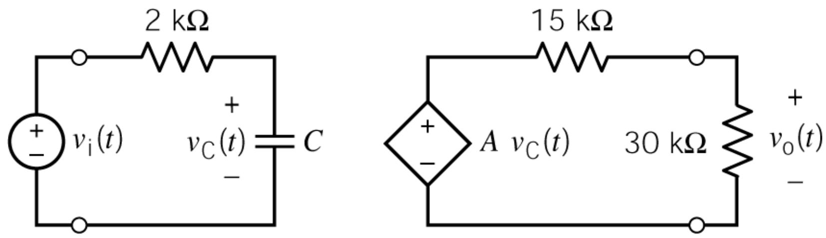


Determine the values of k and p:

$k =$ ________ , and $p =$ _______rad/s .

21. The input to the circuit is the voltage of the voltage source, $v_i(t)$. The output is the voltage $v_o(t)$. The network function of this circuit is

$$\mathbf{H}(\omega) = \frac{\mathbf{V_o}(\omega)}{\mathbf{V_i}(\omega)} = \frac{4}{1 + j\dfrac{\omega}{100}}$$

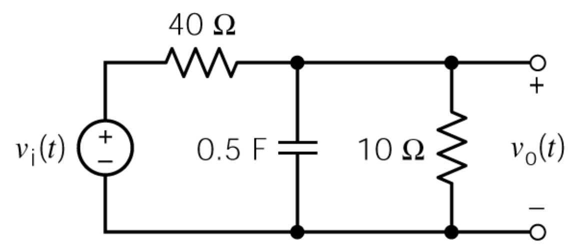


Determine the values of the capacitance, C, and the VCVS gain, A.

$C =$ _________ μF and $A =$ _______ V/V .

22. The network function of this circuit is:

$$\mathbf{H}(\omega) = \frac{\mathbf{V}_o(\omega)}{\mathbf{V}_i(\omega)} = \frac{k}{1 + j\dfrac{\omega}{p}}$$



Determine the values of k and p:

$k =$ _________ , and $p =$ __________ rad/s .