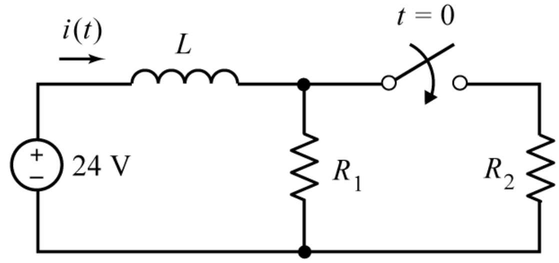
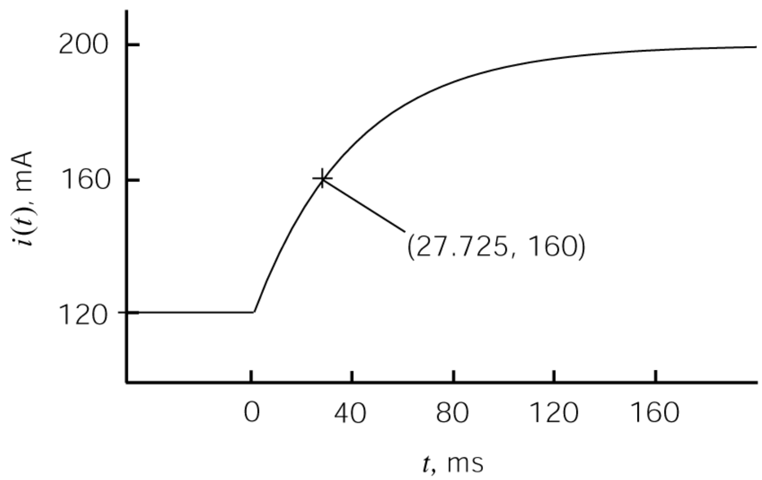
EE221 - Practice for the 1st Midterm Exam

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



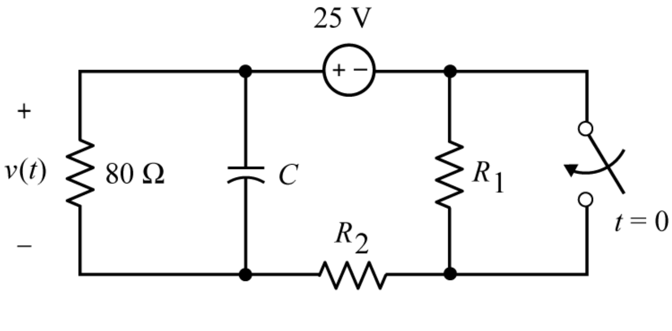


Determine the values of L, R_1 and R_2: $L =$ __4.8__ H, $R_1 =$ __200__ Ω and $R_2 =$ __300__ Ω.

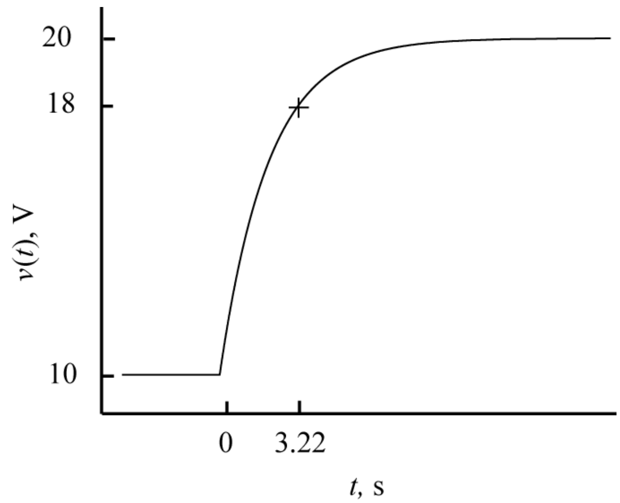
Hint: Use the plot to determine values of *D*, *E*, *F* and a such that the inductor current can be represented as

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

2.



(*a*)

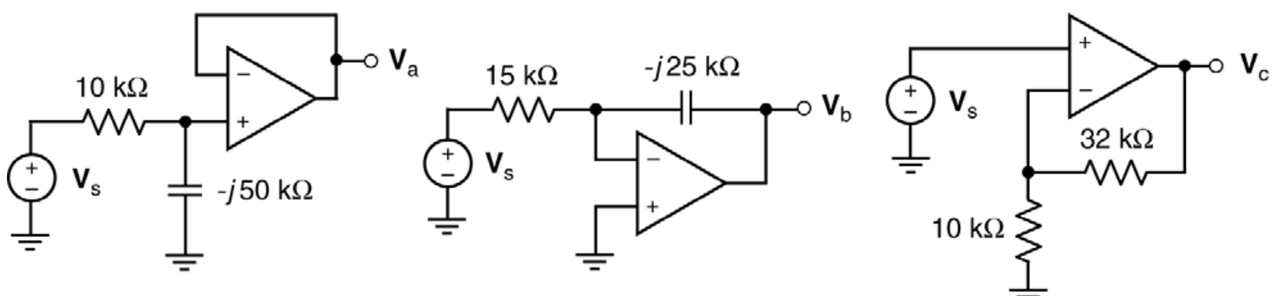


(*b*)

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

C = ___0.125__ F, R_1 = ____100___ Ω and R_2 = ____20____ Ω.

3.



(*a*) (*b*) (*c*)

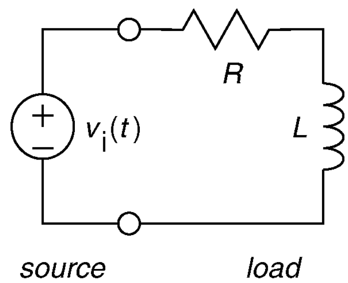
Here are three ac circuits, each represented in the frequency domain. The input to each of these circuits is the phasor voltage $\mathbf{V}_s = 2.5\angle -75°$ V . Let P_a , P_b and P_c denote the average power supplied by the source in circuit (*a*), (*b*) and (*c*) respectively. Determine the values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

P_a = ___0.0120__ mW, P_b = __0.2084__ mW and P_c = ___0____ mW

4. Given that

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

answer the following questions:



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

$P =$ __8.47__ W, $\mathbf{S} =$ __ $8.47 + j14.1$__ VA and $Q =$ __14.1__ 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= __9__ Ω and *L* = __5__ H

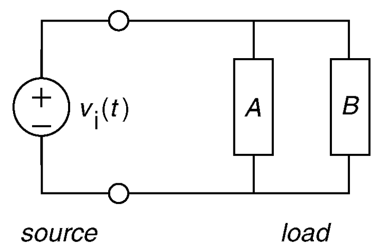
c) Suppose the source delivers 14.12 W to the load at a power factor of 0.857 lagging. What are the values of the resistance, *R*, and the inductance, *L*?

R= __15__ Ω and *L* = __3__ 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*.

$\mathbf{Z} =$ __ $9.016\angle 45°$__ Ω, $\mathbf{S} =$ __ $22.59 + j22.59$__ VA

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

$\mathbf{Z} =$ __ $9.016\angle 45°$__ Ω, $\mathbf{S} =$ __ $22.59 + j22.59$__ 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 $9 + j15\,\Omega$.

$\mathbf{Z} =$ __ $9.016\angle 45°$__ Ω, $\mathbf{S} =$ __ $22.59 + j22.59$__ VA

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

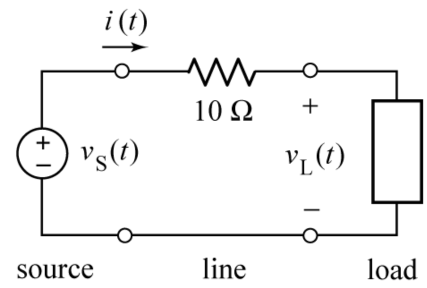
$\mathbf{Z} =$ __ $9.016\angle 45°$__ Ω, $\mathbf{S} =$ __ $22.59 + j22.59$__ VA

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

$$\mathbf{I} = 0.5208\angle -36.87° \text{ Arms}$$

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

$|\mathbf{V}s|$ = ___124.2__ Vrms and P_s = ___52.71__ W

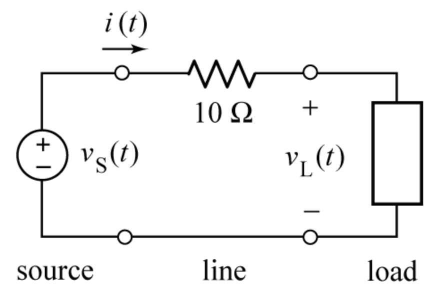


7. In this circuit an ac source is connected to a load by the line. The load voltage is $\mathbf{V}_L = 120\angle 0°$ Vrms and the load receives 50 W at a power factor of 0.8 lagging. The line current is

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

Determine the values of B and ϕ.

B = __0.5208__ Arms and ϕ = __–36.87__ °

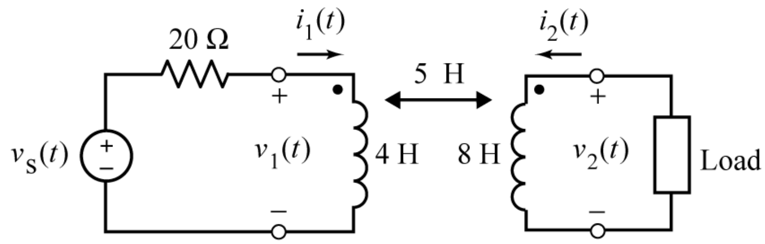


8. The input to this circuit shown is

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

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*.

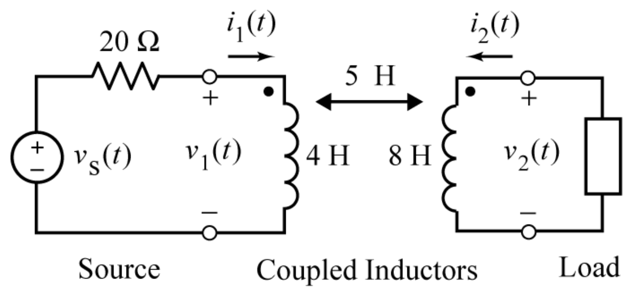
$a =$ ____20____ Ω, $b =$ ___25____ Ω, $c =$ ___25____ Ω, and $d =$ ____55___ Ω

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



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

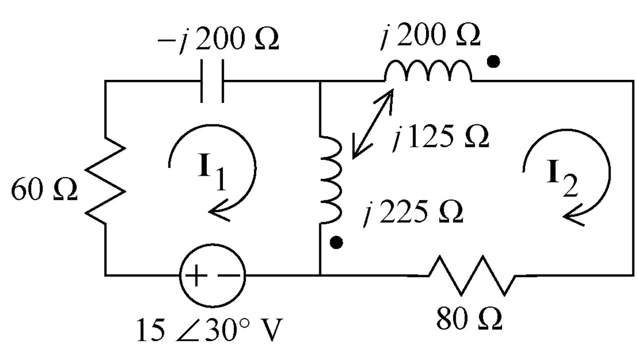
Determine the values of **S**, the complex power supplied by the source, $\mathbf{S}_c$, the complex power received by the coupled inductors and $\mathbf{S}_L$, the complex power received by the load.

S = _2.5855_ + *j* _1.0893_ VA, $\mathbf{S}_c$ = ___0___ + *j* __0.79__ VA and $\mathbf{S}_L$= __0.399_ + *j* _0.299__ 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

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

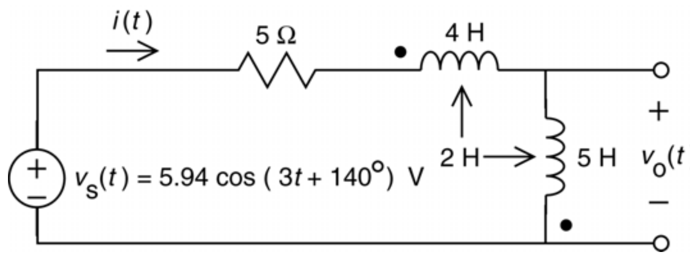
$$(c + jd)\mathbf{I}_1 + (80 + jf)\mathbf{I}_2 = 0$$



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

$a =$ ___60_____ , $b =$ ___25___ , $c =$ ____0_____ , $d =$ ____-100___ , $f =$ ___175____

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

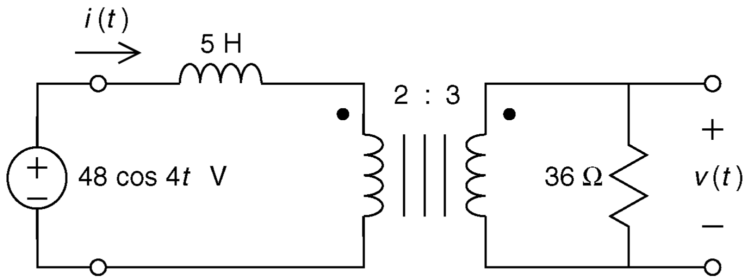


$$i(t) = \underline{\quad 0.376 \quad} \cos(3t + 68.4°) \ \text{A}$$

and

$$v(t) = \underline{\quad 3.38 \quad} \cos(3t + \underline{\quad 158.4 \quad}°) \ \text{V}$$

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

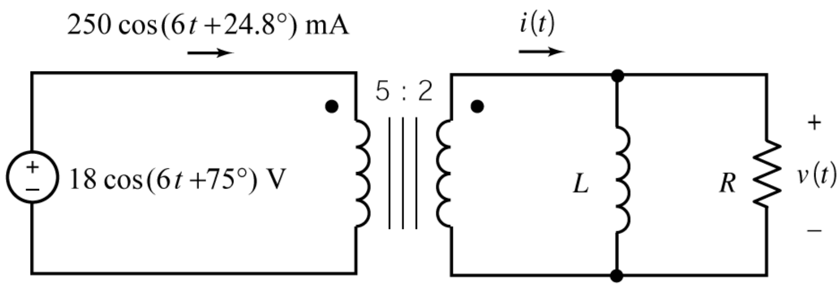


$$i(t) = \underline{\quad 1.87 \quad} \cos(4t - 51.3°) \ \text{A}$$

and

$$v(t) = \underline{\quad 45 \quad} \cos(4t - \underline{\quad 51.3 \quad}°) \ \text{V}$$

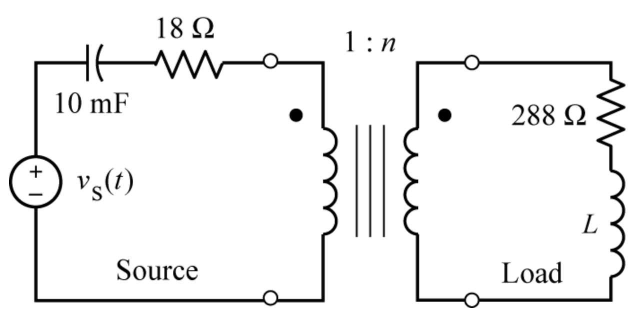
13.



Determine the values of R and L: R = _____18_____Ω and L = _____2.5_____H

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

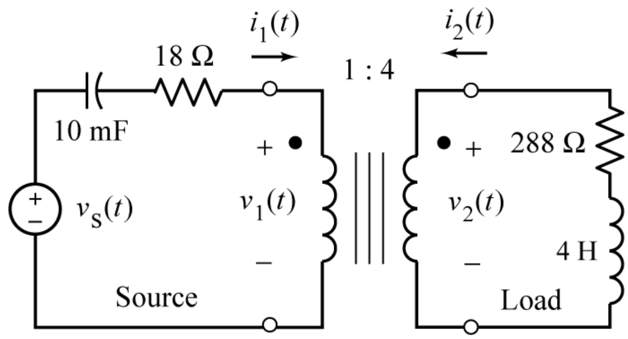
$$v_s(t) = 12\cos(20t) \ \text{V}$$



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

n = ______4_____ and L = _____4_____ 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

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

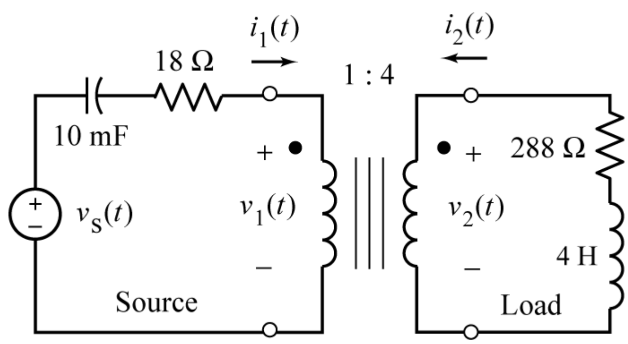
$$v_2(t) = B\cos(20t + 15.5°) \text{ V}$$

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

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

A = ___6.227___ V, *B* = ___24.91___ V, *C* = ____0.33___ A and *D* = __0.0833__ 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

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

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

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

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.

$\mathbf{S}_p$ = ___1____ + *j* __0.277__ VA and $\mathbf{S}_L$ = ____1____ + *j* __0.277__ 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	___−116.6__
40	__178.9__	−153.4

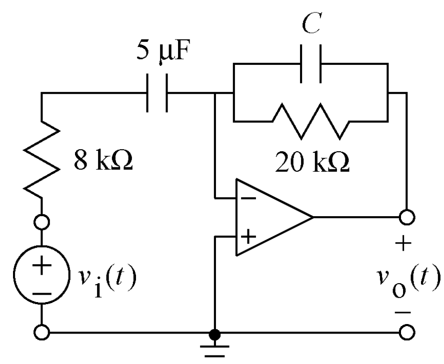
18. The network function of a circuit is $\mathbf{H}(\omega) = \dfrac{k}{1 + j\dfrac{\omega}{p}}$. The table below tabulates frequency response data for this circuit.

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: $p =$ _____32___ rad/s and $k =$ ____18____ 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

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

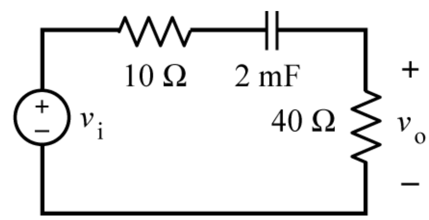


Determine the values of the capacitance, C, and the pole, p.

$C =$ _____0.4_______ μF and $p =$ ______25______ rad/s .

20. The network function of this circuit is:

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

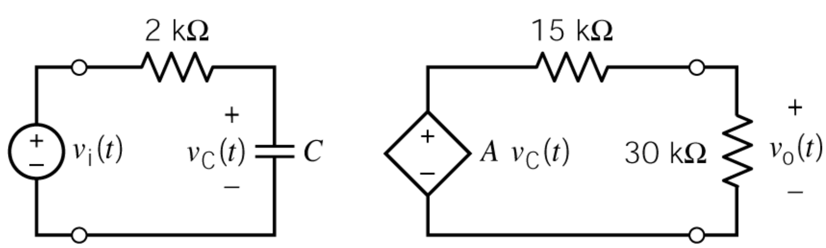


Determine the values of k and p:

$k =$ ___0.08___ , and $p =$ ___10____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

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

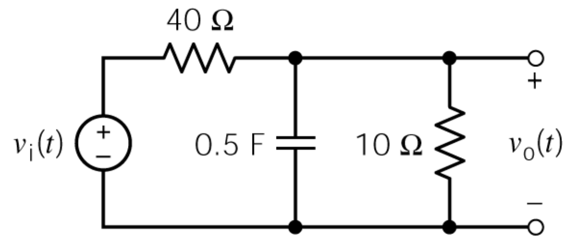


Determine the values of the capacitance, C, and the VCVS gain, A.

$C =$ _____5____ μF and $A =$ ___6____ V/V .

22. The network function of this circuit is:

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



Determine the values of *k* and *p*:

$k =$ ___0.2___ , and $p =$ ___0.25____rad/s .