Alexandria University
Faculty of Engineering
Electrical Engineering Department

ECE: Principles and Applications of Electrical Engineering
Sheet 3

1. The voltage across a 100-μF capacitor takes the following values. Calculate the expression for the current through the capacitor in each case.
   a. $v_C(t) = 40 \cos(20t - \pi/2)$ V
   b. $v_C(t) = 20 \sin 100t$ V
   c. $v_C(t) = -60 \sin(80t + \pi/6)$ V
   d. $v_C(t) = 30 \cos(100t + \pi/4)$ V

2. The current through a 250-mH inductor takes the following values. Calculate the expression for the voltage across the inductor in each case.
   a. $i_L(t) = 5 \sin 25t$ A
   b. $i_L(t) = -10 \cos 50t$ A
   c. $i_L(t) = 25 \cos(100t + \pi/3)$ A
   d. $i_L(t) = 20 \sin(10t - \pi/12)$ A

3. Find the energy stored in each capacitor and inductor, under steady-state conditions, in the circuit shown in Figure 1.

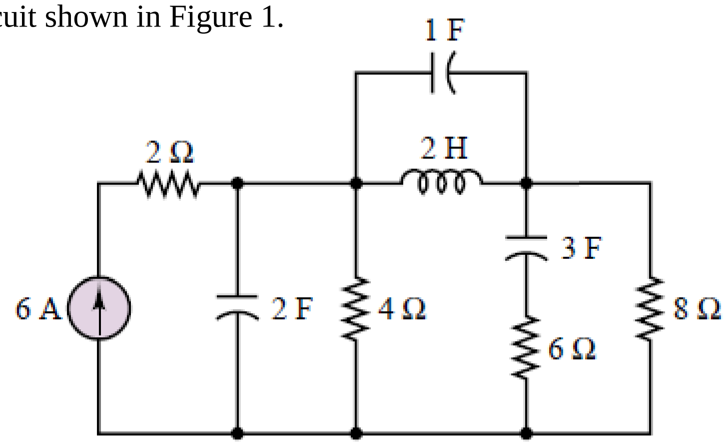


Figure 1

4. Find the energy stored in each capacitor and inductor, under steady-state conditions, in the circuit shown in Figure 2.

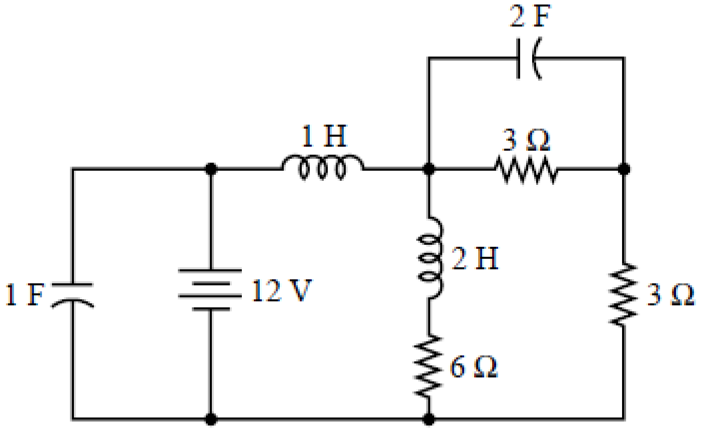


Figure 2

5. The plot of time-dependent voltage is shown in Figure 3. The waveform is piecewise continuous. If this is the voltage across a capacitor and C = 80 μF, determine the current through the capacitor. How can current flow “through” a capacitor?

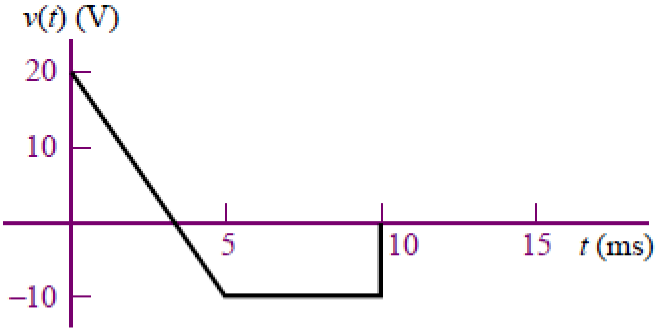


Figure 3

6. If the waveform shown in Figure 4 is the voltage across a capacitor plotted as a function of time with:
v_{PK} = 20 V T = 40 μs C = 680 nF
determine and plot the waveform for the current through the capacitor as a function of time.

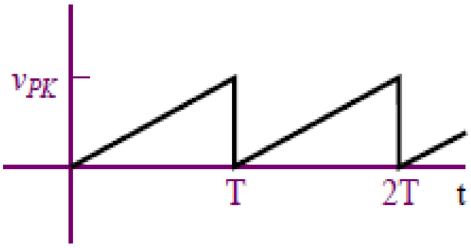


Figure 4

7. If the current through a 16 μh inductor is zero at t = 0 and the voltage across the inductor (shown in Figure 5) is:
v_L(f) = 0 t < 0
= 3t ^{2} 0 < t < 20 μs
= 1.2 nV t > 20 μs
determine the current through the inductor at t = 30 μs.

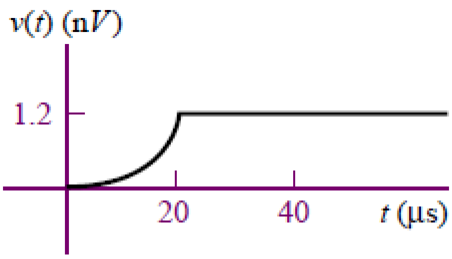


Figure 5

8. Determine and plot as a function of time the current through a component if the voltage across it has the waveform shown in Figure 6 and the component is a:
a. Resistor R = 7 Ω.
b. Capacitor C = 0.5 μF.
c. Inductor L = 7 mH.

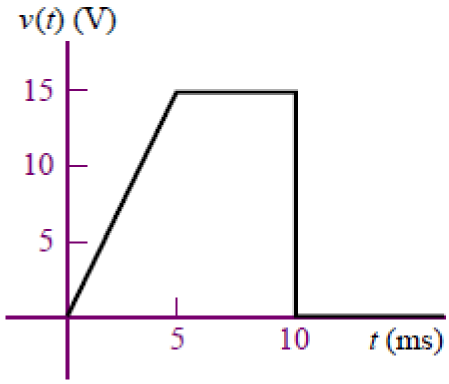


Figure 6

9. Find the rms value of x(t) if x(t) is a sinusoid that is offset by a DC value: $x(t) = 2\sin(\omega t) + 2.5$.

10. For the waveform of Figure 7:
    a. Find the rms current.
    b. If θ_1 is $\pi/2$, what is the rms current of this waveform?

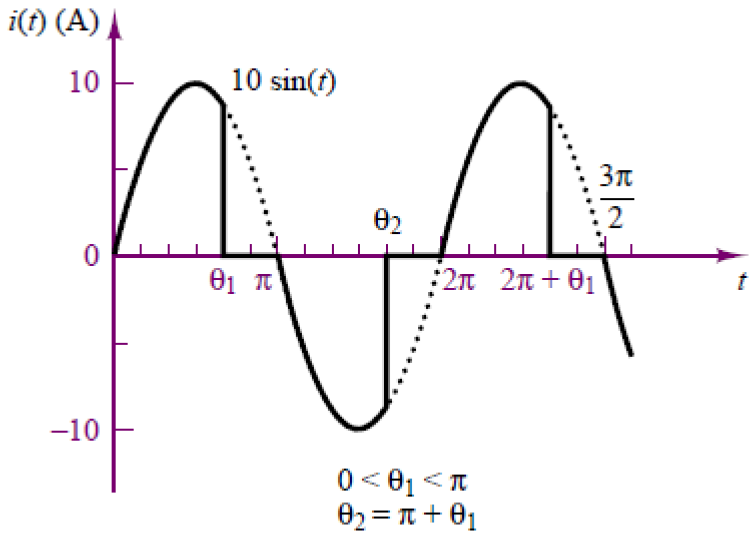


Figure 7

11. Find the rms value of the waveform of Figure 8.

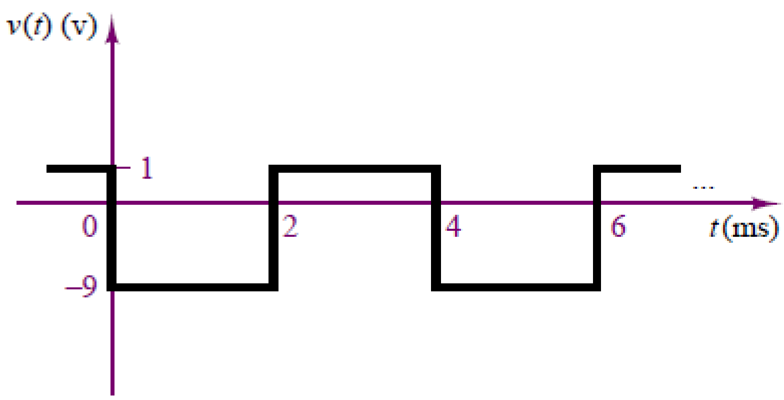


Figure 8

12. Find the rms value of the waveform of Figure 9.

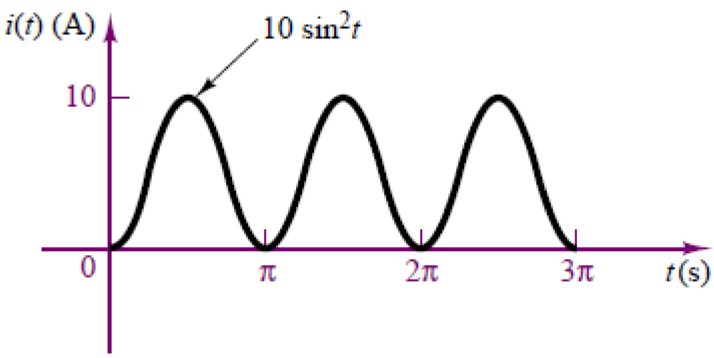


Figure 9

13. Find the rms voltage of the waveform of Figure 10.

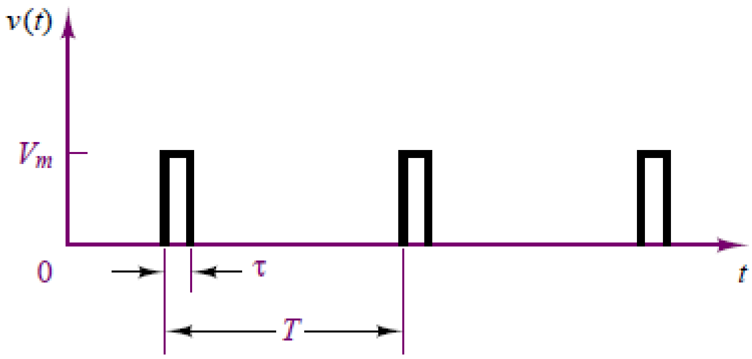


Figure 10

14. Find the rms value of the waveform shown in Figure 11.

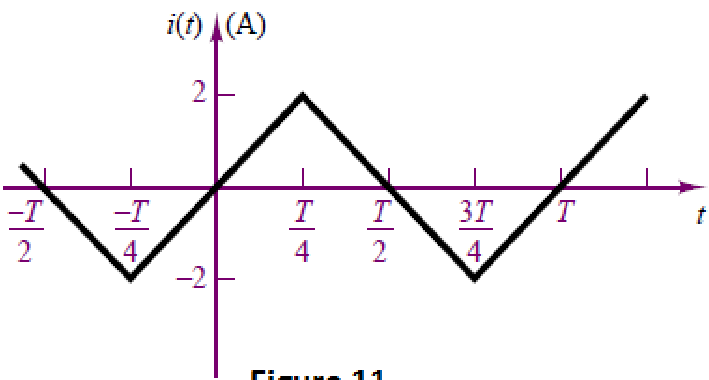


Figure 11

15. Determine the rms (or effective) value of:
    $v(t) = V_{DC} + v_{AC} = 50 + 70.7 \cos(377t)$ V

16. If the current through and the voltage across a component in an electrical circuit are:
    $i(t) = 17 \cos[\omega t - \pi/12]$ mA
    $v(t) = 3.5 \cos[\omega t + 1.309]$ V
    where $\omega = 628.3$ rad/s, determine:
    a. Whether the component is a resistor, capacitor, or inductor.
    b. The value of the component in ohms, farads, or henrys.

17. Describe the sinusoidal waveform shown in Figure 12 using time-dependent and phasor notation.

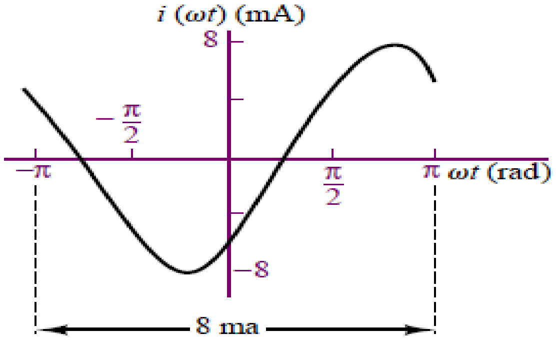


Figure 12

18. If the current through and the voltage across an electrical component are:
    $i(t) = Io \cos(\omega t + \pi/4)$ $v(t) = Vo \cos \omega t$
    where:
    $I_o = 3$ mA $V_o = 700$ mV $\omega = 6.283$ rad/s

    a. Is the component inductive or capacitive?
    b. Plot the instantaneous power p(t) as a function of ωt over the range $0 < \omega t < 2\pi$.
    c. Determine the average power dissipated as heat in the component.
    d. Repeat parts (b) and (c) if the phase angle of the current is changed to zero degrees.

19. Determine the equivalent impedance in the circuit shown in Figure 13:
    $v_s(t) = 7 \cos(3{,}000t + \pi/6)$ V
    R1 = 2.3 kΩ R2 = 1.1 kΩ
    L = 190 mH C = 55 nF

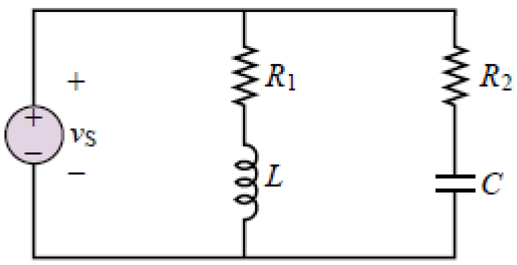


Figure 13

20. Determine $i_3(t)$ in the circuit shown in Figure 14, if:
    $i_1(t) = 141.4 \cos(\omega t + 2.356)$ mA
    $i_2(t) = 50 \sin(\omega t - 0.927)$ mA
    $\omega = 377$ rad/s

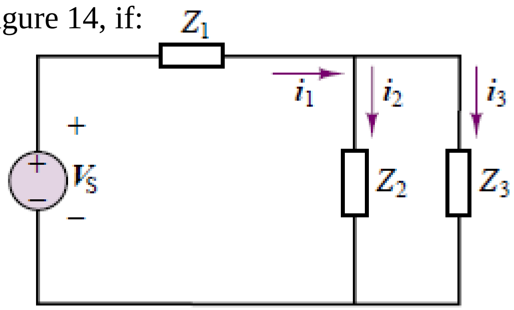


Figure 14

21. Determine the current through Z_3 in the circuit of Figure 15.
    $V_{s1} = v_{s2} = 170 \cos(377t)$ V
    $Z_1 = 5.9\angle 0.122\ \Omega$
    $Z_2 = 2.3\angle 0\ \Omega$
    $Z_3 = 17\angle 0.192\ \Omega$

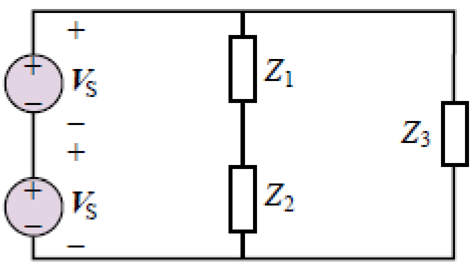


Figure 15

22. Determine the frequency so that the current I_i and the voltage V_o in the circuit of Figure 16 are in phase.

$Z_s = 13{,}000 + j\omega 3\ \Omega$

$R = 120\ \Omega$

$L = 19\ mH$ $C = 220\ pF$

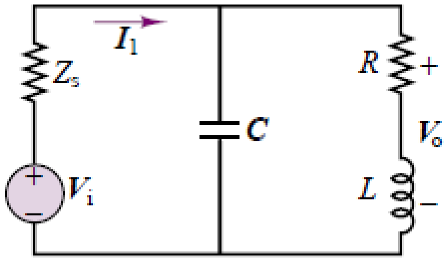


Figure 16

23. The coil resistor in series with L models the internal losses of an inductor in the circuit of Figure 17. Determine the current supplied by the source if:

$v_s(t) = Vo\cos(\omega t + 0)$

$V_o = 10\ V$ $\omega = 6$ Mrad/s $R_s = 50\ \Omega$

$R_c = 40\Omega$ $L = 20\ \mu H$ $C = 1.25\ nF$

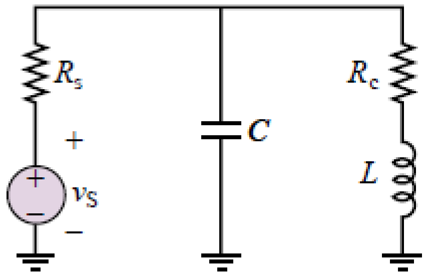


Figure 17

24. Using phasor techniques, solve for the current in the circuit shown in Figure 18.

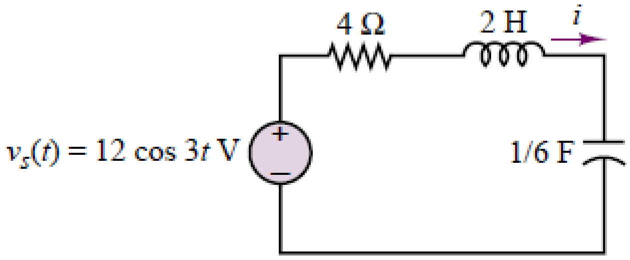


Figure 18

25. Using phasor techniques, solve for the voltage, v, in the circuit shown in Figure 19.

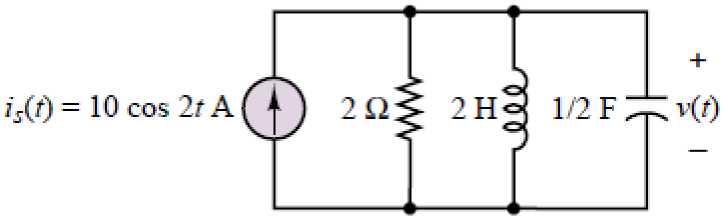


Figure 19

26. Solve for V_2 in the circuit shown in Figure 20. Assume $\omega = 2$.

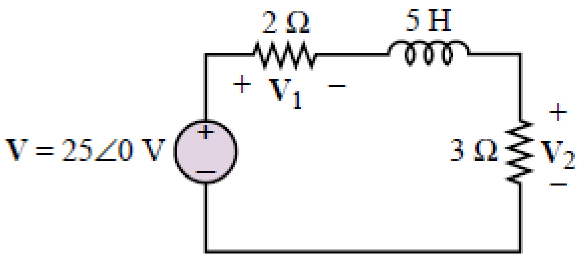


Figure 20

27. Find $v_{out}(t)$ for the circuit shown in Figure 21.

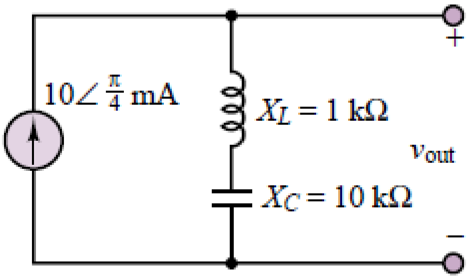


Figure 21

28. For the circuit shown in Figure 22, find the impedance Z, given ω = 4 rad/s.

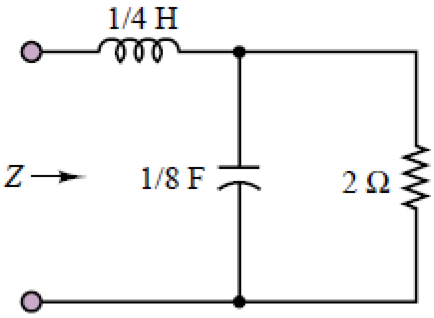


Figure 22

29. Using phasor techniques, solve for v in the circuit shown in Figure 23.

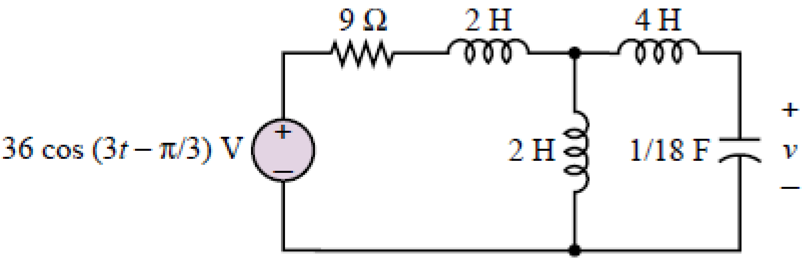


Figure 23

30. Using phasor techniques, solve for i in the circuit shown in Figure 24.

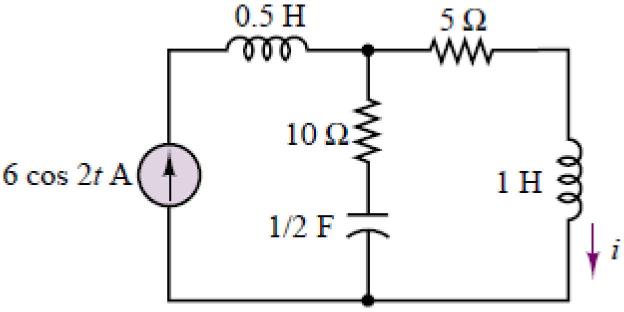
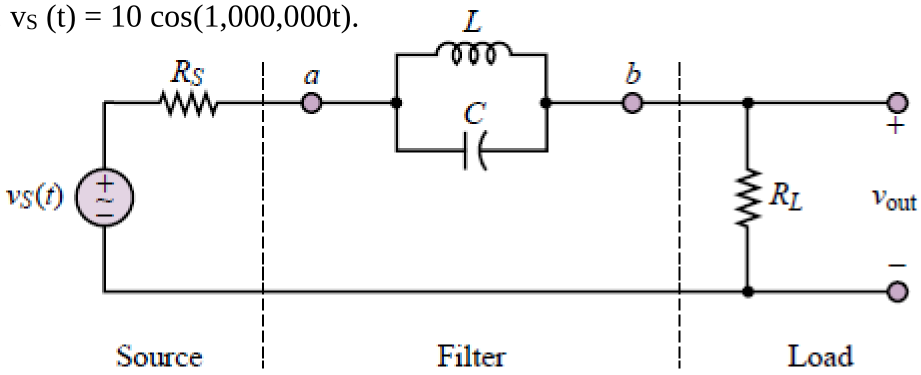


Figure 24

31. Determine the Th´evenin equivalent circuit as seen by the load shown in Figure 25 if:
   a. v_S (t) = 10 cos(1,000t).
   b. v_S (t) = 10 cos(1,000,000t).



$R_S = R_L = 500\ \Omega$
$L = 10$ mH
$C = 0.1\ \mu$F

Figure 25

32. Solve for i(t) in the circuit of Figure 26, using phasor techniques, if v_S (t) = 2 cos(2t), $R_1 = 4\ \Omega$, $R_2 = 4\ \Omega$, L = 2 H, and C = 14 F.

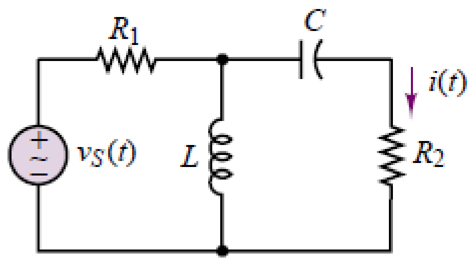


Figure 26

33. Using mesh current analysis, determine the currents i_1(t) and i_2(t) in the circuit shown in Figure 27.

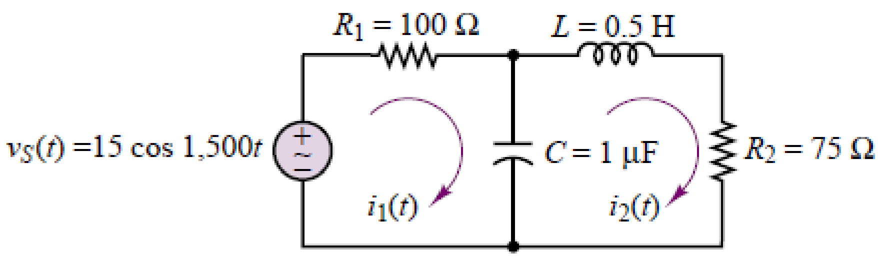
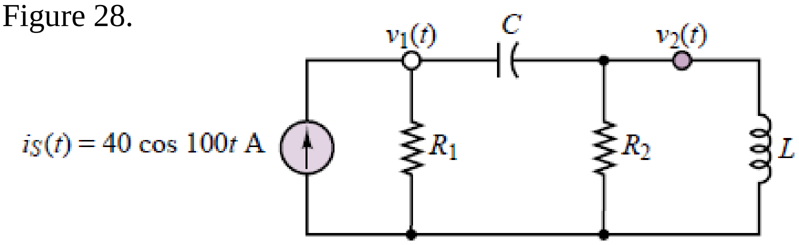


Figure 27

34. Using node voltage methods, determine the voltages v_1(t) and v_2(t) in the circuit shown in Figure 28.



$R_1 = 10\ \Omega$
$R_2 = 40\ \Omega$
$C = 500\ \mu$F
$L = 0.2$ H

Figure 28

35. Find the Th´evenin equivalent circuit as seen from terminals a-b for the circuit shown in Figure 29.

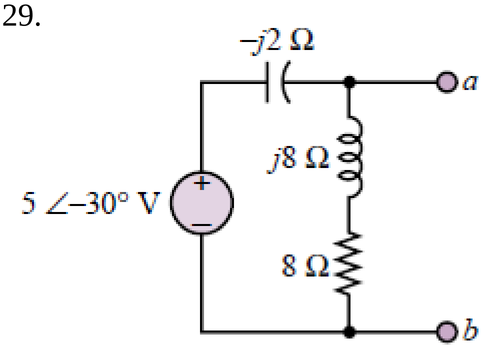


Figure 29

36. Determine V_o in the circuit of Figure 30 if:
$v_i = 4\cos(1{,}000t + \pi/6)$ V
L = 60 mH   C = 12.5 μF
$R_L = 120\ \Omega$

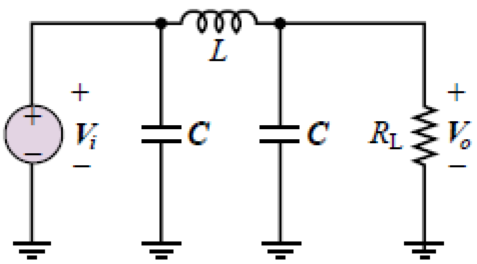


Figure 30