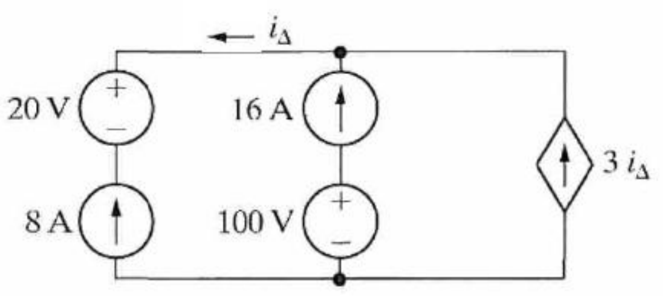
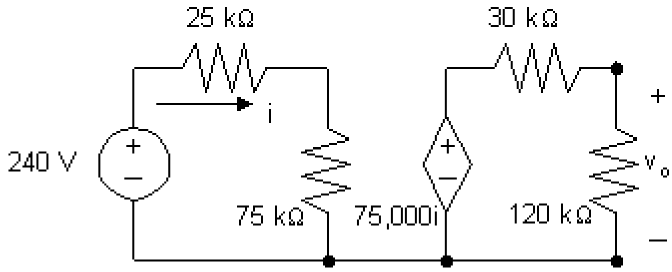
STUDY QUESTIONS-1

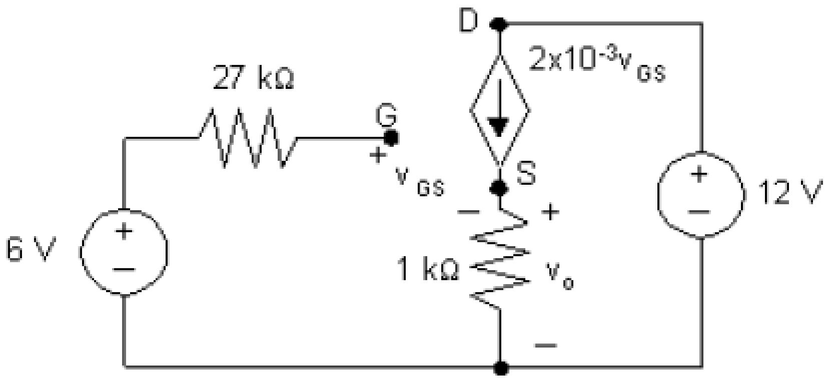
1)a) Is the interconnection in the figure valid? Explain.
b) Can you find the total energy developed in the circuit? Explain.



2) For the circuit shown, find:
a) the current i and the voltage v_0,
b) the power dissipated in each resistor,
c) the power delivered by each source.



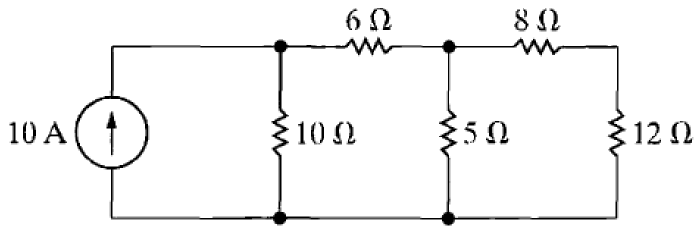
3) Given the circuit shown in the figure, find the values of v_{GS} and v_o.



4)A power generating linear circuit produces 1000 W when 10 Ohms connected to it. It produces 530 W when 85 Ohms connected . What is the maximum power that could be obtained from such generator? Which resistor value must be used for that?

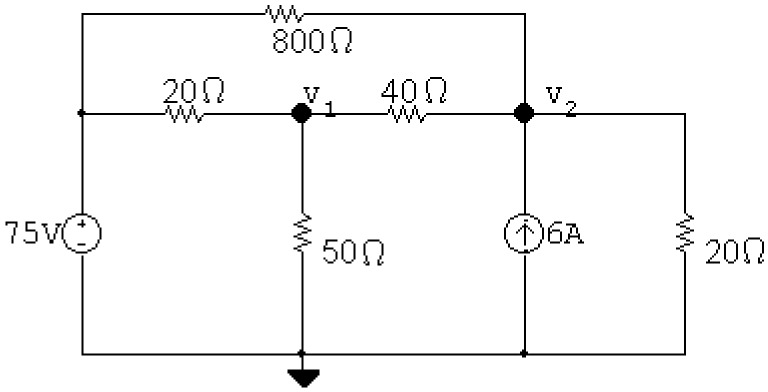
3.10 Find the power dissipated in the 5 Ω resistor in the circuit in Fig. P3.10.
PSPICE
MULTISIM

Figure P3.10

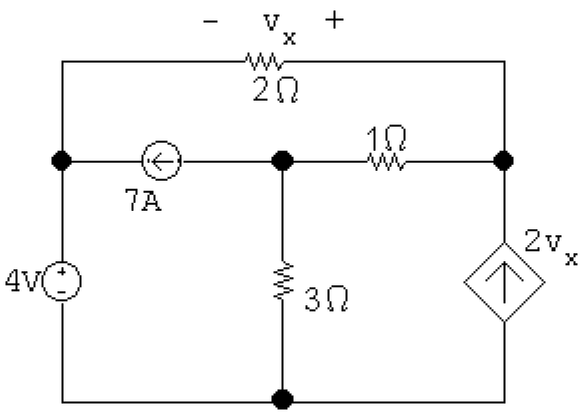


STUDY QUESTIONS - 2

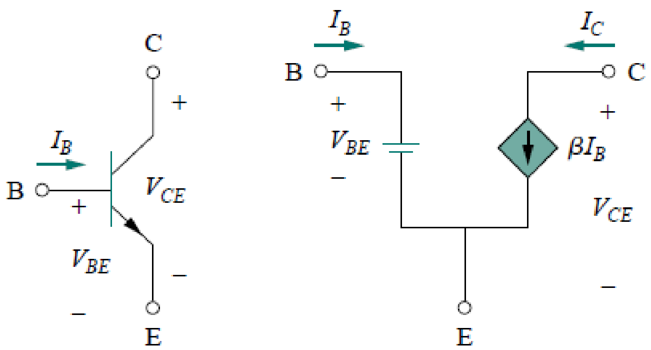
1) Write the node voltage equations for $\mathbf{v_1}$ and $\mathbf{v_2}$, and solve the equations.



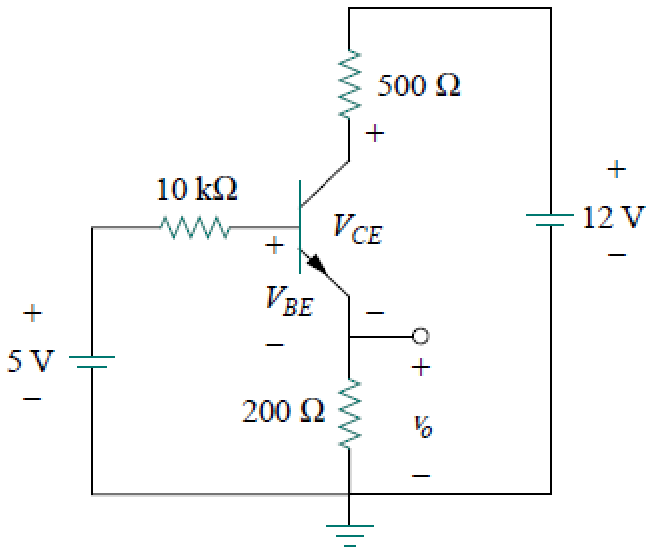
2) Write the necessary equations for solving $\mathbf{v_x}$. Define all the necessary variables you use on the circuit diagram. Solve the equations and find $\mathbf{v_x}$.



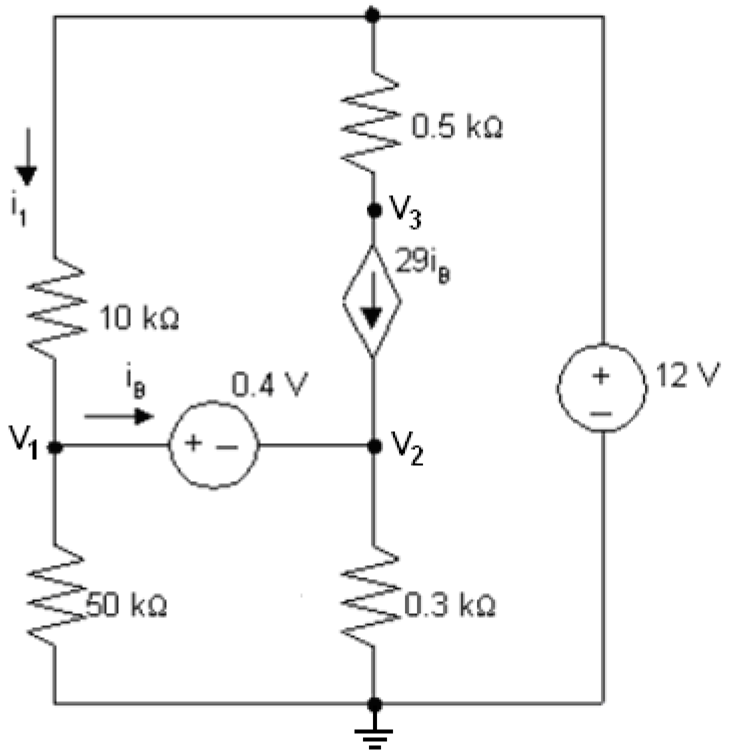
3) An npn transistor in Figure (a) can be modeled using a constant voltage source and a dependent current-controlled current source as shown in the dc equivalent model in Figure (b).
For the transistor circuit in below, let β = 100 and VBE = 0.7 V. Determine Vo and VCE.



(a) An *npn* transistor, (b) its dc equivalent model.



4) For the circuit shown, write five equations which are necessary to solve for the unknowns V_1, V_2, V_3, i_B, and i_1. **Do not** solve the equations; just write them correctly and completely.



Equation 1:

Equation 2:

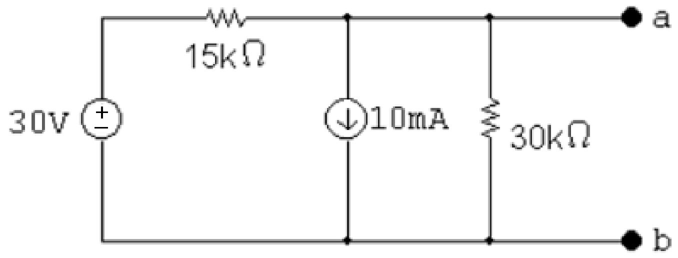
Equation 3:

Equation 4:

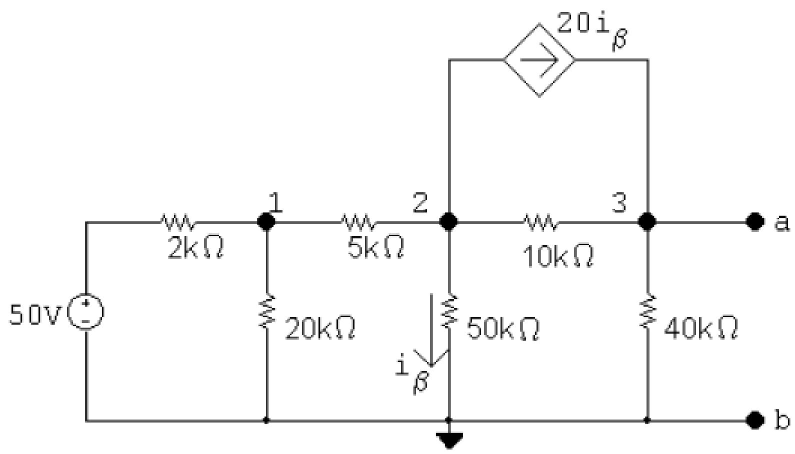
Equation 5:

STUDY QUESTIONS – 3

1) Find the Thevenin equivalent at terminals a-b of the following circuit.



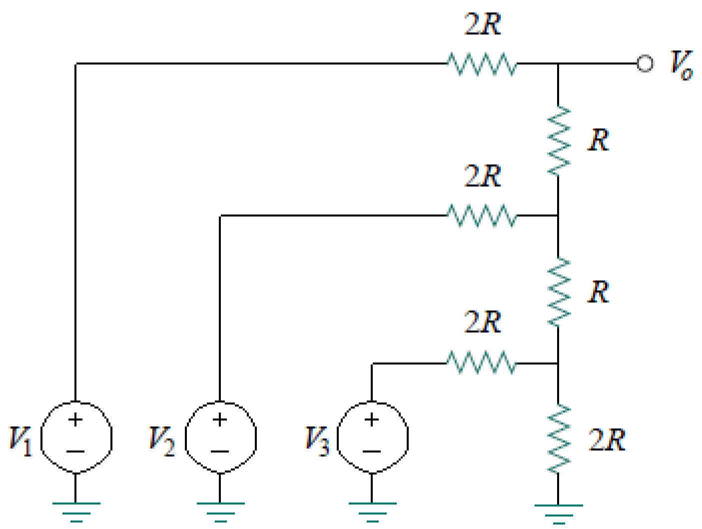
2) Find the Thevenin and Norton equivalents of the following circuit.



3) A power generating linear circuit produces 720 W when 5 Ohms or 20 Ohms connected to it. What is the maximum power that could be obtained from such generator? Which resistor value must be used for that?

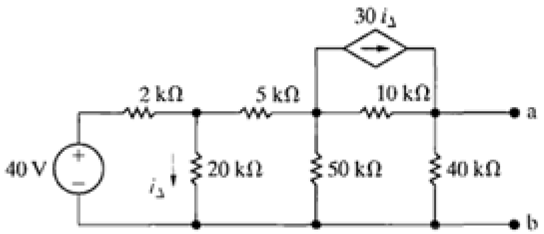
Hint: Use a Thevenin equivalent model for the circuit and find the parameters V_{TH} and R_{TH} using the given data.

4) Find the output voltage $\mathbf{V_o}$ in terms of the input voltages $\mathbf{V_1}$, $\mathbf{V_2}$, and $\mathbf{V_3}$.



5)

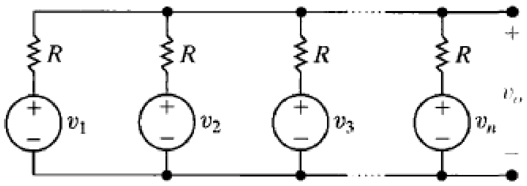
Find the Norton equivalent with respect to the terminals a,b for the circuit seen in Fig.



6)

a) Use the node-voltage method to show that the output voltage v_o in the circuit in Fig. is equal to the average value of the source voltages.

b) Find v_o if $v_1 = 100$ V, $v_2 = 80$ V, and $v_3 = -60$ V.

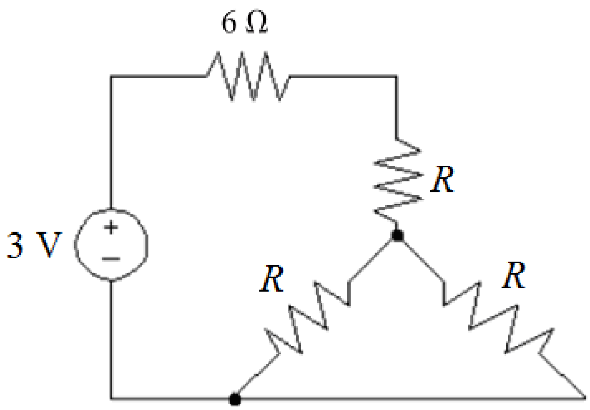


7) For the circuit below:

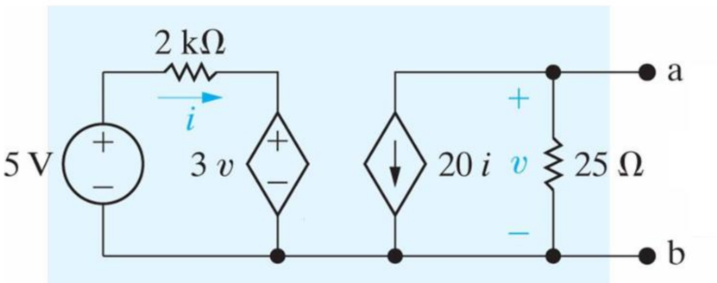
a) Calculate the *current* delivered by the voltage source in terms of the value R.

b) Calculate the *total power delivered to three R resistors* (in terms of the value R).

c) To get the *most* total power calculated at (b), what should be the value of R?



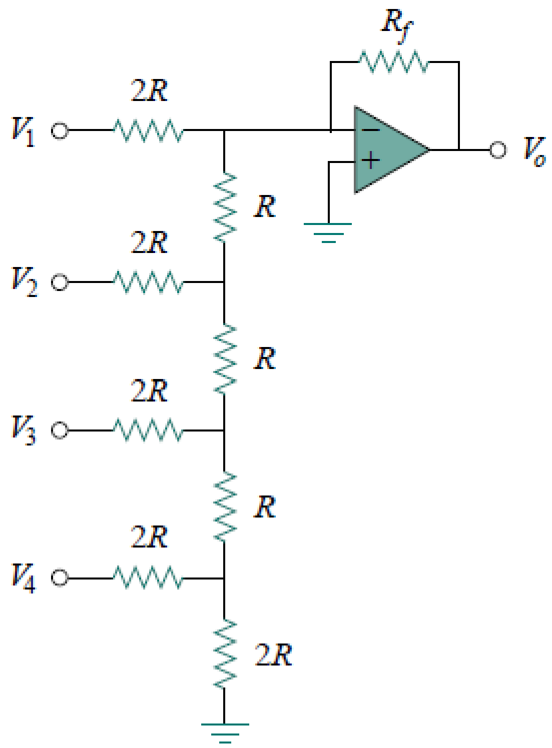
8) Find the Thevenin and Norton equivalents of the following circuit.



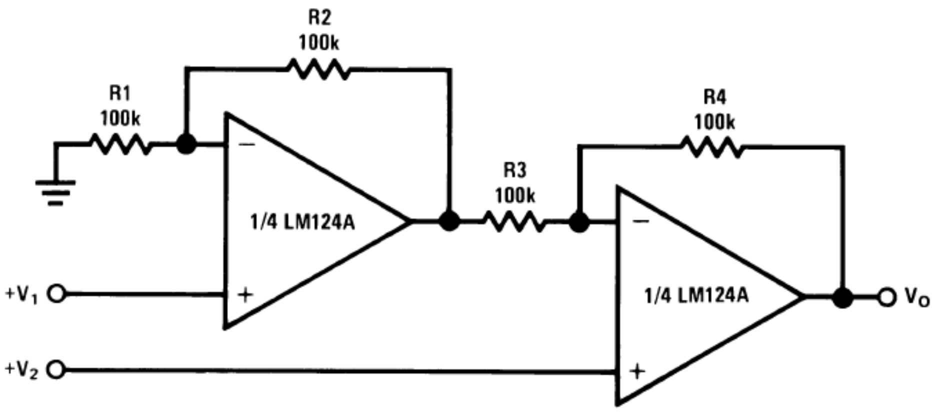
STUDY QUESTIONS – 4

1) A four-bit R-2R ladder Digital-to-Analog Converter (DAC) is presented in the figure.
Show that the output voltage is given by

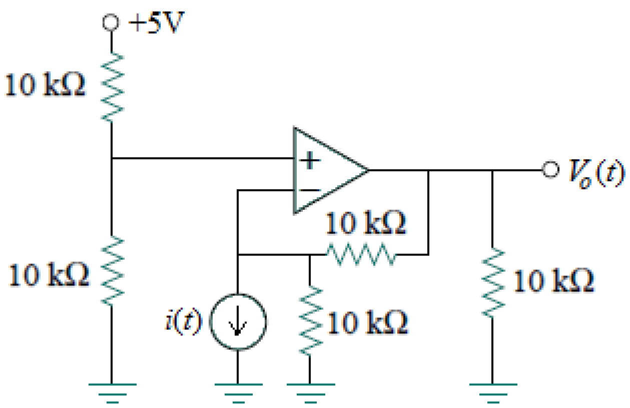
$$-V_o = R_f\left(\frac{V_1}{2R}+\frac{V_2}{4R}+\frac{V_3}{8R}+\frac{V_4}{16R}\right)$$



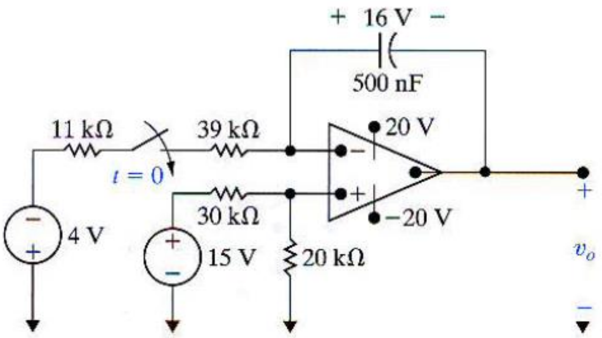
2) a) For the following circuit, show that $V_o=2(V_2-V_1)$.
b) How can we change some of the resistor values to make the difference gain as 10?



3) A sensor circuit is shown below. Find $V_o(t)$ in terms of the sensor input current $i(t)$.



4) At the instant the switch is closed, the voltage on the capacitor is 16 V. Assume an ideal operational amplifier. How many milliseconds after the switch is closed will the output voltage v_o equal zero?

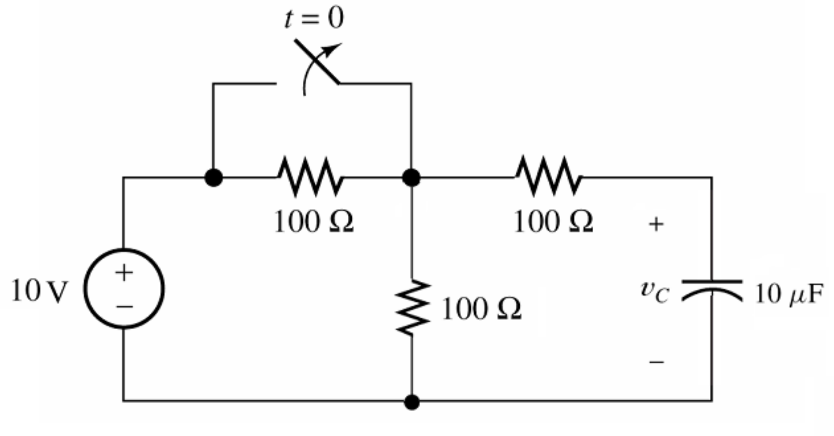


5) Implement a circuit with two voltage inputs V_1 and V_2 ; and one voltage output V_o such that:

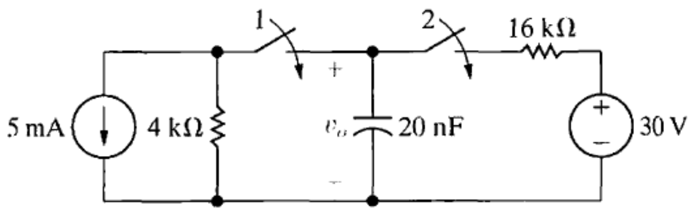
$$V_o = V_1 - 3V_2 + 0.1\frac{dV_1}{dt}$$

STUDY QUESTIONS – 5

1) Consider the circuit given. The switch has been closed for a long time before opening at t=0. Find the initial voltage $v_c(0)$. Find and sketch $v_c(t)$ for t≥0 (show all important aspects and units).

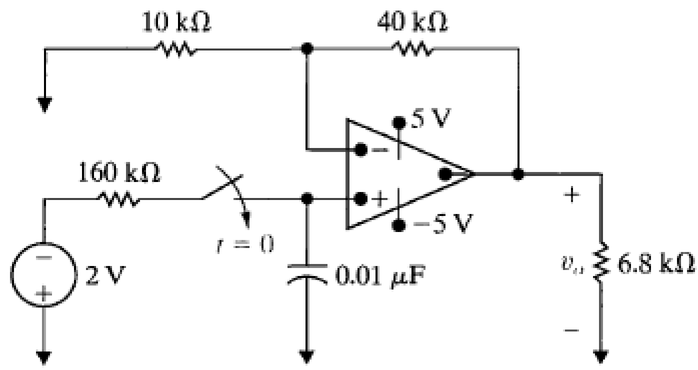


2) There is no energy stored in the capacitor in the circuit in the figure when switch 1 closes at $t = 0$. Ten microseconds later, switch 2 closes. Find $v_o(t)$ for $t>=0$.

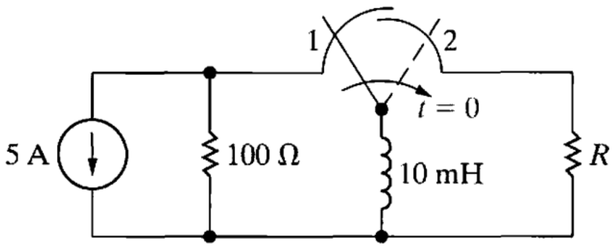


7.10 a) When the switch closes in the circuit shown, there is no energy stored in the capacitor. How long does it take to saturate the op amp?

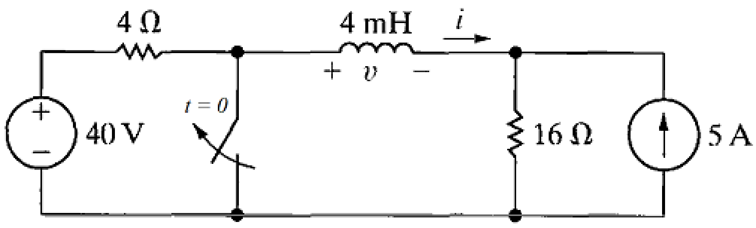
b) Repeat (a) with an initial voltage on the capacitor of 1 V, positive at the upper terminal.



7.8 The switch in the circuit seen in Fig. P7.8 has been in position 1 for a long time. At $t = 0$, the switch moves instantaneously to position 2. Find the value of R so that 10% of the initial energy stored in the 10 mH inductor is dissipated in R in 10 μs.



3) Consider the circuit given.
a) Find the initial current $i(0)$.
b) Find the differential equation of $i(t)$ for $t \geq 0$.
c) Solve the differential equation and find $i(t)$.
d) Sketch $i(t)$ for $t \geq 0$.
(Please show all important aspects and units)



a)

---

b)

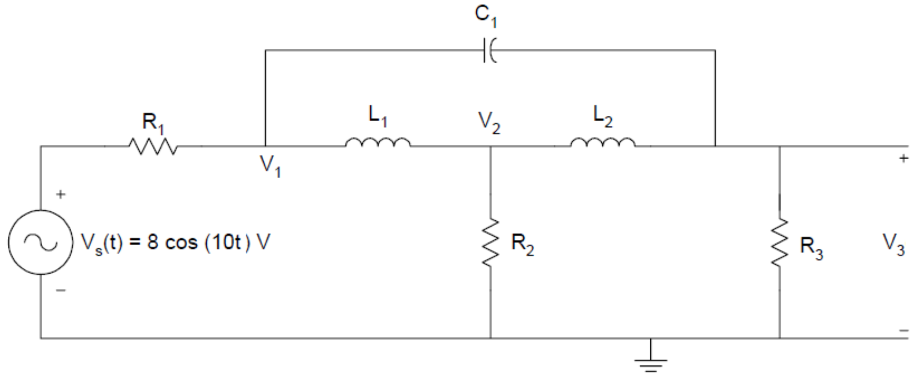
---

c)

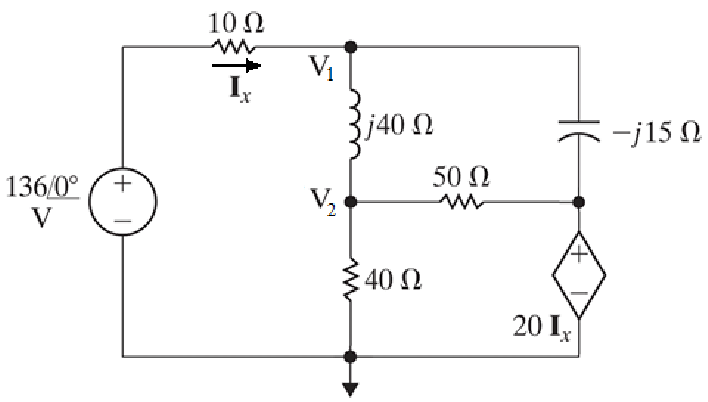
d)

STUDY QUESTIONS – 6

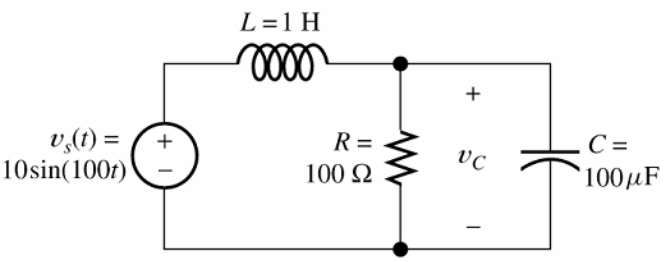
1) The circuit below is operating in the sinusoidal steady state. Write three equations which are necessary to solve for the phasor voltages V_1, V_2, V_3. **Do not** solve the equations; just write them correctly and completely.



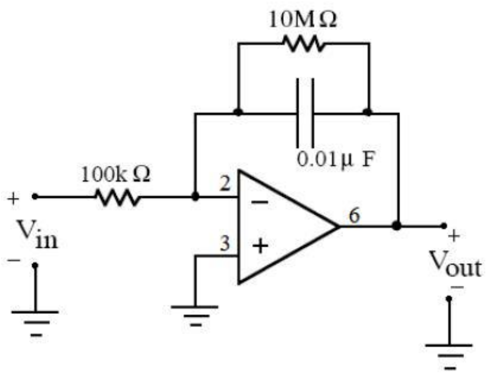
2) Write the necessary equations for solving the node voltages V_1 and V_2; and, the current I_x in the following AC circuit. **Do not** solve the equations; just write them correctly and completely.



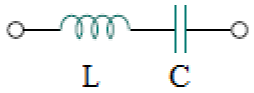
3) For the following AC circuit, find the voltage $v_C(t)$.



4) Assume that the following circuit is operating in the sinusoidal steady state. Find the transfer function, $H(\omega)$, which is the ratio of the output voltage phasor to the input voltage phasor. Draw the magnitude of the transfer function ($|H(\omega)|$), in terms of the angular frequency ω.



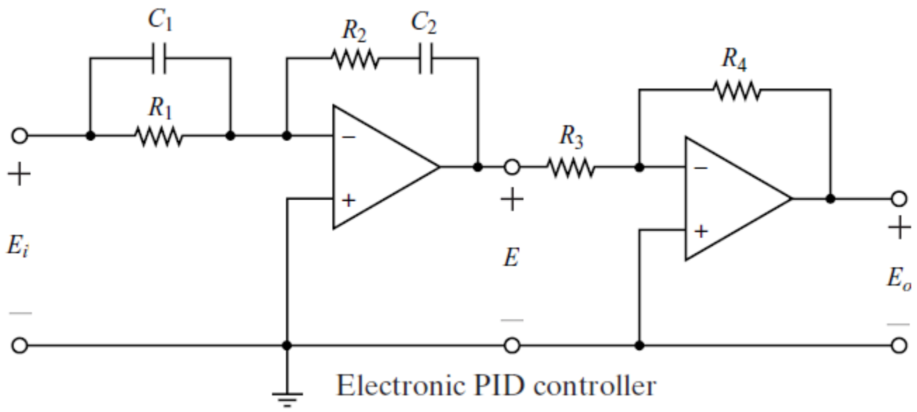
5) Consider an inductance and capacitance connected serially. Find and draw the magnitude of the equivalent impedance (|Z|) in terms of the angular frequency (ω). At what frequency (in Hz), the equivalent impedance (Z) becomes zero?



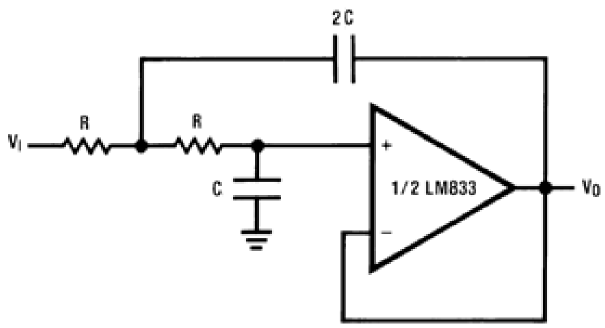
6) The circuit below is operating in the sinusoidal steady state, and the voltage variables shown are the phasor voltages.

a) Find the E_o/E_i gain (in terms of the angular frequency ω).

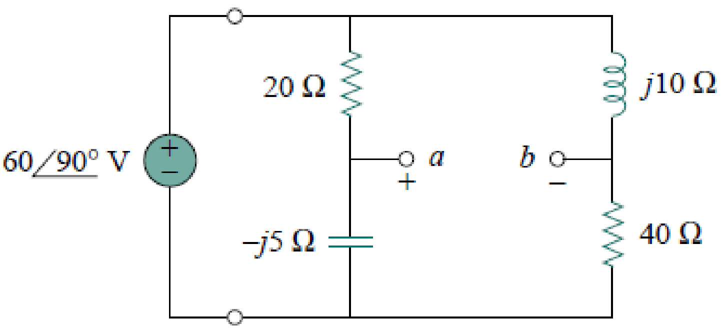
b) Determine the values of R_1, R_2, R_3, R_4, C_1, C_2 such that $\frac{E_o}{E_i} = 30\frac{(j\omega+1)^2}{j\omega}$.



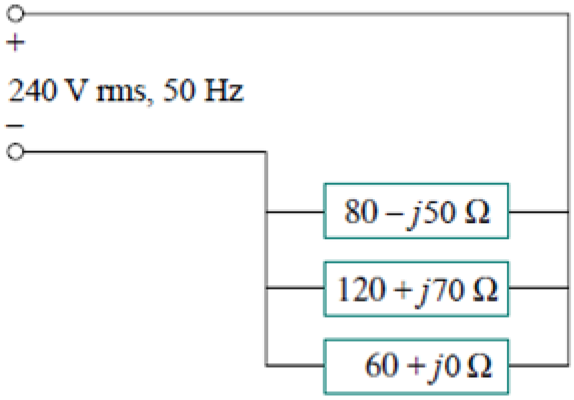
7) For the second order Butterworth circuit below, find the transfer function $H(j\omega) = \frac{V_O(j\omega)}{V_I(j\omega)}$



8) Find the Thevenin equivalent at terminals a-b of the following AC circuit.



1) Consider the power system shown in the figure.



Calculate:
(a) the total complex power,
(b) the power factor,
(c) the capacitance necessary to establish a unity power factor.

Example 10.8 **Determining Maximum Power Transfer without Load Restrictions**

a) For the circuit shown in Fig. 10.20, determine the impedance Z_L that results in maximum average power transferred to Z_L.
b) What is the maximum average power transferred to the load impedance determined in (a)?

Solution

a) We begin by determining the Thévenin equivalent with respect to the load terminals a, b. After two source transformations involving the 20 V source, the 5 Ω resistor, and the 20 Ω resistor, we simplify the circuit shown in Fig. 10.20 to the one shown in Fig. 10.21. Then,

$$\mathbf{V}_{Th} = \frac{16\angle 0^\circ}{4 + j3 - j6}(-j6)$$

$$= 19.2\angle -53.13^\circ = 11.52 - j15.36 \text{ V}.$$

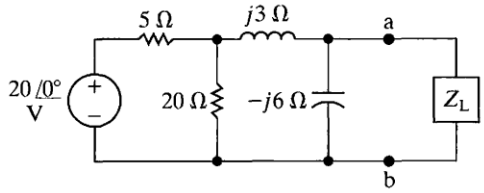


Figure 10.20 ▲ The circuit for Example 10.8.

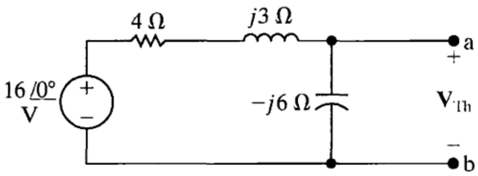


Figure 10.21 ▲ A simplification of Fig. 10.20 by source transformations.

We find the Thévenin impedance by deactivating the independent source and calculating the impedance seen looking into the terminals a and b. Thus,

$$Z_{Th} = \frac{(-j6)(4 + j3)}{4 + j3 - j6} = 5.76 - j1.68 \ \Omega.$$

For maximum average power transfer, the load impedance must be the conjugate of Z_{Th}, so

$$Z_L = 5.76 + j1.68 \ \Omega.$$

b) We calculate the maximum average power delivered to Z_L from the circuit shown in Fig. 10.22, in which we replaced the original network with its Thévenin equivalent. From Fig. 10.22, the rms magnitude of the load current **I** is

$$I_{eff} = \frac{19.2/\sqrt{2}}{2(5.76)} = 1.1785 \text{ A}.$$

The average power delivered to the load is

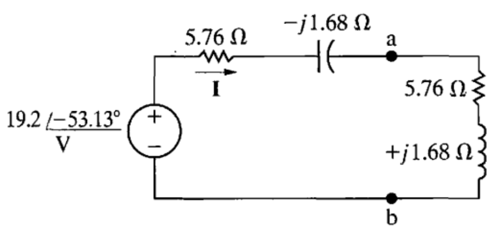
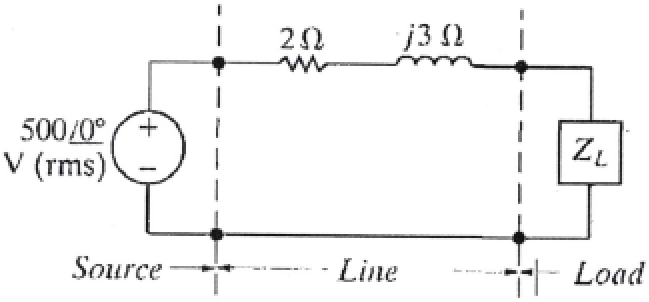


Figure 10.22 ▲ The circuit shown in Fig. 10.20, with the original network replaced by its Thévenin equivalent.

$$P = I_{eff}^2(5.76) = 8 \text{ W}.$$

(30 pts.) **5)** Consider the following power transmission circuit. The load impedance Z_L has the magnitude of 20 Ω with a power factor of 0.8 lagging.



a) Find the average power dissipated in the line and at the load.
b) Find the capacitive reactance that when connected in parallel with the load will make the load look purely resistive. What is the equivalent impedance of the load in this case?
c) Find the average power dissipated in the line and at the load when the capacitive reactance is connected across the load.

Answer 5: pts

a) (4) $Z_L = 20\cdot(0.8+j0.6) = 16+j12\ \Omega$ math → −2

(4) $I = \frac{500}{\underbrace{Z_L + 2+j3}_{18+j15}} = 16.39 - 13.66j = 21.34\angle{-39.8^\circ}$ A (rms)

(2) $P_{Line} = (21.34)^2 \cdot 2 = 910.7$ W

(2) $P_{Load} = (21.34)^2 \cdot 16 = 7286$ W

b)
(3) $Y_L = \frac{1}{Z_L} = \frac{1}{16+j12} = 0.04 - 0.03j$

(4) $\Rightarrow j\omega C = 0.03j \Rightarrow \omega C = 0.03\ S \rightarrow X_c = \frac{-1}{\omega C} = -33.3\ \Omega$
w/o ↑ → (−2)

(3) $\Rightarrow Z_{eq} = \frac{1}{0.04} = 25\ \Omega$

c) (4) $I = \frac{500}{Z_{eq} + 2+j3} = 18.29 - 2.03j = 18.4\angle{-6.34^\circ}$ A (rms)

(2) $P_{Line} = (18.4)^2 \cdot 2 = 677.5$ W

(2) $P_{Load} = 8469$ W ← $(18.4)^2 \cdot 25$