CHAPTER 4: PROBLEMS

4.1 Determine the value of resistance of the network shown below that would be measured between:

(a) terminals A and B (terminal C is open)
(b) terminals B and C (terminal A is open)
(c) terminals A and C (terminal B is open)

4.2 Determine the value of resistance of the network below that you would measure between:

(a) terminals A and C
(b) terminals B and C
4.3 Find the voltage, $V_1$, across resistor $R_1$ below.

![Circuit Diagram](image)

4.4 Find the current, $I_2$, through resistor $R_2$ below.

![Circuit Diagram](image)

4.5 Consider the circuit shown below.

![Circuit Diagram](image)

(a) Find the voltage across the 2kΩ resistor.
(b) Find the voltage across the 6kΩ resistor.
(c) Find the current flowing through the 6kΩ resistor.
(d) Find the equivalent resistance obtained by combining all 4 resistors as shown in the above circuit into one resistor connected across the 6V supply.
(e) Redraw the circuit and show where you would place an ammeter in this circuit to measure the current flowing the 9kΩ resistor.

4.6 Consider the following circuit.

![Circuit Diagram](image)

(a) Find $V_{oc}$, the open circuit voltage between A and B.
(b) Find $I_{sc}$, the value of the current between A and B when terminals A and B are shorted together.
(c) Find and draw the Thevenin equivalent circuit from the viewpoint of terminals A and B. Be sure to label your drawings.

4.7 In this problem you will use superposition to find $I_t$.

![Circuit Diagram](image)

(a) Find $I_v$, the contribution to $I_t$ in this circuit from the voltage source.
(b) Find $I_s$, the contribution to $I_t$ in this circuit from the current source.
(c) Using the principle of superposition, determine $I_t$. 
**4.8** For the circuit shown below, use superposition to solve for \( V_o \) by solving for \( V_{ov} \) and \( V_{ot} \), the contributions to \( V_o \) from the independent voltage and current sources. (Hint: this problem is easier to solve using equivalent resistances than nodal analysis, though either will work.)

![Circuit Diagram](image)

**4.9** For the resistive voltage divider circuit shown in Fig. P4.1 please answer the following questions:

![Resistive Voltage Divider Circuit](image)

(a) If \( R_1 = 1000 \Omega \), \( R_2 = 1000 \Omega \), and \( R_3 = 1000 \Omega \), what is the value of \( V_{OUT} \)?

(b) How much power is dissipated in \( R_3 \) under the conditions described in Part (a) of this problem?

(c) Resistors are typically available with the following power dissipation ratings: 1/4 Watt, 1/2 Watt, 1 Watt, and 2 Watt. The higher its power dissipation rating, the larger and more costly the resistor is. If you wanted to minimize the cost of the circuit, but not have any resistor dissipating more power than its maximum power dissipation rating, what would you
choose for the power dissipation rating for $R_1$, $R_2$, and $R_3$, when operating under the conditions described in Part (a) of this problem?

4.10 For the circuit shown in Fig. P4.1 you are asked to change the value for component $R_3$ in order to make $V_{OUT} = 2V$. The values of the other resistors are unchanged: $R_1 = 1\, \text{k}\Omega$, $R_2 = 1\, \text{k}\Omega$. What value would you pick for $R_3$?

4.11 Determine the current, $I$, for both circuits shown in Fig. P4.2.

![Figure P4.2](image)

4.12 Determine the voltage across the terminals, $V_0$, for the circuit shown in Fig. P4.3.

4.13 Determine the voltage across the terminals, $V_0$, for the circuit shown in Fig. P4.4.
4.14 Find the Thevenin and Norton equivalent circuit representations for the circuit shown in Fig. P4.5 for the case where $V_s=60\,\text{V}$, $R_1=20\,\Omega$, $R_2=4\,\Omega$, $R_3=10\,\Omega$. 

**Figure P4.3** Circuit for analysis.

**Figure P4.4** Circuit for analysis.

**Figure P4.5** Two terminal circuit for analysis.
4.15 Using linear superposition, find $V_o$ for the circuit shown in Fig. P4.6 assuming that $V_s=5V$, $I_s=1.2\,A$, $R_1=16\,\Omega$, $R_2=20\,\Omega$, $R_3=6\,\Omega$.

![Figure P4.6](image)

4.16 Assume that you are given a speaker that can be modelled as an $8\,\Omega$ resistor and a high impedance headphone can be modelled as a $2K\,\Omega$ resistor. Assume that your audio amplifier can be modelled as a voltage source with a value of $4V$ (you should ignore the fact that audio signals actually vary with time and just assume that the output of the amplifier is constant like a battery).

(a) How much power would be dissipated in the speaker and the headphone if they were connected to the amplifier in series?

(b) How much power would be dissipated in the speaker and the headphone if they were connected to the amplifier in parallel?

4.17 For the circuit shown in Fig. P4.7 the component values are $R_1=1000\,\Omega$, $R_2=1000\,\Omega$, and $R_3=1000\,\Omega$. Please answer the following questions.

(a) Please draw the Thevenin equivalent circuit and indicate the values for the voltage source and the resistor.

(b) Please draw the Norton equivalent circuit and indicate the values for the current source and the resistor.
4.18 For the circuit shown in Fig. P4.8 the component values are $R_1 = 1000\, \Omega$, $R_2 = 1000\, \Omega$, and $R_3 = 1000\, \Omega$. Please answer the following questions.

(a) Please solve for $V_X$ as a function of $V_1$ under the assumption that $V_2 = 0$ and $I_3 = 0$.

(b) Please solve for $V_X$ as a function of $V_2$ under the assumption that $V_1 = 0$ and $I_3 = 0$.

(c) Please solve for $V_X$ as a function of $I_3$ under the assumption that $V_1 = 0$ and $V_2 = 0$. Please solve for $V_X$ as a function of $I_3$, $V_1$ and $V_2$ simultaneously using the node method.
4.19 For the circuit shown in Fig. P4.9 determine $V_X$ as a function of $V_S$. The component values are $R_1 = 1000\Omega$, $R_2 = 1000\Omega$, and $R_3 = 1000\Omega$. HINT: remember the voltage divider.

![Figure P4.9](image)

Figure P4.9 Circuit with a voltage dependent current source.

4.20 Please answer the following questions concerning the circuit shown in Fig. P4.10. Note, this circuit contains a current-controlled current source: $I_X$.

![Figure P4.10](image)

Figure P4.10 Circuit with a current dependent current source.

(a) What is the value of the controlling current $I_2$?
(b) What is the value of the internal voltage, $V_2$?
(c) What is the value of the output voltage, $V_3$?
4.21 Determine the Thevenin and Norton equivalent circuits for the network shown in Fig. P4.11 between terminals A and B.

**Figure P4.11** Circuit for two-terminal element.