

GEORGIA INSTITUTE OF TECHNOLOGY
School of Electrical and Computer Engineering

Course ECE 2040
Circuit Analysis

Assigned: August 25, 2000

Due: September 1, 2000

Problem Set #1

Reading: Read the following sections from the class notes:
Chapter 1, Sections 1.1–1.4

Reading: Read the following sections from Dorf and Svoboda:
Chapter 1, Sections 1.3–1.5; (definitions of voltage and current)
Chapter 2, Sections 2.5, 2.6; (resistors, sources)
Chapter 3, Sections 3.3; (Kirchoff's Laws)
Chapter 7, Sections 7.3, 7.6; (definitions of capacitors and inductors)

Problem 1.1: The voltage waveform for the voltage source in the network of Figure 1 is

$$v_s(t) = \begin{cases} \sin 2\pi(100)t, & t \geq 0 \\ 0, & t < 0 \end{cases}$$

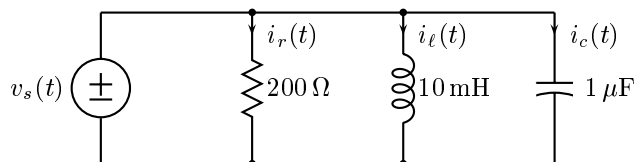


Figure 1: Circuit for Problem 1.1.

- (a) Determine $i_r(t)$.
- (b) Assuming $i_l(0) = 0$, determine $i_l(t)$.
- (c) Determine $i_c(t)$.

Problem 1.2: For the circuit in Figure 2 write a sufficient set of KCL equations in terms of the voltage variables that are labeled. You should incorporate Ohm's Law for the resistors. Exploit any obvious series and parallel connections to reduce the number of equations and variables.

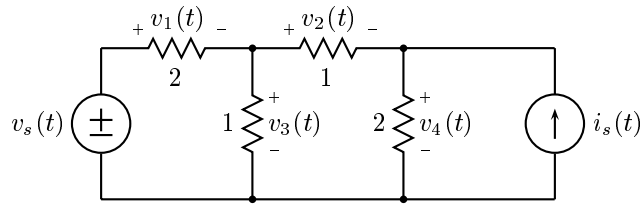


Figure 2: Circuit for Problem 1.2.

Problem 1.3: For the circuit in Figure 3 write a sufficient set of KVL equations to constrain all of the element variables in terms of the current variables that are indicated. You should incorporate Ohm's Law for the resistors. Use any obvious series and parallel connections to reduce the number of equations and variables.

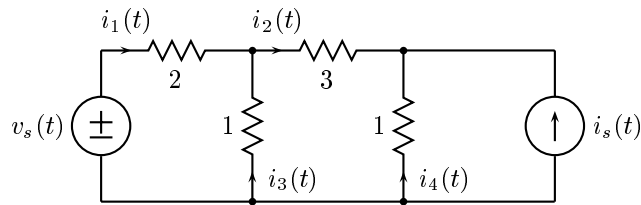


Figure 3: Circuit for Problem 1.3.

Problem 1.4: Determine $v(t)$ and $i(t)$ in the network shown in Figure 4

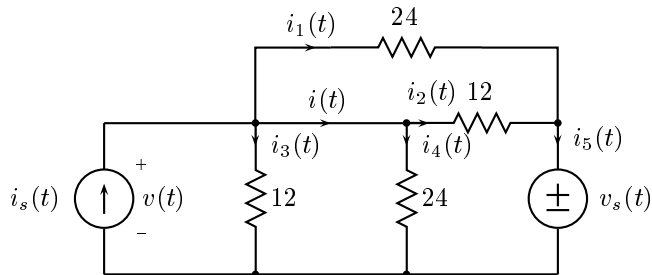


Figure 4: Circuit for Problem 1.4.

Problem 1.5: The instantaneous power dissipated by an element or source is equal to the product of the voltage drop across the element, $v(t)$ and the current passing through it, $i(t)$

$$P_{inst}(t) = v(t)i(t).$$

It is important for this definition that the reference direction for the current flows into the $+$ reference terminal for the voltage drop. The instantaneous power associated with an element

can be either positive or negative; when it is positive, the element is dissipating power and when it is negative it is supplying power. Resistors always dissipate power.

Consider the circuit shown in Figure 5.

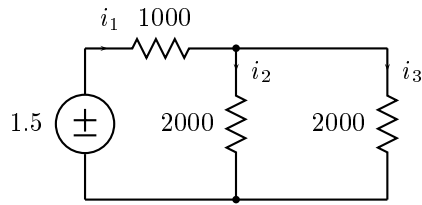


Figure 5: Circuit for Problem 1.5.

- This circuit contains three elements and thus there are six element variables, all of which are constant since the voltage source is constant. The currents are labeled and the voltage drops across the three resistors are implied by the default sign convention. Write a set of six linear equations in the variables v_1 , v_2 , v_3 , i_1 , i_2 , and i_3 that specify the equilibrium solution. These should take the form of three element relations, one KCL equation, and two KVL equations.
- Solve the above set of equations to determine the equilibrium values of the element variables.
- Evaluate the power dissipated by all of the elements and sources. Show that the total power dissipated in the resistors is equal to the total power supplied by the source.

The net power in any circuit must always be zero, i.e. the total power dissipated must always equal the total power supplied. This problem demonstrates that fact for one particular circuit. We will prove the general case later in the course.