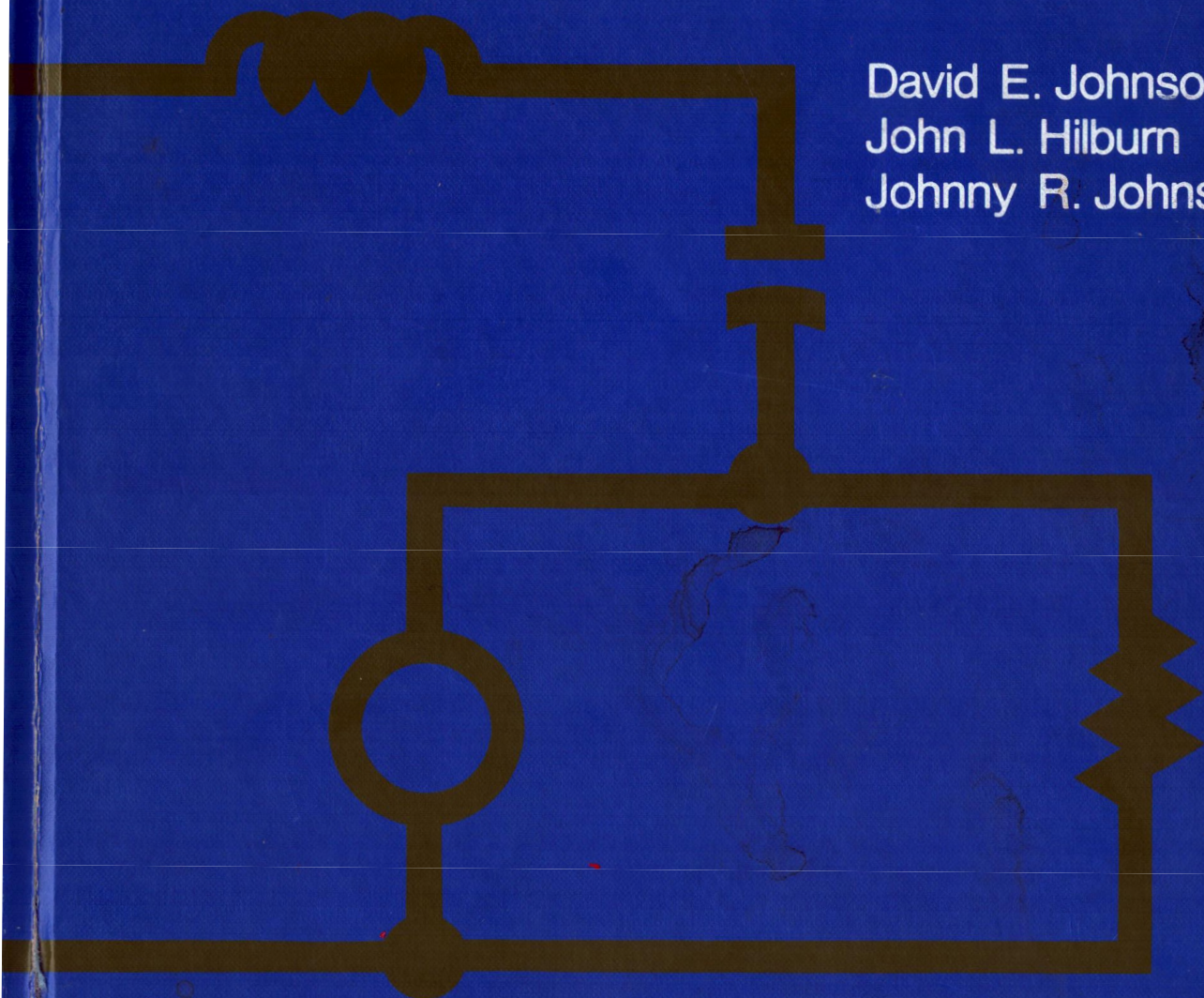


BASIC ELECTRIC CIRCUIT ANALYSIS

David E. Johnson
John L. Hilburn
Johnny R. Johnson



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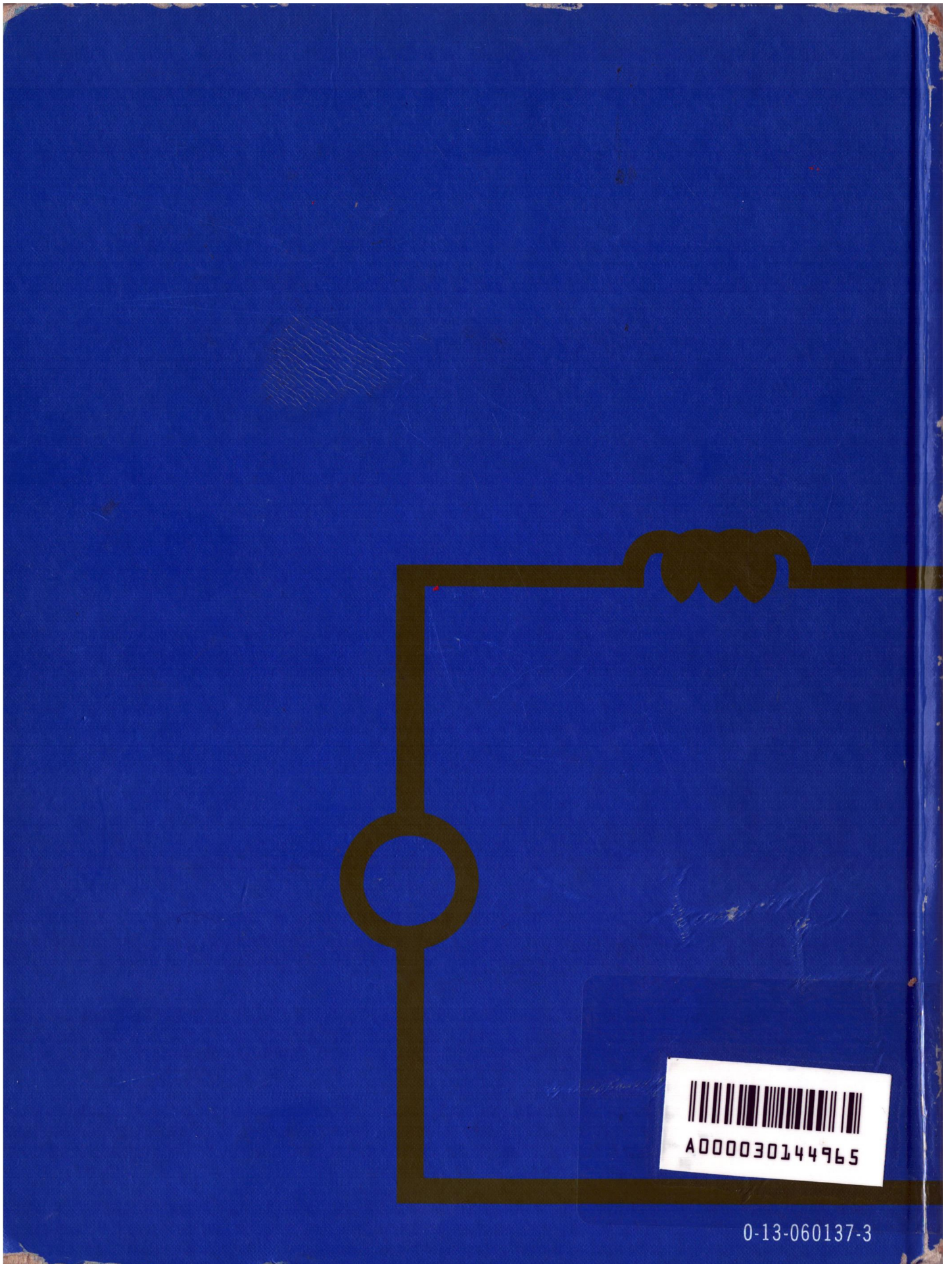
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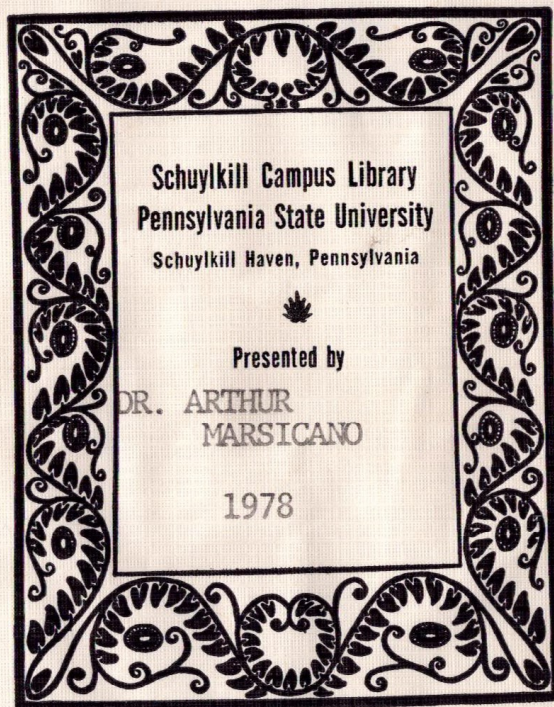
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BASIC ELECTRIC CIRCUIT ANALYSIS

D.E. JOHNSON, J.L. HILBURN, and J.R. JOHNSON

*Department of Electrical Engineering
Louisiana State University*

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course, mind-boggling numbers, but their sizes enable us to use more manageable numbers, such as 2 C, in the circuit theory to follow.

The symbol for charge will be taken as Q or q , the capital letter usually denoting constant charges such as $Q = 4$ C, and the lowercase letter indicating a time-varying charge. In the latter case we may emphasize the time dependency by writing $q(t)$. This practice involving capital and lowercase letters will be carried over to the other electrical quantities as well.

The primary purpose of an electric circuit is to move or transfer charges along specified paths. This motion of charges constitutes an *electric current*, denoted by the letters i or I , taken from the French word “intensité.” Formally, current is the time rate of change of charge, given by

$$i = \frac{dq}{dt} \quad (1.1)$$

The basic unit of current is the *ampere* (A), named for André Marie Ampère (1775–1836), a French mathematician and physicist who formulated laws of electromagnetics in the 1820s. An ampere is 1 coulomb per second.

In circuit theory current is generally thought of as the movement of positive charges. This convention stems from Benjamin Franklin (1706–1790), who guessed that electricity traveled from positive to negative. We now know that in metal conductors the current is the movement of electrons that have been pulled loose from the orbits of the atoms of the metal. Thus we should distinguish *conventional* current (the movement of positive charges), which is used in electric network theory, and *electron* current. Unless otherwise stated, our concern will be with conventional current.

As an example, suppose the current in the wire of Fig. 1.3(a) is $I = 3$ A. That is, 3 C/s pass some specific point in the wire. This is symbolized by the arrow labeled 3 A, whose direction indicates that the motion is from left to right. This situation is equivalent to that depicted by Fig. 1.3(b), which indicates -3 C/s or -3 A in the direction from right to left.

Figure 1.4 represents a general circuit element with a current i flowing from the left toward the right terminal. The total charge entering the element between time t_0 and t is found by integrating (1.1). The result is

$$q_T = q(t) - q(t_0) = \int_{t_0}^t i \, dt \quad (1.2)$$

We should note at this point that we are considering the network elements to be *electrically neutral*. That is, no net positive or negative charge can accumulate in the element. A positive charge entering must be accompanied by an equal positive

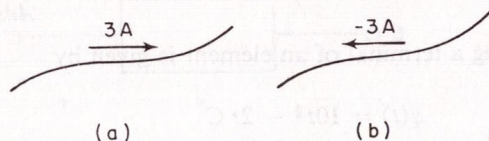


FIGURE 1.3 Two representations of the same current

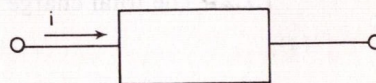


FIGURE 1.4 Current flowing in a general element