Chapter I :- Circuit Variables

1.1 Electrical engineering :- an overview

An electric circuit :- is a mathematical model that approximates the behavior of an actual electrical system

Three basic assumptions to use circuit theory

1) A lumped-parameter system :- electrical effects happen instantaneously throughout a system.

If the wavelength of the signal is large compared the the physical dimensions of the system, we have a lumped-parameter system.

$\lambda = \frac{c}{f}$ $\quad c = 3 \times 10^8$ m/s $\quad f = 50, 60$ Hz

If the dimension of the system is 1/10th (or smaller) of the of the dimension of the wavelength, we have a lumped-parameter system.

2) The net charge on every component in the system is always zero

3) There is no magnetic coupling between the components in a system.

1.2 The international system of units (SI)

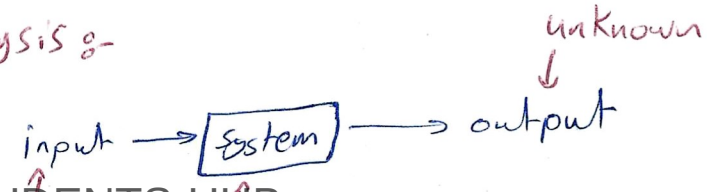
Table 1.1, Table 1.2, Table 1.3

Table 1.1, Table 1.2 → Basic and derived SI units

Table 1.3 → Prefixes to signify power of 10

1.3 Circuit analysis :- An overview

Analysis :-



1.4 Voltage and Current

Voltage :- is the energy per unit charge created by the separation of positive and negative charge.

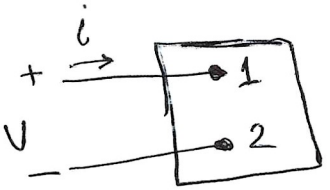
$$v = \frac{dw}{dq}$$

Current :- The rate of charge flow

$$i = \frac{dq}{dt}$$

1.5 Ideal and basic Circuit element

1) has only two terminal
2) Can be described Mathematically in terms of current and voltage
3) Can't be subdivided into other elements



ideal basic Circuit element

* The passive Sign Convention

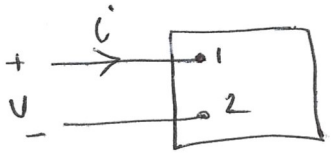
whenever the current in the element is in the direction of the voltag drop (from + to −), use positive sign in any expression that relates the voltage to the current. otherwise, use negative sign.

1.6 Power and energy

Power :- is the rate of expanding or absorbing energy

$$p = \frac{dw}{dt} = \left(\frac{dw}{dq}\right)\left(\frac{dq}{dt}\right) = vi$$

Example 3- Suppose that we have selected the polarity reference shown in the figures below. Assume $i = 4A$ and $V = -10\ V$. Find the power associated with the terminal pair 1 and 2?



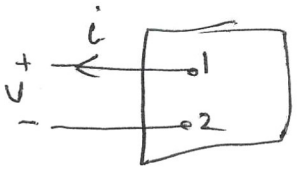
a

$P = vi$

$= (-10)(4) = -40\ W$

the circuit inside the box is expanding power

Energy



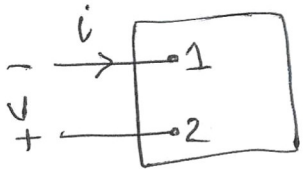
b

$P = -vi$

$= -(-10)(4) = 40\ W$

the circuit absorbing power

Energy

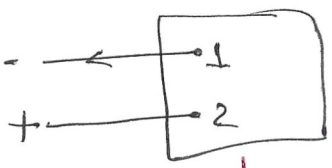


c

$P = -vi$

$= -(-10)(4) = 40\ W$

Expanding Energy



d

$P = vi$

$= (-10)(4) = -40W$

Absorbing Energy