Main Template

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1 Introduction

1.1 Categorization of Components

Rather than trying to understand full circuits at once, it is easier to break them into two groups: **passive** components and **active** components.

Passive Components **1.1**

Passive components are ones that don't require any power supply to operate. For example, a resistor or a capacitor are both passive components.

Active Circuits **1.2**

Active components require power to operate. In other words, they need to be connected to a power supply to function. Logic gates (74LSXX) are active since they require a power supply.

Another way to divide components is between **linear** and **non-linear**.

Linear Components **1.3**

Linear components are... They also can be subdivided into components that store energy (capacitors and inductors) and components that dissipate energy (resistors).

Non-Linear Components **1.4**

...

1.2 Overview of Concepts

1.2.1 Charge and Current

Charge **1.5**

Charge (Q) is an electrical property of the atomic particles of which matter consists, measured in coulombs (C).

$$Q(t) = \int i(t)\,dt$$

When charged particles move in space over time, such as throughout a wire in a circuit, an electrical current is generated.

Electric Current **1.6**

Electric current (I) is the time rate of change of charge, measured in amperes (A).

$$i(t) = \frac{dQ}{dt}$$

Current is simply a rate of change of a charge, and thus the two are related as the others' derivative/integral.

1.2.2 DC vs. AC

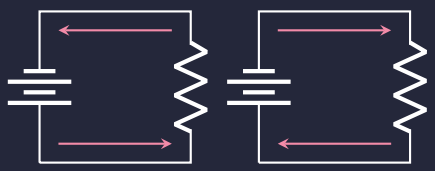
Direct Current **1.7**

A direct current (dc) flows only in one direction and can be constant or time varying.

There are two ways of describing the *direction* in which the electrons flow in a direct current: **conventional flow** and **electron flow**. Both are shown in Figure 1.

Alternating Current **1.8**

An alternating current (ac) is a current that changes direction with respect to time.



(a) Conventional (b) Electron

Figure 1: Electron Flow in Direct Currents

Voltage **1.9**

Voltage (or *potential difference*) is the energy required to move a unit charge form a reference point (-) to another point (+), measured in Volts (V).

$$v(t) = v_b - v_b = \frac{dw}{dQ} = \frac{dE}{dQ}$$

1.2.3 Power and Energy

Power **1.10**

Power is the time rate of expending or absorbing energy measured in watts (W). It is the rate of change of energy.

$$p(t) = \frac{dE}{dt} = \frac{dE \cdot dQ}{dt \cdot dQ} = \frac{dE}{dQ} \cdot \frac{dQ}{dt}$$
$$p = v \cdot i$$

Energy **1.11**

Energy is the capacity to do work measured in Joules (J).

$$E(t) = \int p(t)\, dt$$

Again, these two values are related as the derivative/integral of the other.

1.3 Circuit Elements

Ideal Independent Source **1.12**

An ideal independent source is an active element that provides a specified voltage or current that is completely independent of other circuit elements.

Ideal Dependent Source **1.13**

Also called an *Ideal Controlled Source*, this is an active element in which the source quantity is controlled by another voltage or current.

There are four types of dependent sources:

1. Voltage Controlled Voltage Source (VCVS)
2. Voltage Controlled Current Source (VCCS)
3. Current Controlled Voltage Source (CCVS)
4. Current Controlled Current Source (CCCS)