SIGNALS AND SYSTEMS

Lect # 1

Note Title 10/20/2008

About us:

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Research Interests:

General area of communication systems and networks.

Next:

- What is a signal ?
- What is a system ?
- Voltage and current
- Ideal Basic Circuit Element
- Passive sign convention

Objectives:

- know and be able to use the definitions of voltage and current
- be able to use passive sign convention

What is a "signal"?

Examples of Signals:

- voltage out of a radio tuner
- read out of an aircraft altimeter

A signal is a function of time (usually) that conveys information
(it could also be a function of frequency)

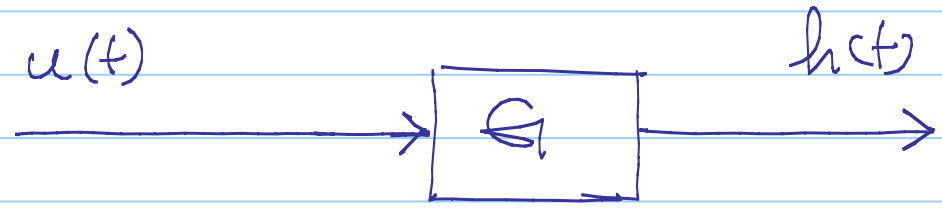
What is a "system"?

Example of system

- radio tuner
- spacecraft
- aircraft

A system operates on an input signal to produce an output signal

Block diagram



- Communication Systems:

  - electrical systems that generate, transmit and distribute information

  - examples:

    television equipment such as camaras, transmitters, receivers, and VCRs

    radio telescope, used to explore the universe

    satellite systems, which would return images

    radar systems, used to coordinate plane flights,

- Computer systems:

  - uses electronic signals to process information ranging from word processing to mathematical computations.

    range in size and power from pocket calculators to personal computers to super computers

- Control systems
  - use electrical signals to regulate processes.
  - control of temperature, mixture of fuel-air in a fuel injected engine. auto pilot systems that help to fly and land air planes

- Signal processing systems
  - act on electric signals that represent information.
  - image-processing system that gather massive quantities of data from orbiting weather satellites, reduce the data to meangeable level, tranform the remaining data into a video image or even a news broadcast
  -

Interaction among these systems take place
eg.

- sophisticated communications system enable the pilot and air traffic controller to monitor the plane's location

- Onboard system on Fighter jet, implementing navigation and flight control systems, generating video information in a cockpit.

  cockpit command to adjust the position and speed of the airplane

  producing the appropriate signals to the engines and control surfaces (such as wing flaps, airerons, rudder)

- signal processing systems reduce noise in air traffic communications and transform about plane location to more meaningful form of a viedio display in a cockpit.

Circuit Theory

electric circuit is a mathamatical model that approximate the behavior of an actual electrical system.

Charge - bipolar i.e. electrical effects are described in terms of positive and negative charges.

- exists in discrete quantities, integral multiples of the electronic charge 1.6022×10^{-19} C

- electrical effects are attributed to both the separation of charge and charges in motion

  seperation of charge creates an electric force (voltage)

  motion of charge creates an electric fluid (current)

Voltage - whenever positive and negative charges are separated, energy is expanded

Voltage is the energy per unit charge created by the separation

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

v = the voltage in volts

w = the energy in joules

q = the charge in coloumbs

Current

The electrical effects caused by charges in the motion depends on the rates of charge flow.

The rate of charge flow is known as current which is expressed as

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

i = current in amperes

q = the charge in coloumbs

t = time in seconds.

Note: The above definitions are magnitude of voltage and current
Bipolar nature of electric charge requires that we assign polarity references to these variables.

The Ideal Basic Circuit Element

An ideal basic circuit element has three attributes:

1) it has only two terminals, which are points of connection to other circuits components

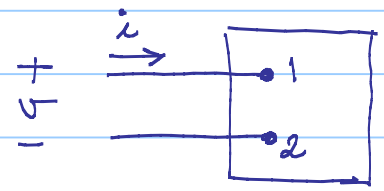
2) it is described mathematically as current and/or voltage

3) cannot be subdevided into other elements.

- ideal implies that a basic element does not exists as a realizable physical component (however, they can be connected inorder to model actual devices and systems)

- basic implies that circuit element cannot be further reduced or subdivided into other elements

- forms basic building block



An ideal basic circuit element

Note: the "box" is blank because we are making no commitment at this time as to the type of circuit element.

- voltage across the terminal of the box is denoted by v
- polarity is denoted by + and − signs.

- current in the circuit element is denoted by i.
- reference direction is shown by the arrow placed alongside the current

- polarity is not a function of the basic element nor the type of interconnection made with the basic elements.

	positive values	negative values
v	voltage drop from terminal 1 to terminal 2 voltage raise from terminal 2 to terminal 1	voltage rise from terminal 1 to terminal 2 voltage drop from terminal 2 to terminal 1
i	positive charge flowing from terminal 1 to terminal 2 negative charge flowing from terminal 2 to terminal 1	positive charge flowing from terminal 2 to terminal 1 negative charge flowing from terminal 1 to terminal 2

- Assignment of reference polarity is completely arbitrary.
- Once you have assigned the references, all subsequent equations must agree with chosen references
- Most widely used sign convention is called passive sign convention

Passive sign convention

- whenever the reference direction for the current in an element is in the direction of the reference voltage drop across the element (see above figure), use a positive sign in any expression that relates the voltage to the current. otherwise use a negative sign.