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Electronics 1 Part 1 (Quickstudy: Academic)

Quick Study ACADEMIC

ELECTRONICS 1 PART ONE

PART 1 of FUNDAMENTALS OF ELECTRONIC DEVICES AND BASIC ELECTRONIC CIRCUITS

CIRCUITS & SYSTEMS: BASIC DEFINITIONS

ELECTRONIC CIRCUITS

An electronic circuit is an information-bearing signal processing network formed by interconnections of passive components and/or active devices.

Passive Components: Resistor, inductor and capacitor.

Active Devices: (or energy source devices) — transistor, metal-oxide semiconductor, etc.

Electronic System: An arrangement of components (passive elements and/or active devices) with a specified input signal producing a defined output signal.

Signal Processing: Fundamentally, electronic circuits and systems process the input signal. Common processing includes:

- Amplification (magnification)
- Inversion
- Differentiation
- Filtering: Changing the relative magnitude of different frequency components of the signal
- Modulation: Substitution/modification of a particular part of the signal on a carrier wave

Other Electronic Circuits are:

- Harmonic oscillators:** Produce sinusoidal wave forms of desired frequency, or, critical non-sinusoidal waveforms, their other outputs can produce non-sinusoidal wave forms such as square, triangular, etc.
- Digital circuits:** Specific circuits which handle digital wave forms; they can perform computational operations such as addition, subtraction, multiplication, etc. in binary form.

ELECTRICAL SIGNAL

Electrical signal is an information-bearing electrical entity (such as voltage or current) derived from a transducer (e.g. transducer) which is converted to a voltage or current signal by a transducer. Signal processing refers to processing the electrical signal in a predetermined manner so as to modify the nature of the information contained in it. Signal sources can be represented by Fig. 1.

Thomson's equivalent circuit: A signal source represented by a voltage generator V_s in series with a source (internal) resistance R_s .

Norton's equivalent circuit: A signal source is replaced by a current generator with a short resistance R_s .

Electrical signal is characterized by:

- Amplitude, Frequency and phase parameters. The signal is a time-varying function representing the wave-shape as a function of time. It can be periodic with a definite period T , or, it can be aperiodic. A complex waveform consists of several wave forms of different frequencies. A periodic signal with a complex structure of waveforms has a discrete spectrum of harmonics, sinusoidal wave forms of magnitudes as dictated by Fourier series expansion. An aperiodic waveform has a continuous spectrum of harmonic components or per Fourier integral transform.

Examples of signal representation by Fourier series and Fourier transform:

A periodic, continuous, time-varying signal can be represented by a superposition of infinite number of harmonics (line and/or continuous wave forms). Fig. 2 shows the Fourier expansion of a square wave (Fig. 2).

$$f(t) = \frac{A}{\pi} \left[\sin(\omega t) + \frac{1}{3} \sin(3\omega t) + \frac{1}{5} \sin(5\omega t) + \dots \right]$$

Fundamental angular frequency

DIODES: IDEAL & PRACTICAL VERSIONS

Ideal diode: An ideal diode is a two-terminal, unidirectional, non-linear, electrical component which allows the current to flow in the opposite direction. Compared to Fig. 3, an ideal diode has a voltage V characteristic of a bilateral element (such as a resistor R) and an ideal diode has a nonlinear $V-I$ relationship shown as being exponential in the forward bias with its anode kept at positive (conventional) relative to its other (cathode) terminal. In the reverse bias (anode being at negative potential with respect to cathode), there is a small reverse current (anode to an ideal diode, cathode to an ideal diode, anode to an ideal diode, cathode to an ideal diode) which, in an ideal diode, is zero. In a practical diode, there is a small reverse current (anode to an ideal diode, cathode to an ideal diode) which, in an ideal diode, is zero. In a practical diode, there is a small reverse current (anode to an ideal diode, cathode to an ideal diode) which, in an ideal diode, is zero.

DIODES AS CIRCUIT ELEMENTS

Basic applications of diodes:

- Rectification
- Waveform clipping
- Diode as a switch
- Diode as a variable capacitor
- Diode as a variable inductor
- Diode as a variable resistor

Ideal Diode Switch: An ideal diode switch is a two-terminal, unidirectional, non-linear, electrical component which allows the current to flow in the opposite direction. Compared to Fig. 3, an ideal diode has a voltage V characteristic of a bilateral element (such as a resistor R) and an ideal diode has a nonlinear $V-I$ relationship shown as being exponential in the forward bias with its anode kept at positive (conventional) relative to its other (cathode) terminal. In the reverse bias (anode being at negative potential with respect to cathode), there is a small reverse current (anode to an ideal diode, cathode to an ideal diode, anode to an ideal diode, cathode to an ideal diode) which, in an ideal diode, is zero. In a practical diode, there is a small reverse current (anode to an ideal diode, cathode to an ideal diode) which, in an ideal diode, is zero.

SIGNAL DISTORTION

Electrical signal processed by a circuit may undergo three types of distortion: amplitude distortion, frequency distortion and phase distortion.

Amplitude distortion: Also known as harmonic or nonlinear distortion, this is caused by the nonlinear transfer function characteristics of the components/devices in the circuit (Fig. 4). That is, an input signal $x(t)$ will be delivered at the output of the circuit as $y(t) = a_0x(t) + a_2x^2(t) + a_3x^3(t) + \dots$, where a_0, a_2, a_3, \dots are the coefficients of the nonlinear transfer function. If $x(t)$ is a single frequency signal, the output will contain higher harmonic components due to square, cubic terms, etc. As a result, the output signal wave shape (waveform) will be seen distorted (nonlinear distortion).

Frequency distortion: Due to the presence of resistive (R) and/or inductive (L) elements in the circuit, a complex signal (comprised of a spectrum of several frequency components) will face filtering of its components, inasmuch as the reactance offered by R and/or L elements are frequency-dependent. As a result, the transfer function relating the input and the output would vary as a function of frequency.

Phase distortion: Considering the input and output signals, their relative phase angle is again decided by R (and/or L) elements present in the circuit. Hence, their phase difference is frequency-dependent. For a complex input signal with a spectrum of frequency components, the phase angle (lag) of the transfer function of the circuit when plotted against frequency is typically as shown in Fig. 5. Except over a midrange of frequencies, it lags at low and high frequencies due to series and shunt capacitive elements respectively (or respectively, due to shunt and series inductive elements, if present).

NOISE

Noise: An undesired entity introduced into the signal in the circuit, either caused by various circuit elements or electromagnetic interference coupled to the circuit from external sources. Noise is a random phenomenon and affects the quality of the signal. For a complex signal, the noise in the circuit, the noise level should be measured (high signal-to-noise ratio).



Synopsis

Fundamentals of electronic devices and basic electronic circuits. As an engineer, tradesman or electronics student, this guide will help with over 50 diagrams and equations.

Book Information

Series: Quickstudy: Academic

Misc. Supplies: 6 pages

Publisher: QuickStudy; Chrt edition (March 1, 2001)

Language: English

ISBN-10: 1572225262

ISBN-13: 978-1572225268

Product Dimensions: 8.5 x 11 x 0.1 inches

Shipping Weight: 2.4 ounces (View shipping rates and policies)

Average Customer Review: 4.5 out of 5 stars [See all reviews](#) (17 customer reviews)

Best Sellers Rank: #34,578 in Books (See Top 100 in Books) #1 in [Books > Engineering & Transportation > Engineering > Electrical & Electronics > Circuits > VLSI & ULSI](#) #2 in [Books > Engineering & Transportation > Engineering > Electrical & Electronics > Electronics > Transistors](#) #3 in [Books > Arts & Photography > Music > Theory, Composition & Performance > MIDI, Mixers, etc.](#)

Customer Reviews

I bought probably most of the QuickStudy guides over the years and they were almost always a big help both in and out of class. The several electronics guides were among my favorites. This one covers basic electronics as opposed to electricity and so deals with electronic devices like amplifiers, which it focuses on. Includes amplification, feedback, cascading, and more. You can't include everything of course in a little primer like this but the most important concepts get covered. These guides were durable, colorful, attractive, and fun to use. I have some that are going on decades old and the colors still haven't faded. In school they were almost constant companions in some of my courses. Overall another great little guide from BarCharts/QuickStudy.

Stashed this away for reference on projects if anything is forgotten or disputed. No longer need internet if its not available. The quality is good, but the amount of information is overwhelming. If you are going to actually be studying for a class, I recommend making your own study card in addition to buying this as there are many benefits to doing so.

It's legible, convenient, durable, water proof, etc. It's a handy little cheat sheet. I keep in a binder with the documents for a TI Nspire Calculator. I was kinda hoping that it would cover microwave transmission parameters. Some of that is on the Circuit Theory/Analysis card. Still, there was not much on the cards concerning practical impedance matching circuits. You just can't cram everything on a couple or three cards. All the basics are there. You should be able to derive the rest.

BarCharts are a great little reference. I would not recommend them as a study aid, but as a quick reference, they are great! I have used them for Chem, Physics, Electronics and Math. They are great for what they are.

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