DOWNLOAD PDF BASICS OF CIRCUIT THEORY

Chapter 1 : Network analysis (electrical circuits) - Wikipedia

Circuits (also known as "networks") are collections of circuit elements and wires. Wires are designated on a schematic as being straight lines. Nodes are locations on a schematic where 2 or more wires connect, and are usually marked with a dark black dot. Circuit Elements are "everything else" in a.

Understanding Electricity Even though basic electrical theory was not understood until much later, electricity has existed in the world since the beginning of time. Long before anyone heard the word electricity, people had seen lightning and experienced shocks from electric fish. Ancient writings from Pliny the Elder and other naturalists described a numbing effect when shocked by a catfish or a torpedo ray, and realized such a shock could travel along a conductive object. However, electricity remained mostly a strange phenomenon until , when the English scientist William Gilbert began to study electricity more closely. Many other scientists, inventors and experimenters became fascinated with electricity and began their own research, which led to our understanding of electricity today. The negative charge is carried by electrons, while the positive charge is carried by the protons, and neutrons are naturally neutral. Electrons orbit the nucleus, and therefore can be lost or gained. An example of this is often seen when someone is working without wearing properly insulated footwear. This means the body has become part of the circuit. The amount of current is based on the supply voltage and the resistance in the circuit. Electrical Resistance How much opposition the conductor or metal wire presents to the electric current flow is the electrical resistance. The lower the resistance, the easier current will flow. Think of current like water flowing through a pipe, if the pipe is small there is more resistance to water flow, if the pipe is large the water will flow much easier. Electrical resistance is measured in units of Ohms. Resistance is also affected by the material itself. Most metals are good conductors, which means they have low resistance, because their electrons can be gained and lost very easily. Also, as a material heats up, its resistance increases, and the resistance decreases as it cools down. It was named after Georg Ohm, a German physicist who published a treatise in In it, he explained measurements of applied voltage and current by using a simple electrical circuit made with varying lengths of wire. If we move the formula around, we find that: Parallel wiring simply means that there are multiple paths for the current to travel. Typically, each resistive device will have its own direct path to the voltage source. We can determine the circuit resistance with the formula: Electric Circuit An electric circuit provides a path for the current to flow to a from a point. The electric current always flows from positive to negative, and takes the path with the least resistance. The worker will experience an electrical shock, because the body offers a path towards the ground with very low resistance. The name â€" electromotive force â€" implies this is a force, when in fact the e. This potential is measured in volts. What is a Transistor? A transistor is mainly used as either an amplifier or a switch. The transistor is made of semiconductor material, and is an important part of the circuit. The device has three terminals base, collector and emitter , one of which is used to turn the transistor ON or OFF. Inside there are two junctions of semiconductors. Further Reading These are the electrical quantities used to describe basic electrical theory. You will find them in all electrical systems. Some systems may be more complicated and complex, while others might be very simple, but every one will contain these quantities. Read more articles on electrician information resource to help you learn more about basic electrical theory. This company has a massive selection of certified courses on electrical theory.

Chapter 2 : Basic Hydraulic Theory | Cross Mfg.

Video: Circuit Theory Basics Learn what a circuit is, how to describe the features of circuits, and be able to differentiate between AC and DC circuits in everyday life. Complete a quiz to test.

This principle allows large forces to be generated with relatively little effort. As illustrated, a 5 pound force exerted against a 1 inch square area creates an internal pressure of 5 psi. This pressure, acting against the 10 square inch area develops 50 pounds of force. In a basic hydraulic circuit, the force exerted by a cylinder is dependent upon the cylinder bore size and the pump pressure. There is no force generated unless there is resistance to the movement of the piston. With psi pump pressure exerted against a 12 square inch piston area approximately 4" dia. The speed at which the piston will move is dependent upon the flow rate gpm from the pump and the cylinder area. Hence, if pump delivery is 1 gallon per minute cu. The simplest hydraulic circuit consists of a reservoir, pump, relief valve, 3-way directional control valve, single acting cylinder, connectors and lines. This system is used where the cylinder piston is returned by mechanical force. With the control valve in neutral, pump flow passes through the valve and back to the reservoir. With the valve shifted, oil is directed to the piston side of the cylinder, causing the piston to move, extending the rod. If the valve is returned to neutral , the oil is trapped in the cylinder, holding it in a fixed position , while pump flow is returned to the reservoir. Shifting the valve in the opposite direction permits the oil to pass through the valve back to the reservoir. The relief valve limits the system pressure to a pre-set amount. Relief valves are commonly incorporated into the directional control valve. A hydraulic system using a double acting cylinder and a 4-way valve differs from the single acting cylinder system in that the cylinder can exert force in both directions. With the control valve in, neutral flow is returned to the reservoir. When shifted in one direction , oil is directed to the piston side of the cylinder, causing the cylinder to extend. Oil from the rod side passes through the valve back to the reservoir. If the valve is shifted to neutral , oil in the cylinder is trapped, holding it in a fixed position. When the valve is shifted in the opposite position, oil is directed to the rod side of the cylinder, causing the cylinder to retract. Oil from the piston side passes through the valve back to the reservoir. Cylinder extend force is the result of the pressure psi times the piston area minus any force resulting from the pressure acting against the rod side of the piston. Retract force is a result of the pressure psi times the area difference between the rod and the piston minus any force resulting from pressure acting against the piston side of the cylinder. Rotary hydraulic motor circuits are basically the same as cylinder circuits. Systems may be uni-directional or bi-directional as shown. The amount of rotary force torque available from the motor is a function of pressure psi and motor size. Speed is a function of flow and motor size. All of the systems described above are open center systems due to the oil flowing through the control valve back to the tank. Most systems are this type. Closed center systems use control valves with the inlet port blocked and variable displacement pumps. With the control valve in neutral , the pump is "de-stroked" to zero flow.

Chapter 3 : Basic Electrical Theory: Understanding Electricity

What is the Definition of Circuit Theory? An electrical circuit is a network consisting of a closed loop, giving a return path for the current through a switch. When the switch is actuated, the load activates and the current gets a path to complete the circuit from a high potential level to the opposite low potential level.

Because of the widespread use of complex numbers in Electrical Engineering, it is common for electrical engineering texts to use the letter "j" lower-case J as the imaginary number, instead of the "i" lower-case I commonly used in math texts. This wikibook will adopt the "j" as the imaginary number, to avoid confusion. Energy and Power Electrical theory is about energy storage and the flow of energy in circuits. Energy per coulomb is voltage. The velocity of a coulomb is current. Multiplied together, the units are energy velocity or power Energy Energy is measured most commonly in Joules, which are abbreviated with a "J" upper-case J. The variable most commonly used with energy is "w" lower-case W. The energy symbol is w which stands for work. From a thermodynamics point of view, all energy consumed by a circuit is work Practically speaking, this can not be true. If it were true, computers would never consume any energy and never heat up. The reason that all the energy going into a circuit and leaving a circuit is considered "work" is because from a thermodynamic point of view, electrical energy is ideal. All of it can be used. Ideally all of it can be turned into work. Most introduction to thermodynamics courses assume that electrical energy is completely organized and has entropy of 0. The sum of all the power entering and leaving a circuit should add up to zero. No energy should be accumulated theoretically. Of course capacitors will charge up and may hold onto their energy when the circuit is turned off. Inductors will create a magnetic field containing energy that will instantly disappear back into the source through the switch that turns the circuit off. This course uses what is called the " passive " sign convention for power. Energy put into a circuit by a power supply is negative, energy leaving a circuit is positive. Power the flow of energy computations are an important part of this course. The symbol for power is w for work and the units are Watts or W. Electric Circuit Basics Circuit Theory Circuits Circuits also known as "networks" are collections of circuit elements and wires. Wires are designated on a schematic as being straight lines. Nodes are locations on a schematic where 2 or more wires connect, and are usually marked with a dark black dot. Circuit Elements are "everything else" in a sense. Most basic circuit elements have their own symbols so as to be easily recognizable, although some will be drawn as a simple box image, with the specifications of the box written somewhere that is easy to find. We will discuss several types of basic circuit components in this book. Ideal Wires For the purposes of this book, we will assume that an ideal wire has zero total resistance, no capacitance, and no inductance. A consequence of these assumptions is that these ideal wires have infinite bandwidth, are immune to interference, and are â€” in essence â€” completely uncomplicated. This is not the case in real wires, because all wires have at least some amount of associated resistance. Also, placing multiple real wires together, or bending real wires in certain patterns will produce small amounts of capacitance and inductance, which can play a role in circuit design and analysis. This book will assume that all wires are ideal. Here a physical node is discussed. A junction is a group of wires that share the same electromotive force not voltage. Wires ideally have no resistance, thus all wires that touch wire to wire somewhere are part of the same node. The diagram on the right shows three big blue nodes, two smaller green nodes and two trivial one wire touching another nodes. Sometimes a node is described as where two or more wires touch and students circle where wires intersect and call this a node. This only works on simple circuits. One node has to be labeled ground in any circuit drawn before voltage can be computed or the circuit simulated. Typically this is the node having the most components connected to it. Logically it is normally placed at the bottom of the circuit logic diagram. Ground is not always needed physically. Some circuits are floated on purpose. Node Quiz Measuring instruments Voltmeters and Ammeters are devices that are used to measure the voltage across an element, and the current flowing through a wire, respectively. Ideal Voltmeters An ideal voltmeter has an infinite resistance in reality, several megaohms , and acts like an open circuit. A voltmeter is placed across the terminals of a circuit element, to determine the voltage across that element. In practice the voltmeter siphons a enough energy to move a needle, cause thin strips of metal to separate or turn on a transistor so a number is displayed. Ideal Ammeters An ideal ammeter has zero resistance and acts like a short circuit. Ammeters require cutting a wire and plugging the two ends into the Ammeter. In practice an ammeter places a tiny resistor in a wire and measures the tiny voltage across it or the ammeter measures the magnetic field strength generated by current flowing through a wire. Ammeters are not used that much because of the wire cutting, or wire disconnecting they require. All power supplies fit into this category. The elements which will receive the energy and dissipate it are called "Passive elements". Resistors model these devices. Reactive elements store and release energy into a circuit. Capacitors, and inductors fall into this category. Open and Short Circuits Open No current flows through an open. Normally an open is created by a bad connector. Dust, bad solder joints, bad crimping, cracks in circuit board traces, create an open. Capacitors respond to DC by turning into opens after charging up. Uncharged inductors appear as opens immediately after powering up a circuit. The word open can refer to a problem description. The word open can also help develop an intuition about circuits. Voltage sources respond to an open with no current. Opens are the equivalent of clogs in plumbing.. On one side of the open, EMF will build up, just like water pressure will build up on one side of a clogged pipe. Typically a voltage will appear across the open. Short A voltage source responds to a short by delivering as much current as possible. An extreme example of this can be seen in this ball bearing motor video. The motor appears as a short to the battery. Notice he only completes the short for a short time because he is worried about the car battery exploding. Maximum current flows through a short. Normally a short is created by a wire, a nail, or some loose screw touching parts of the circuit unintentionally. Most component failures start with heat build up. The heat destroys varnish, paint, or thin insulation creating a short. The short causes more current to flow which causes more heat. This cycle repeats faster and faster until there is a puff of smoke and everything breaks creating an open. Most component failures start with a short and end in an open as they burn up. Feel the air temperature above each circuit component after power on. Build a memory of what normal operating temperatures are. Cold can indicate a short that has already turned into an open. An uncharged capacitor initially appears as a short immediately after powering on a circuit. An inductor appears as a short to DC after charging up. The short concept also helps build our intuition, provides an opportunity to talk about electrical safety and helps describe component failure modes. A closed switch can be thought of as short. Switches are surprisingly complicated. It is in a study of switches that the term closed begins to dominate that of short. Resistors and Resistance Circuit Theory Resistors Mechanical engineers seem to model everything with a spring. Electrical engineers compare everything to a Resistor. Resistors are circuit elements that resist the flow of current. A pure resistor turns electrical energy into heat. Devices similar to resistors turn this energy into light, motion, heat, and other forms of energy. This is called the " positive charge " flow sign convention. Some circuit theory classes often within a physics oriented curriculum are taught with an "electron flow" sign convention. The goal of most circuits is to send energy out into the world in the form of motion, light, sound, etc. Ohms are also used to measure the quantities of impedance and reactance, as described in a later chapter.

Chapter 4 : Circuit Theory/All Chapters - Wikibooks, open books for an open world

Introduction to Basic Circuit Theory This information covers basic direct current theory by reviewing the three basic types of electrical circuits and the laws that apply to each type circuit: Series Circuits Parallel Circuits Series-Parallel Circuits.

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This cycle repeats faster and faster until there is a puff of smoke and everything breaks creating an open. Most component failures start with a short and end in an open as they burn up. Feel the air temperature above each circuit component after power on. Build a memory of what normal operating temperatures are. Cold can indicate a short that has already turned into an open. An uncharged capacitor initially appears as a short immediately after powering on a circuit. An inductor appears as a short to DC after charging up. The short concept also helps build our intuition, provides an opportunity to talk about electrical safety and helps describe component failure modes. A closed switch can be thought of as short. Switches are surprisingly complicated. It is in a study of switches that the term closed begins to dominate that of short.

Chapter 5 : Vol. I - Direct Current (DC) - Electronics Textbook

The theory of electrical circuits can be a complex area of study. The chapters in this section will introduce the reader to the world of electric circuits, introduce some of the basic terminology, and provide the first introduction to passive circuit elements.

What is Alternating Current AC? DC is the kind of electricity made by a battery with definite positive and negative terminals , or the kind of charge generated by rubbing certain types of materials against each other. Certain sources of electricity most notably, rotary electro-mechanical generators naturally produce voltages alternating in polarity, reversing positive and negative over time. Figure below Direct vs alternating current Whereas the familiar battery symbol is used as a generic symbol for any DC voltage source, the circle with the wavy line inside is the generic symbol for any AC voltage source. One might wonder why anyone would bother with such a thing as AC. It is true that in some cases AC holds no practical advantage over DC. In applications where electricity is used to dissipate energy in the form of heat, the polarity or direction of current is irrelevant, so long as there is enough voltage and current to the load to produce the desired heat power dissipation. However, with AC it is possible to build electric generators, motors, and power distribution systems that are far more efficient than DC, and so we find AC used predominately across the world in high power applications. To explain the details of why this is so, a bit of background knowledge about AC is necessary. This is the basic operating principle of an AC generator, also known as an alternator: Figure below Alternator operation Notice how the polarity of the voltage across the wire coils reverses as the opposite poles of the rotating magnet pass by. Connected to a load, this reversing voltage polarity will create a reversing current direction in the circuit. While DC generators work on the same general principle of electromagnetic induction, their construction is not as simple as their AC counterparts. Figure below DC generator operation The generator shown above will produce two pulses of voltage per revolution of the shaft, both pulses in the same direction polarity. The diagram shown above is a bit more simplified than what you would see in real life. The problems involved with making and breaking electrical contact with a moving coil should be obvious sparking and heat , especially if the shaft of the generator is revolving at high speed. If the atmosphere surrounding the machine contains flammable or explosive vapors, the practical problems of spark-producing brush contacts are even greater. An AC generator alternator does not require brushes and commutators to work, and so is immune to these problems experienced by DC generators. While DC motors require the use of brushes to make electrical contact with moving coils of wire, AC motors do not. This relative simplicity translates into greater reliability and lower cost of manufacture. But what else is AC good for? Surely there must be more to it than design details of generators and motors! There is an effect of electromagnetism known as mutual induction , whereby two or more coils of wire placed so that the changing magnetic field created by one induces a voltage in the other. If we have two mutually inductive coils and we energize one coil with AC, we will create an AC voltage in the other coil. When used as such, this device is known as a transformer: The fundamental significance of a transformer is its ability to step voltage up or down from the powered coil to the unpowered coil. If the secondary coil is powering a load, the current through the secondary coil is just the opposite: This relationship has a very close mechanical analogy, using torque and speed to represent voltage and current, respectively: Figure below Speed multiplication gear train steps torque down and speed up. Step-down transformer steps voltage down and current up. Figure below Speed reduction gear train steps torque up and speed down. Step-up transformer steps voltage up and current down. When transmitting electrical power over long distances, it is far more efficient to do so with stepped-up voltages and stepped-down currents smaller-diameter wire with less resistive power losses , then step the voltage back down and the current back up for industry, business, or consumer use. Transformers enable efficient long distance high voltage transmission of electric energy. Transformer technology has made long-range electric power distribution practical. Without the ability to efficiently step voltage up and down, it would be cost-prohibitive to construct power systems for anything but close-range within a few miles at most use. As useful as transformers are, they only work with AC, not DC. Because the phenomenon of mutual inductance relies on changing magnetic fields , and direct current DC can only produce steady magnetic fields, transformers simply will not work with direct current. Of course, direct current may be interrupted pulsed through the primary winding of a transformer to create a changing magnetic field as is done in automotive ignition systems to produce high-voltage spark plug power from a low-voltage DC battery , but pulsed DC is not that different from AC. Perhaps more than any other reason, this is why AC finds such widespread application in power systems. AC electromechanical generators, known as alternators, are of simpler construction than DC electromechanical generators. AC and DC motor design follows respective generator design principles very closely. A transformer is a pair of mutually-inductive coils used to convey AC power from one coil to the other. Often, the number of turns in each coil is set to create a voltage increase or decrease from the powered primary coil to the unpowered secondary coil.

Chapter 6 : How to Understand Basic Circuit Theory? Designing Basic Electronic Circuits Made Easy

are related with two basic circuit concepts: short circuit and open circuit. Ohm's Law (1) BSC Modul 1: Electric Circuits Theory Basics.

Understanding Basic Electronic Theory written by: Read on to learn the bare essentials required for designing your own basic electronic circuits. In simple terms, electronics may be understood as a branch of science that utilizes and controls the flow of electrons through specially designed networks of active and passive devices to produce a desired result. These networks are basically an interconnection of selected electronic components and constitute an electronic circuit. The electronic components involved are fundamentally classified as active and passive components. Active components play a live role in dimensioning or optimizing the flow of electrons through them as per their design specifications. These are all particularly semiconductor parts which include devices like LEDs, diodes, transistors, ICs, SCRs, triacs and many more, the list may be too long. The passive components are normally made up of carbon or chemical electrolytes and although not able to contribute actively yet play an important part in association with the active devices and complement them in every respect. Components like resistors, capacitors, inductors etc. In this article we will try to learn regarding the basic circuit theory of electronics. We will try to understand the functioning of a few electronic components and also how they may be configured into small basic circuits. As shown in the picture a diode is a two terminal component and is recognized by a band or a ring at one of its ends. In the symbol the band is indicated by a straight line at the arrow point. The lead which is terminating from this side is the cathode and the other one is the anode. A diode will always allow a positive voltage to pass through its anode towards the cathode and block the other way round. Due to this particular characteristic, diodes are also used as rectifiers to convert AC into DC. LEDs are quite similar to the normal diodes as explained above, but since LEDs are able to emit light in the process, are specifically used as indicators and in other forms of lighting purposes. LEDs are unable to tolerate high currents and therefore always incorporate a series resistor to dimension the required minimum current through them. We all are quite familiar to this versatile member of the electronic family. Transistors are basically used to amplify small electrical signals and also for switching purposes. Since most semiconductor devices are sensitive to high currents, resistors are employed to restrict a correct flow of current through them. The values of these resistors are dimensioned by calculating them using various formulas. The following examples will clearly explain regarding how basic electronic circuits are designed: As shown in the figure, the trigger voltage which is generally received from an IC output or some other similar source is applied to R1. The received current is correctly optimized through R1 and is used to bias the transistor T1 so that it may conduct and light up the LED connected to its collector arm. As explained above, resistor R2 has been incorporated to safeguard the LED from excessive currents. The value of R2 is calculated using the following formula: The value of R1 may be achieved using the following formula: The LED in the circuit may be easily replaced by a relay, in case it becomes necessary to switch heavy loads at the output. The base resistor value then may also be calculated appropriately using the above formula. Sometimes we may find the source voltage to R1 too small and difficult for T1 to sense. During such conditions an interesting modification can be introduced by conjugating another transistor with T1 as shown in the adjoining figure. This configuration is termed as a Darlington pair. Here the received weak signals are amplified to a suitable level by the first transistor and applied to the base of the next transistor which amplifies it sufficiently to energize the collector load. It is another indispensable passive electronic component and inevitably finds a place in almost all electronic circuits. They are basically used to block DC and allow AC but may also find important applications in producing time delays, suppressing or filtering noise.. If a capacitor is linked with the above circuit, interesting results are obtained. The two adjoining figures may be explained respectively as follows: In the first fig. T1 continues to conduct for quite some time even after the trigger voltage is cut OFF due to the charge stored inside C1, indicating how a capacitor is used in producing time delays. The second circuit indicates how a capacitor can be used to produce a momentary pulse so that on receiving a base voltage the transistor and its collector load is switched ON only for an instant and then switched OFF. Here the trigger signal is allowed to pass instantaneously only during the charging process of C1 and inhibits its flow once C1 gets fully charged. Well, I can just go on and on without ending as the topic of electronic basic circuit theory can be infinitely long. But for the time being, I will have to conclude here. Please let me know through your comments comments need moderation, may take time to appear.

Chapter 7 : Circuit Theory/Circuit Basics - Wikibooks, open books for an open world

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Chapter 8 : What is Alternating Current (AC)? | Basic AC Theory | Electronics Textbook

What is Basic Electronic Circuit Theory? In simple terms, electronics may be understood as a branch of science that utilizes and controls the flow of electrons through specially designed networks of active and passive devices to produce a desired result.