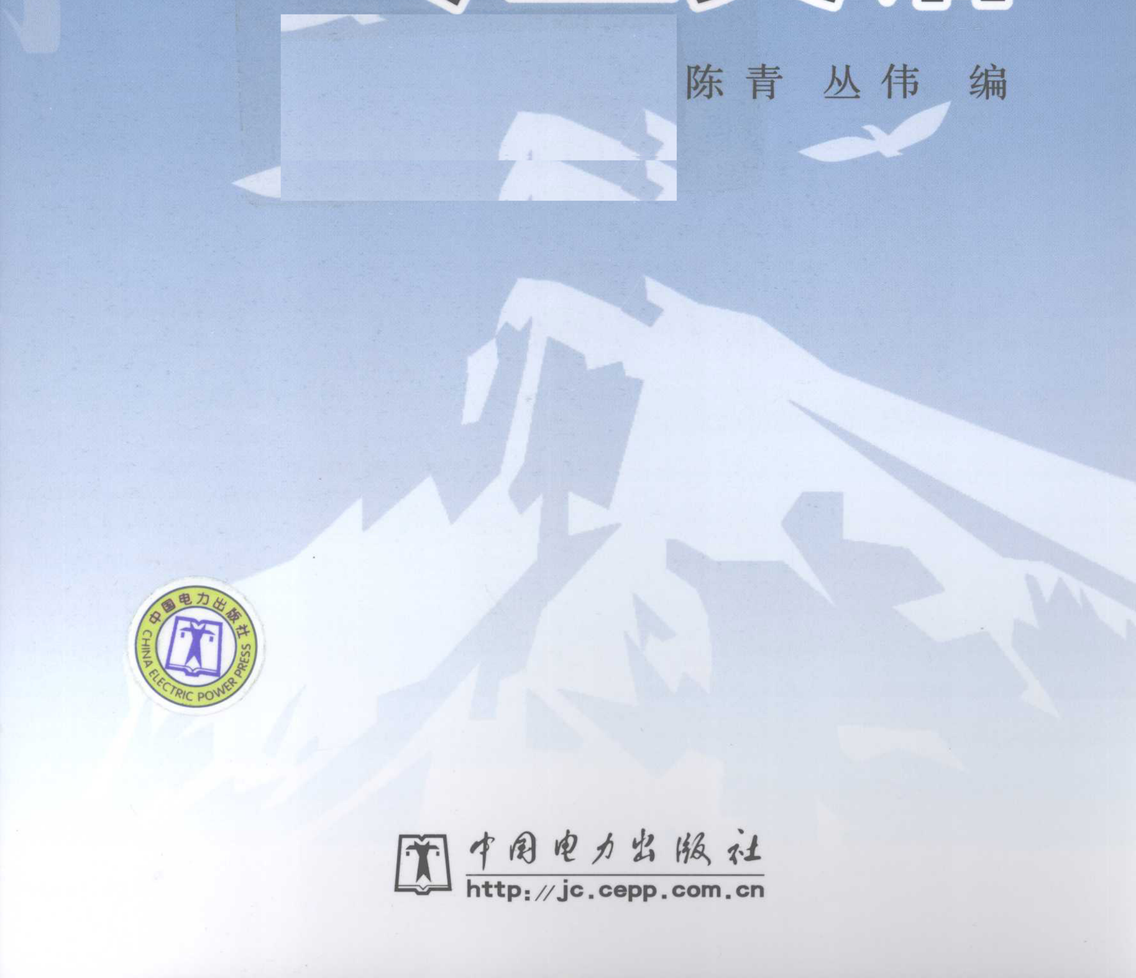
普通高等教育“十一五”规划教材
PUTONG GAODENG JIAOYU SHIYIWU GUIHUA JIAOCAI

DIANQI GONGCHENG
ZHUANYE YINGYU

电气工程专业英语

陈青 丛伟 编



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前　言

为贯彻落实教育部《关于进一步加强高等学校本科教学工作的若干意见》和《教育部关于以就业为导向深化高等职业教育改革的若干意见》的精神，加强教材建设，确保教材质量，中国电力教育协会组织制订了普通高等教育"十一五"教材规划。该规划强调适应不同层次、不同类型院校，满足学科发展和人才培养的需求，坚持专业基础课教材与教学急需的专业教材并重、新编与修订相结合。本书为新编教材。

本书为普通高等教育"十一五"规划教材，根据教育部新颁布专业目录中"电气工程及其自动化专业"的宽口径特点而编写。

本书分为6个单元，所选文章内容不仅包括了电磁场理论、电路、电子技术、微机原理等专业基础课程的内容，还包含了电机学、电力电子、电力系统运行与分析等电气工程方向专业课程的内容，除此之外，单独设置了一个单元介绍电力系统新技术之一——分布式发电技术。本书充分考虑了专业英语的课程特点，为满足教学需要，用一个单元的篇幅对专业英语的阅读翻译与写作方法进行了讨论，旨在进一步提高读者的阅读、翻译和写作技巧。本书还对常用的电气工程类英语词汇、短语进行了总结归纳，方便了读者的查阅和使用。

本书在选材和内容的设置上突出了"覆盖面广、实用性强、内容丰富、难易结合"的特点，注重基础英语与专业英语相衔接，适应课程内容改革的需要。本书主要作为普通高等学校电气工程及其自动化专业的本科和硕士研究生专业英语教材，也可作为高职高专电气技术类专业的专业英语教材，亦可作为相关工程技术人员学习专业英语的参考用书。

本书由山东大学陈青教授、丛伟副教授编写。承蒙华北电力大学冯俊宝副教授百忙中对本书进行审阅，并提出了很多有价值的修改意见；硕士研究生邢鲁华、付兆远、丁羽在资料整理、校对过程中做了大量的工作，在此一并表示衷心的感谢！

由于时间仓促、编者水平所限，书中难免存在疏漏和有误之处，敬请读者不吝指教，以共同提高本书的质量。

编　者
2009年9月

目 录

Unit 1 Basic Theory for Electrical Engineering

1.1 Electricity and Electromagnetic

1.1.1 What Electricity Is

To most people electricity is a rather mysterious thing, perhaps because it is a silent-and invisible-almost a secret-agent which we do not know in the direct way we know things that we can see and touch. But every one of the many thousands of different materials in the world contains hidden electricity. All materials are made from different simple substances[1] called ‘elements’. Some materials, for instance, copper, iron, carbon, and oxygen and hydrogen gases, contain only one kind of element. Water contains two kinds-hydrogen and oxygen; sugar contains three-carbon, hydrogen, and oxygen; only a few substances contain more than five or six different elements.

If we were to take a piece of carbon and cut it into smaller and smaller pieces, we should soon have to stop because the pieces would be too small for any knife to cut. Even if we imagine a knife sharp enough to carry on cutting, we should finally have to stop when the carbon was divided into the smallest possible pieces, called atoms. When an atom of carbon is itself split[2], the pieces are no longer pieces of carbon but the extremely small particles[3] of which the carbon atom-and, indeed, all atoms-are made. The most important of these particles are the electrons.

Electricity, then, is an important part of all substances. Usually, equal amounts of positive and negative electricity are present and cancel each other's effect, and so we do not notice that any electricity is there at all. But when the positive and negative parts are separated in some way, we see their effects and recognize that electricity is present. When, for instance, an ebonite[4] fountain pen[5] is rubbed[6] with a silk handkerchief, some of the atoms in the silk have one or two of their electrons knocked off. The loose electrons collect on the pen so that it has a surplus[7] of electrons, and consequently a surplus of negative electricity—that is, a negative electric charge. The silk, having lost some electrons, has a surplus of positive electricity. Electricity is not being created in this process, it is merely being moved from one place to another; and this is what usually happens in electrical work.

The outer electrons of the atoms in a metal wire are continually moving from one atom to another and back again. When an electric current flows through the wire, these electrons also drift slowly along the wire, passing on from atom to atom. The separate electrons travel only slowly along the wire, passing on from atom to atom. The separate electrons travel only slowly along the wire, at about one inch a minute, but they all start to move together immediately the electric circuit is complete. The number of electrons in the stream is usually very large: for instance, in an ordinary electric-torch bulb[8] about two million, million, million electrons pass through the bulb each second.

The electric current in a wire is usually said to flow from the positive to the negative electrodes of the battery, which is opposite to the way in which the electrons move. The direction of the current was decided before electrons were discovered. It was unlucky that the wrong direction was chosen, but for most purposes it does not matter, as we think simply of an electric current, without needing to consider it as a stream of electrons.

New Words

[1]	substance	*n* 物质;要旨;本体
[2]	split	*vt & vi* (使) 裂开;(使) 破裂
[3]	particle	*n* 微粒,颗粒,【物】粒子
[4]	ebonite	*n* 硬橡胶
[5]	fountain pen	*n* 钢笔
[6]	rub	*vt* 擦;搓;揉;*vt & vi* 接触;摩擦
[7]	surplus	*adj* 过剩的;*n* 过剩
[8]	bulb	*n* 电灯泡

1.1.2 Faraday's Law of Electromagnetic Induction

Michael Faraday (1791-1867) distinguished himself as an outstanding experimentalist.

In 1820, the whole scientific world was excited over the discovery by Hans Christian Oersted that a current carrying wire could be made to deflect[1] a freely suspended magnet. Faraday repeated Oersted's experiment and then went further to show that not only was it possible for a magnet to move round a current-carrying wire but also for a current-carrying wire to move round a magnet. The reason for the phenomena, however, remained a mystery. This mystery further deepened when in 1825 Andre M. Ampere demonstrated that a force also existed between two current-carrying wires. Although Oersted and Ampere both kept searching for the answer in the conductor or the magnet, Faraday did not. Rather he conceived the forces to be due to tension in the medium in which the conductors and/or magnets were placed. As a matter of fact it was this attitude which led Faraday to introduce the concept of lines of force. Since he was not a mathematician, he used descriptions which enhanced visualization.

In 1831 Faraday showed that electricity could be produced from magnetism. He demonstrated that induced currents could be made to flow in a circuit whenever ①current in a neighboring circuit is established or interrupted, ②a magnet is brought near a closed circuit, and ③a closed circuit is moved about in the presence of a magnet or other closed current-carrying circuits.

Faraday was a disciplined and meticulous[2] experimenter who kept careful and complete records of his laboratory work. From these descriptions it has been possible to formulate Faraday's law of induction mathematically as follows

$$e = -\frac{\mathrm{d}\lambda}{\mathrm{d}t} \tag{1-1}$$

The quantity e denotes[3] the electromotive force induced in a closed circuit having a flux linkage of λ weber-turns. The negative sign is due to Emil lenz, who subsequent to Faraday's experiments pointed out that the direction of the induced current is always such as to oppose the action that produced it . This reaction is commonly called Lenz's law.

Faraday's law is One of the two basic relationships upon which the entire theory of electromagnetic and electromechanical energy conversion devices is based. In fact, soon after Faraday's work of genius was published in 1831 explanations were at last possible for the phenomena observed by Oersted, Ampere, and other experimenters. The foundation was now established to facilitate the ensuing rapid development of electric motors and generators.

Faraday was also the first experimenter to identify the emf of self-induction which manifested[4] itself whenever circuits carrying current in long wires or circuits wound with many turns were disconnected. The American inventor Joseph Henry also independently discovered the current of self-induction but not before Faraday. Both experimenters were able to demonstrate that a changing current produced an emf of self-induction in a coil of wire which varied directly with the time rate of change of current.

New Words

[1] deflect	*vt & vi*	(使)偏斜,(使)偏离,(使)转向
[2] meticulous	*adj*	极仔细的,一丝不苟的
[3] denote	*vt*	为……的符号;为……的名称;指示;指出
[4] manifest	*vt*	清楚表示,显露;*adj* 明显的

1.1.3 Magnetic Field

1. The Magnetic Field

Before Faraday, the interaction between magnets, between currents, and between currents and magnets were thought of as forces of action-at-a-distance type. But we now think of them as acting through the medium of a magnetic field. The magnetic field is a form of matter. The concept of the magnetic field is embodied in the following two points:

(1) A moving charge (or a current, or a magnet) sets up a magnetic field in the space around it.

(2) The magnetic field is capable of exerting[1] a magnetic force on any moving charge (or

a current, or a magnet) placed in it.

A line of distinction should be drawn between an electric field and a magnetic field: An electric field exists around an electric charge, whether it is moving or not, but a magnetic field exists only around a moving charge. An electric force is exerted on a charge, whether it is moving or not, but a magnetic force is exerted on a moving charge only.

Between two moving charges there are electric forces as well as magnetic forces.

2. Magnetic Induction

Analogous to the electric field intensity, the magnetic induction B, sometimes called magnetic flux density, is used to describe the strength and direction of the magnetic field. We would like to call B the intensity of magnetic field, by analogy with the name for E, but for historical reasons, that name has been preempted for another quantity.

In order to explore a magnetic field, we should use a test object which is sensitive to the field. Any one of the following can be used as a test object: a moving charge, segment of a current-carrying conductor, a small current-carrying coil, or a compass[2] needle, With different test objects, different definitions for B are used accordingly.

Since B is a vector[3] quantity, we should define its magnitude as well as its direction. For convenience of description, its direction will be defined first, while its magnitude will be defined in subsection 4.

3. Direction of the Magnetic Field

Among the various test objects mentioned above, a small magnetic needle is the most convenient one for exploring the magnetic field with a view to defining the direction of B vector. The fact that a compass needle aligns[4] itself in the north-south direction in the earth's magnetic field in-plies[5] that the earth's magnetic field has its direction. Likewise, if small magnetic needles are placed around a magnet, we see every needle aligns itself in a specific direction characteristics of that point at which the center of the needle is placed, as shown in Figure 1-1. Strictly speaking, this direction characterizes the resultant of the magnetic field due to the earth and that due to the magnet. Fortunately the earth's magnetic field is so much weaker than the field in the vicinity[6] of an ordinary magnet that the direction of the needle is almost entirely determined by the field due to the latter.

We define the direction of the magnetic field, or the direction of B vector, as the direction which the north pole of a small magnetic needle will indicate if placed in the field.

Now let us study, in terms of mechanics, how the needle can align itself in the direction of the field. If the needle was initially not aligned with the

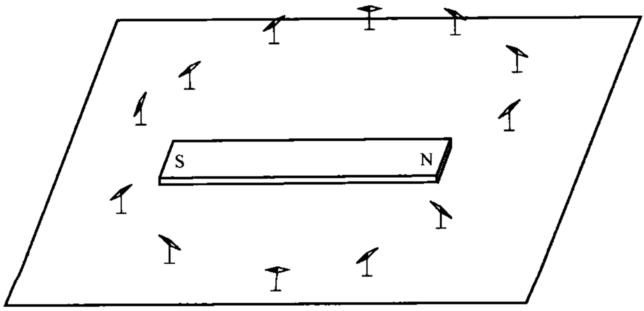

Figure 1-1 Direction characterizes of magnetic field

field, there must have been a couple acting on the needle so as to make it rotate. In the final equilibrium position, the couple must vanish[7]. We reason that the couple is composed of a magnetic force F_1 acting on the north pole in the direction of B, and another force F_2 acting on the south pole in the opposite direction[Figure 1-2(a)], although we cannot test the forces individually, because a single pole does not exist. The rotation goes on until the needle is aligned with the field, in which position the two forces act in the same line and the couple vanishes [Figure 1-2(b)].

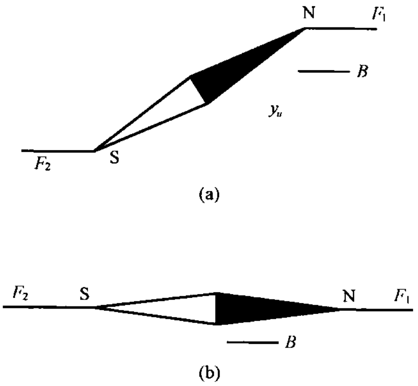

Figure 1-2 Magnetic force on single pole

4. The Magnitude of B

We use a small segment of a current-carrying straight wire as our test object to explore the magnetic field with a view to defining the magnitude of B. Let the current be I and the length of the segment be L. This length must be so small that it practically measures the situation at a point. First, it is found that the same current segment, placed at the same point in a magnetic field, will receive different forces (different in magnitude as well in direction) when differently orientated.

(1) When the current is parallel or antiparallel to the field, it experiences no force at all.

(2) When the current makes an angle with the field the force varies with the angle.

(3) When the current is perpendicular[8] to the field, the force on it is a maximum. It is therefore obvious that B can only be defined in terms of the maximum force.

Second, the maximum force $F_{\max}$ is found to be directly proportional not only to I, but also to L, that is, proportional to the product of I and L. When the same current segment is moved from place to place in a magnetic field, the maximum force generally varies. Thus we define the magnitude of the magnetic induction B as the ratio of the maximum force on a current segment to the product IL of that segment, or

$$B = \frac{F_{\max}}{IL} \tag{1-2}$$

It is obvious that B so defined characterise the field and is independent of the current segment.

The unit of the magnetic induction is the tesla (T) which equals N/(A · m).

New Words

[1]	exert	vt	用(力);尽(力):运用,发挥,施加
[2]	compass	n	罗盘,指南针;圆规;界限
[3]	vector	n	矢量,向量

[4] align	*vt*	使成一线
[5] in-pile	*n*	反应堆内部
[6] vicinity	*n*	近,接近,密切;附近,邻近
[7] vanish	*vi*	消失;绝迹
[8] perpendicular	*adj*	垂直的;直立的

1.2 Engineering Circuit Analysis

1.2.1 Inductance and Capacitance

We should take into consideration both resistance and capacity, inductance is an important property to influence the flow of current in an electric circuit. We shall turn our whole attention to inductance here.

An electric current acts in that very way, that is to say ,it takes time to start and once started it takes time to stop. The factor of the circuit to make it act like that is its inductance.

In its effect, inductance may be also compared to the inertia of water flowing in a pipe.

In any case, inductance is a property which opposes the flow of current as resistance does but in a different manner. By virtue of varying the current which passes through the circuit containing inductance an e. m. f. is induced in this circuit. The e. m. f. known as an induced e. m. f. impedes any change of current magnitude. The inductance of a circuit is, therefore, of importance only where the current is changing. It goes without saying that a steady direct current has no inductive effect.

When an alternating current flows through a circuit that has inductance, the induced electromotive force and the current do not move along evenly together, that is, in phase. but the induced electromotive force does lag behind the current, and this is called phase lag. The induced electromotive force lags and the current leads.

We know an alternating current to be continuously changing by rising, falling, changing direction, and by rising and falling in the opposite direction. So one would expect an alternating current to be greatly affected by presence of all inductance coil in the circuit, and such, indeed, is the case.

Electrical energy can be stored in two metal plates separated by an insulating medium. Such a device is called a condenser, and its ability to store electrical energy is termed capacitance.

Just as inductance is an important characteristics for circuits with alternating current in a coil of wire, capacitance is a similar but opposite characteristic that is important with alternating voltage across an insulator or a dielectric.

Any combination of conductors and insulators that is capable of storing electric charge is a capacitor; moreover, its ability to do so depends on the surface area of the conductors and, what is more important, the kind of material and thickness of the insulating material. The latter called the dielectric not only will determine how much charge can be stored on each unit of area of the metallic surfaces but will indicate what maximum voltage can be applied to the capacitor before breakdown occurs. Furthermore, the shape, thickness or kind of terminal plates used in the construction of the capacitor has no particular significance so long as they make good contact with the dielectric.

No chemical changes are involved in this process, and the charge acquired by condenser is due to a displacement current which flows when a potential difference is applied to the plates.

It has been stated earlier that when a dielectric is subjected to an electrical strain a movement of electrons occurs within it, but no actual electron flow occurs. A displacement of electrons in the circuit does occur. However. for the plate which is connected to the negative pole of the source of e. m. f. gains electrons, and the plate which is connected to the positive pole loses electrons. Now the electrons which have been driven on to the negative plate are trying to get back to the positive plate, but cannot do so because of the e. m. f. which is applied to the plates. They cannot pass through the dielectric because of its insulating properties, so if the applied e. m. f. is removed the plates will still remain charged up-until a conducting path is provided between the plates, when the condenser wilt discharge.

1.2.2 Circuit Analysis

Electronic circuit consist of an aggregation[1] of electrically and or magnetically connected building blocks. Each block has two or more electrical connections. The junctions of two or more electrically connected components are termed nodes of the network. Voltages within the network will be measured as differences in voltage between these nodes. Currents leaving the nodes, the branch currents, will flow through circuit components thus generating the voltage differences between the nodes to which the components are connected. The intent of this paper is to present methods and procedures for the analysis of networks made up of practical components. Such components are the familiar two-terminal devices (resistors, capacitors, inductors, diodes, voltage, sources, and current sources) three-terminal devices (transistors) and multiple-terminal devices (transformers). In the absence of a power source, be it a signal input source or the familiar DC power supply, networks of these elements will have no currents flowing, thus having no voltage differences between the various nodes.

The subject of this paper is the calculation of voltages and currents in electronic networks subject to input excitations and the calculation of other closely related problems. These calculations we refer to as the analysis of the nework. We note that circuits need to be analyzed only in order to derive information about the network so that its predicted behavior can be verified or when changes to the network are to be made.

The vast majority of analysis tasks arise from the need of designers to verify their conceived designs or to predict the effects of changes in a circuit. We note that the analysis task starts with a mathematical model of the network that was chosen by the analyst to represent the behavior of the actual network. In no case can the computed results give solutions that exceed the accuracy of the approximation used in choosing the mathematical model. For example, a wire-wound resistor may be treated as having only resistance, while the inductive and capacitive effects could well dominate the behavior under some operating conditions(such as at high frequencies). It is engineering practice to think of electronic circuits normally as containing lumped[2] parameter components that obey some simple voltage—current characteristic. This characteristic is often an equation, for example, Ohm's law for resistors. These characteristics or characteristic equations are based on observed behavior in which the finite speed of propagation of the electromagnetic energy becomes negligible, i. e. the components become infinitesimally[3] small compared with the wavelengths involved.

The environment in which circuit analysis exists is diagrammed in Figure 1-3, a flowchart of the circuit design task. It is assumed for now that a large number of copies of the circuit must be made. The need for the circuit is usually perceived as a problem for whose solution many different alternatives may exist. Since the cost, reliability, size, and speed of electronic components has improved steadily over the years with respect to other mechanization, an increasing share of the problems is being solved by electronic means. The methods to be developed in this paper are of direct use in the methods of CAA; however, they can also be employed in areas of mechanical, thermal, fluidic, and other analyses. Normally, an electric analog is constructed and then the analog is analyzed directly. This procedure is used in setting up analog computer solutions to non-electrical problem. Here we merely point out that an electric analog can be analyzed digitally with great ease and often with greater convenience than the process needed for direct analog solutions.

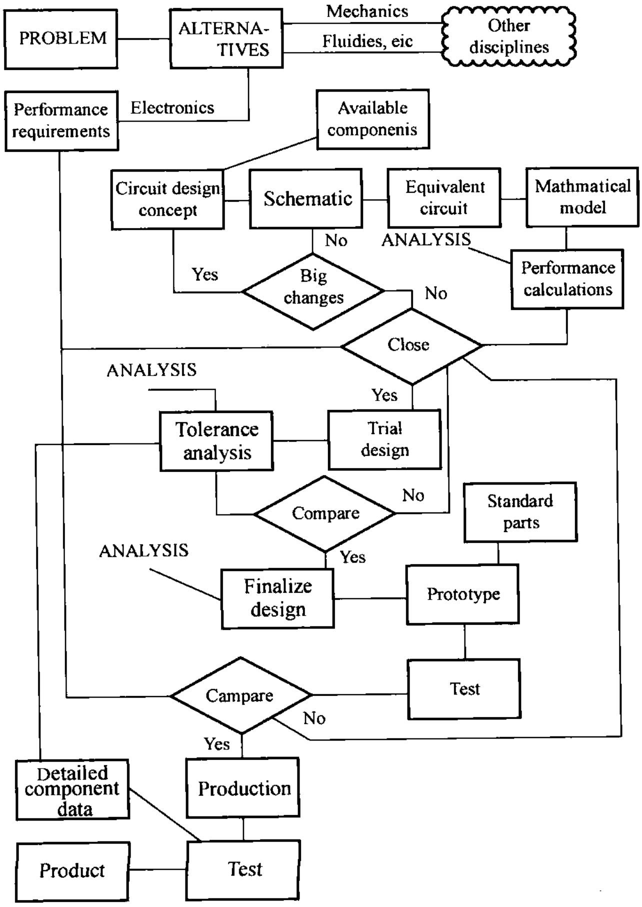

Figure 1-3 Circuit Design Task

When an electronic solution is contemplated, performance requirements are formulated which the designed item must satisfy. These requirements are taken by a designer in formulating a circuit, first as a concept, then as a schematic. The schematic usually is, at this stage in the design, a rather crude sketch; typically, the designer has already made some data may become available for the component data base so that subsequent analyses may benefit from the earlier measured component variations.

For lower—volume production items, the process to be used is obviously less elaborate[4] with many steps in Figure 1-3 either omitted or coalesced[5] into a few steps. However, the analysis task throughout the design remains the prediction of circuit behavior of a known set of interconnected components to specified inputs. The analyst must be prepared to cast a circuit diagram into quantified form and perform a series of mathematical operations. He must be able to relate his results to a set of performance criteria. Since the analyst and the designer usually is the same person, the design analysis cycle can not easily be dichotomized[6]. The most convenient arrangement is to let the designer analyst work an interactive computer system and obtain an optimized solution by trial and refinement[7].

We note that although analysis does not have much application, it is, nevertheless, an integral part of design. Successful analysis procedures must therefore be judged by their applicability ease of use, and receivable to the design cycle. the discussion presented here indicated briefly the areas of competence that an analyst should possess: firm foundation in linear circuit theory, a knowledge of modeling, optimization, statistics, and computer procedures.

Simple performance calculations in order to arrive at his circuit configuration. Detailed analysis of this conceptual design can begin with the establishment of a mathematical model for the circuit. It is at this point that the procedures developed in this paper can be applied for the first time in the design cycle.

The results of the performance calculations are examined and compared with the performance requirements. Usually discrepancies[8] will exist between these. If the differences are small, an adjustment of the circuit parameters may suffice in order to make the response conform to the specifications. For large discrepancies, changes in the circuit topology might be necessary as a different type of circuit might be required. In either case, a number of trials are usually necessary before an acceptable circuit is conceived. In this phase, relatively coarse data is used, simple mathematical models are the rule, and often only back-of-an-envelope type calculations are made. However, as circuits become more complex, even at this stage of the design cycle, a regular circuit analysis program can be used to advantage. It is not clear whether or not simple models that neglect much of the characteristic behavior of devices are beneficial to the understanding of the circuit action, rather, even at this early stage in the design, automated analysis techniques can give more accurate pictures of circuit actions.

Once a circuit is decided upon, detailed analysis of the circuit responses and detailed calculations of the effects of component variations must be made. The analysis may show unacceptable responses or unacceptable behavior of the circuit. Further modifications of the trial circuit may have to be made and a detailed re-analysis may be necessary. Occasionally the conceptual circuit may have to be replaced and a different circuit may be called for. In this latter case, the conceptual design steps must be repeated.

In this phase of the analyst's task much information is needed about the nature of the variations of the network components. Often such information is scanty or non-existent, in which case assumptions must be made. These assumptions must correctly describe the component variations of the elements from which the circuit is to be built. On many occasions a change in suppliers might result in radical changes in the component value distributions and the actual circuit might behave quite differently from what was expected. The discrepancies would typically be in the variations of the performance functions rather than in their nominal values. Good design practice dictates[9], however, that the circuit performance be affected only to a small degree by the parameter variations so that a good design normally will result in a very easy analysis task.

When an acceptable circuit has has been achieved through these trials[10] and analyses, the final design item is built and tested. This prototype[11] is checked against the original performance requirements. Again, if discrepancies are discovered, earlier design steps may have to be repeated. Due consideration must be given to the actual circuit component values used in comparison with the allowable variations on the component values. An acceptable prototype will then be put into production. As the final production items are checked out, now.

New Words

[1]	aggregation	*n*	集合,集合体
[2]	lumped	*adj*	集中,集总的
[3]	infinitesimal	*adj*	极微小的
[4]	elaborate	*vi*	详尽说明;*vt* 详细制定;*adj* 复杂的,精心制作的
[5]	coalesce	*vi*	联合,合并
[6]	dichotomize	*vt&vi*	对分,二分
[7]	refinement	*n*	细微的改变
[8]	discrepancy	*n*	差异;不一致之处
[9]	dictate	*vt & vi*	大声讲,口授;*vt* 指示,指令;*n* 命令,要求
[10]	trial	*n*	审理;测试(事物),忧虑(麻烦)的原因
[11]	prototype	*n*	原型,蓝本

1.3 Electronics and Automation

1.3.1 Logic Devices

All digital or logic circuits are based upon a branch of mathematics discovered by George