types of electric-power machines used general electromechanical converter matrix, typical patterns — double-wound transformer in transient regimes, direct-current starts, single-phase synchronous generator in instantaneous short circuit, induction transient regimes (computer-aided tests).

Mathematical models of electric-power machines with lumped parameters (40 e application of the equation systems with magnetic flux linkage derivatives and arrest ones, matrices of static and dynamic varied inductances, the methods of circuit saturation registration, typical patterns — direct-current generator in self-implant-pole synchronous generator in asymmetry short-circuit, synchronous in different continuous duties, induction motor in different continuous duties — computer-aided tests) (MS-DOS) for practical training (menus: theory, practice tasks, ting etc. are presented in Russian and in English. The computer — aided test on al simulation of implicit — pole synchronous generator in asymmetry short circuit s a detailed example.

4. COMPUTER- AIDED TEST

A digital model can be used for transient analysis of an isolated two-phase generator operating in sudden asymmetrical short-circuits. It is supposed that the disturbances are absent. The rotational speed is assumed to be constant as well.

Mathematical simulation of the synchronous generator in sudden asymmetrical short-circuits in the reciprocal moving reference frame. To obtain the differential of the synchronous generator the differential equations of the general canonical converter in matrix form are used.

The static and dynamic inductances are calculated using flux path saturation curves. It simplified that saturation curves of main flux path and leakage flux path must be studied analytically.

Step of numerical integrating the differential equations containing the time rates of flux linkages the currents are obtained by iterative computing the non-linear set of magnetic connection equations.

he developed mathematical model one can predict the influence of generators on asymmetrical transients (one phase is being closed when flux leakage maximum phase is open). Special attention must be paid to investigating the flash on and overvoltage phenomenon.

its system with basis nominal static saturated mutual inductance is recommended parameters and initial field current of synchronous generator are initial data for the al simulation.

LINKING CIRCUIT ANALYSIS AND FIELD CALCULATIONS IN ELECTRICAL ENGINEERING TEACHING.

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Abstract: Classical electrical engineering teaching devotes a lot of time to circuit analysis. In recent years the importance of numerical field analysis has grown. The subject of CAD in electromagnetism has been introduced in different basic courses on electricity. The students often regard both topics to be separate treatments of similar subjects. Using different practical applications, it is shown how both techniques may be linked, leaving the student with a system approach, rather than an idea of two calculation techniques. Three simple examples are given to illustrate this approach, treating all passive elements of circuits. The first is a parallel plate capacitor. The link between the internal electric field, the material characteristics and the dimensions is shown, as is the importance of the skin effect. The second example deals with the analysis of a iron cored coil containing an air gap. Here special attention is paid to the influence of saturation on the behaviour and on the importance of the correct definition of the global quantities at the inductance in a non-linear system. As a last example resistances are discussed, both in inductive and in ac systems. In the latter case, the influence of the skin effect is important.

1. INTRODUCTIONS

Classical electrical engineering teaching devotes a lot of time to circuit analysis [1,2,3]. The parameters of common circuit elements are inductance L, capacitance C and resistance R. Analytical, often very simplifying formulae are used to link the parameters with the physical dimensions of the components. Material parameters are supposed to be homogeneous, constant and linear. The geometry is reduced to its elementary proportions and no details are provided.

In order to overcome these assumptions and limitations, numerical field analysis techniques are used in combination with Computer Aided Design methods at the input and the output [4,5,6]. They allow the detailed calculation of the electric field strength and the magnetic flux density, accounting for the correct material characteristics and the exact geometry. However, a link with circuit components is seldom available. The link with circuit theory is not provided and in some universities both approaches to this problem (circuits and fields) are taught in different courses. Students do not understand the links and have the impression that the same subject is treated twice.

In order to overcome this discrepancy between circuits and fields, a general approach is developed in which the students are confronted with the components in both ways and where they are shown how both approaches may be linked.

2. CAPACITANCE

The capacitance of a parallel plate capacitor is given by

\[ C = \frac{\varepsilon_0 A}{d} \]
\[ w_e = \frac{CU^2}{2} = \int w_e dV = \int \frac{\varepsilon E^2}{2} dV \] (2)

Capacitance as a function of the distance is shown on Fig. 2. The top curve is the analytical. The higher the distance, the more important the influence of the leakage around the wire and thus the more both curves diverge.

Fig. 3 Flux lines of the coil with an air gap of 3 cm

Fig. 4 Analytical and numerically obtained value for the coil

4. RESISTANCE

The dc resistance is defined as the voltage drop along a conductor when a given current is passing through it. However, problems occur when the current density changes along the resistor's length due to the non-uniformity of the cross section. Such a situation occurs in so-called trimming resistances. The equipotential lines, that are perpendicular to the current density, are shown on fig. 5, while the resistance as a function of the depth of the cut is given in fig. 6. Clearly, it is not possible to have a reasonable analytical approach to this situation. The relation between resistance value and depth of the cut is far from linear.

Fig. 5 Current density lines in a trimming resistance

If a solid conductor is supplied with an ac current, the current density is not evenly distributed over its surface. Due to skin effect, the current density is higher at the surface. This increases the overall resistance and decreases the inductance. If the return conductor is close, the proximity effect is important: the symmetrical distribution of the current density is no longer valid, which may yield an increase or decrease of resistance or inductance. The link between both parameters, resistance and inductance is given by the
ium of active and reactive power:

\[ P = RI^2 \quad Q = \omega LI^2 \]  (5)

Fig. 7 Resistance (left) and inductance (right) as a function of the frequency

5. CONCLUSIONS

A finite element solution coupled with CAD techniques at input and output is a very powerful analysis tool in modern electromagnetics. However, students are trained in circuit design. The extraction of the global parameters from the solution yields the een bop approaches. In this way, the students get the impression to be faced with an solution to one problem: how to obtain the global parameters out of the geometry of a other than two separate approaches to one problem, i.e., the circuit parameters at the and the field solution at the other.

6. ACKNOWLEDGEMENTS

ors are grateful to the Belgian NFWO "Nahtal Fonds voor Wetenschappelijk k" for its financial support of this work and the Belgian Ministry of Scientific for granting the project IUAP No.51 on electromagnetic fields.

7. REFERENCES


EVALUATION OF FIRST YEAR STUDENTS’ UNDERSTANDING OF SIMPLE ELECTRIC CIRCUITS

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Abstract: This paper reports an investigation of the performance of first year students in the Electrical and Computer Engineering Department. The diagnostic test was administered to a sample of 80 students at the beginning and at the end of the course on Introduction to Electrical Measurements. The aim of the research was the evaluation of the students' knowledge about the circuits at the entry level and the assimilation of the course at the final stage of the lecture. Furthermore an attempt was made for the evaluation of their understanding of simple circuit's performance, their ability to make correct predictions about measurements and the distinction between theoretical and an actual model of the circuits.

1. INTRODUCTION

Before commencing with Network Analysis, students attend an introductory course on measuring instruments (multimeter, oscilloscope, function generator, DC- and AC-signals) and basic measuring circuits and methods. The course of the Introduction to Electrical Measurements of the Electrical and Computer Engineering curriculum incorporates classes and mainly laboratory introductory experience for first semester students. The main purpose is the familiarization of the students with the basic electrical instruments and the revision of their basic knowledge about electricity. Every year about 100 students attend the course, which consists of three parts that run in parallel: lecturing, tutoring on next lab and labs.

The course was introduced at an application oriented level a few years ago, and then repeatedly revisited with successively greater levels of detail and theoretical sophistication. Each revision was the result of study department's needs, the students' performance in oral examinations and the evaluation of a number of surveys. The results of a such survey are discussed in this report.

Similar work has been reported in recent years on students' understanding of ideas about simple electric circuits. A large scale survey of students' ability with electricity has been carried out by the Assessment of Performance Unit in five European countries [1]. Related papers also report on the findings of similar study to investigate student's, at age of 15, understanding of the behavior of simple circuits consisting of two resistors connected in series and the potential divider [2] and questions dealing with parallel circuits [3]. Papers [4] and [5] are referred to similar attempts for improvement in laboratory, first courses in Electrical Engineering.

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