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The design and development of interactive Web pages using the HTML editor for computer-based comprehensive self-study procedures in basic electrical engineering

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ABSTRACT: Computer-assisted instructions play an important role in the process of educating modern engineers. However, comprehensive research is required to determine the best methodology to be applied to the design and development of computer-assisted instructions, as well as the efficiency of the teaching/learning processes based on this particular method of instruction. In order to design and investigate the effectiveness of computer-based comprehensive self-study procedures in basic electrical engineering, the first step is to develop a library of suitable software. Before developing authoring tools in this context, it is envisaged to develop libraries of suitable software that can be implemented in further designing the process to accelerate the design and development of the project. The paper gives a brief outline of the developed library functions and suitable authoring systems using texts, diagrams, equations and animations, which will be used to convert them into the relevant software, as well as an overview of the methodology used in the development of a set of instructions with illustrations. It also outlines the development of the essential HTML pages for Java applets. A future development is an online tutoring system, which will be developed using Java.

INTRODUCTION

One of the very important changes to engineering education in the late 1980s was the increasing use of computers in the teaching/learning process, especially in the engineering discipline. Much custom-made, purpose-specific educational software were developed, mostly with very limited financial resources available for this purpose. Most of those products may be characterised as very simple, showing the lack of knowledge of modern instruction design. They were predominantly based on custom-made authoring tools that did not utilise the full potential of the available computer technology [1].

Since its inception in 1990, the World Wide Web (WWW or Web) has quickly emerged as a powerful new tool for connecting people and information on a global scale [2]. Its impact on engineering and technology education is very difficult to predict, but the delivery of instruction is changing as a result of the Web.

There is a need to develop effective techniques and suitable teaching materials in conjunction with technological change. It has been observed that there is a gap between the concepts and principles learnt in lectures and their application in the practical part of a course.

In this paper, the authors seek to describe and demonstrate the development of interactive Web pages using a HTML editor such as Adobe *PageMill*. This material will then be used to develop a powerful tool for online tutoring in the subject of basic electrical engineering using Java. In the case of computer-assisted instructions, designing a powerful and flexible authoring system is one of the essential and important elements of any learning tool.

COMPUTER-ASSISTED INSTRUCTIONS

Educational research on the effectiveness of computer-based education has so far been limited in scope and somewhat fragmented. Nevertheless, it has been found that the computer-assisted instruction method has many advantages in teaching-learning processes, including the following:

- Learners can progress at their own rate and pace.
- Learners can have more individual considerations.
- Immediate feedback is available.
- Visualisation is properly increased.
- Remedial teaching is eliminated and the problem of discontinuance of learning is avoided.
- A dipper analysis of transfer phenomena is permitted and facilitated.
- An opportunity for the introduction of more effective methods for testing in the teaching/learning process is provided.
- Qualitative and quantitative analyses of student achievements are facilitated.
- An access to supplementary material through links is provided [3].

TEACHING BASIC ELECTRICAL ENGINEERING

When students begin their studies of electrical circuit theory, they may experience a certain amount of difficulty. To succeed in electrical engineering, one needs to achieve a certain level of comprehension of the physical phenomena, basic concepts and principles, and also understand how to utilise them in practice [4].

In fact, the conversion of teaching material into teaching instructions is the key factor in designing the process of

computer-assisted instructions. By adopting a comprehensive authoring program such as Java script, it may be possible to convert certain courseware into computer software in the form of teaching algorithms. Work has been in progress on the conversion of the book titled *Basic Electrical Engineering: Laboratory and Tutorial Procedures* and also *Lecture Notes*, both written by Z.J. Pudlowski, into computer software.

OBJECTIVES

The use of computer technology has become an extremely important aspect in the teaching of engineering concepts and principles in the undergraduate curriculum. The application of automated laboratory instructions for undergraduate students is an important alternative that should be considered. Engineering undergraduates need to be prepared for the increasing use of technology in their future workplaces. Hence, by exposing the students to the use of computers in laboratory instructions and, in particular, data acquisition, they will become familiar with the technology and its practical applications [5].

The main objective of this project is to carry out research on the multimedia potential for facilitating the transfer of knowledge and skills in students, as well as to investigate the factors that influence the effectiveness of computer-assisted teaching/learning in general and in basic electrical engineering in particular.

The research project attempts to develop and investigate the role of computers and computer technology in engineering education, as well as to provide a problem-oriented tutoring system for students to acquire basic electrical engineering knowledge in electrical engineering.

LITERATURE SURVEY

A detailed literature survey of the basic educational psychology and educational technology in relation to the application of problem-based learning, computer-based learning, computer-assisted assessment and the development of courseware has been carried out. This included a thorough literature review of the following topics:

- Educational psychology.
- Educational technology.
- Cognitive science.
- Theory of pedagogy.
- Internet search.
- Search for successful case studies.

A detailed review of instructional technology and computer-aided instructions was also carried out.

A comprehensive literature search and survey on computer-assisted instructions/assessment has been carried out and the important results are quoted as below:

> *A computer-based learning (CBL) system has been an integral part of first and second year computing courses at the University of Dundee for several years* [6].

> *Given that one of the main aims of the project was to encourage consistent participation, the project team believe that the Computer Assisted Assessment (CAA) has been a successful component of the Open Learning Environment* [7].

DEVELOPMENT OF STRATEGIES AND COMPUTERISED INSTRUCTION TOOLS USING JAVA

In order to design and investigate the effectiveness of computer-based comprehensive self-study procedures in basic electrical engineering, the first step is to develop a library of suitable software. Before developing authoring tools in this context, it is envisaged to develop libraries of suitable software that can be implemented in further designing the process to accelerate the design and development of the project.

In electrical engineering education, it can be more explicit and meaningful for students if they are presented with graphics. It is desirable that the authoring system enables the teacher or instructor to develop and deliver lessons and instructions that combine text and graphics. As such, an effective authoring system must provide at least a text editor and a graphics editor [8].

Authoring languages should be selected so as to make the programmer's task easier and more flexible. Considering the applicability of the specialised programming language, such as Java, containing multi-level function performing tasks, it is used as an authoring language to develop and design this project. Java is a fully object-oriented programming language and one of the fastest growing programming technologies of all the time. Java represents an evolutionary change from earlier programming languages, rather than a radical departure. It is possible to make a Web page come alive with animations and user interactivity with Java. Java is the most important language for Web and Internet applications.

Java programs can be executed in two ways; applications and applets. Applications are executed utilising a Java interpreter similar to any other program like C, C++ as a standalone. However, applets are interpreted within Web browsers that support Java, such as Netscape, Internet Explorer, etc. Applets must be included within a Web page using HTML tags.

OUTLINES OF THE DEVELOPMENTS

Phase I: Conversion of All Tutoring Material into Computerised Soft Copies

In this initial phase, all the material has been converted to soft copies using Microsoft *Word*. Since *Word97* is compatible with Adobe *PageMill*, all the text, including formulae, is edited in *Word97*. The circuit diagrams and figures are drawn using *SmartDraw 3*. All these files are then exported to GIF images, which are further used in HTML pages.

In order to make the tutoring page more user-interactive and accessible, the HTML pages of the tutorial are designed using Adobe *PageMill 3.0*.

The main window of the design page has been divided up using HTML frames. The layout is shown in Figure 1.

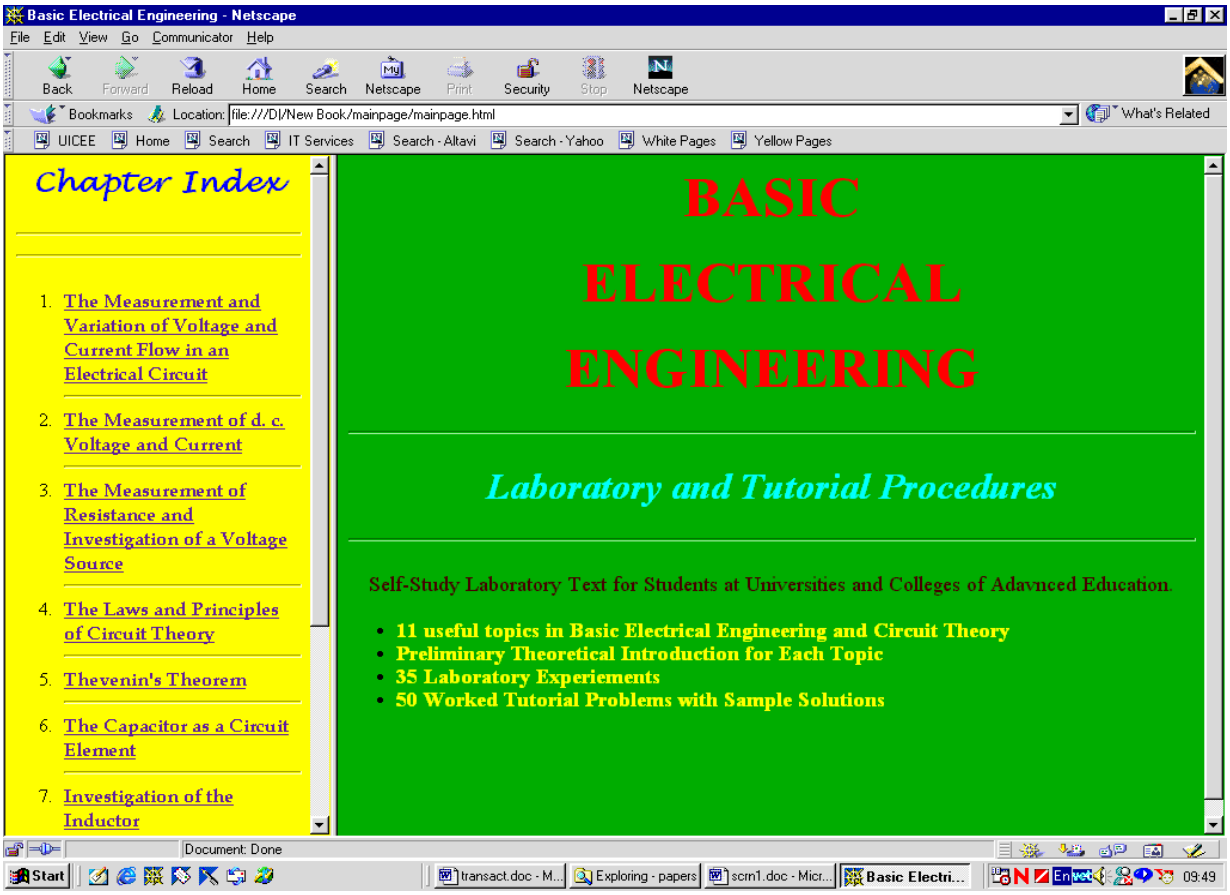

Figure 1: The main window (as viewed in Netscape Communicator).

The left hand frame in Figure 1 gives an index to all the main chapters of the book. In all, there are 11 methodological units, each having a preliminary theoretical introduction. These are:

1. The Measurement and Variation of Voltage and Current Flow in an Electrical Circuit.
2. The Measurement of d.c. Voltage and Current.
3. The Measurement of Resistance and Investigation of a Voltage Source.
4. The Laws and Principles of Circuit Theory.
5. Thevenin's Theorem.
6. The Capacitor as a Circuit Element.
7. Investigation of the Inductor.
8. Locus Diagrams for Phasors.
9. The RLC series Circuit.
10. Parallel and Series-Parallel Circuits.
11. Non-linear Circuits.

The right-hand frame is like a title page and explains briefly the actual contents.

When the student selects one of the links in the left-hand frame, the window will then be updated to display the material of that particular unit or a chapter that has been selected. The layout of the individual unit page is shown in Figure 2. This page of individual units is again divided into two frames. The left-hand frame shows the links to the index of the chapter and the right-hand shows the whole material.

Each unit consists of three main parts, namely:

- Preliminary Theoretical Introduction.
- Procedure Using Laboratory Circuits.
- Tutorial Problems.

An introductory theoretical section gives students access to the relevant theoretical information and definitions within the unit before starting the actual laboratory and tutorial sessions. This is useful in order to refresh and recall the necessary information of that particular unit.

The remaining two sections of the unit (ie Procedure Using Laboratory Circuits and Tutorial Problems) consist of a set of questions with figures and circuit diagrams, wherever necessary. The questions are mostly of simple text where students are asked to enter their answers by typing in some text via the keyboard or selecting drawing figures from the multiple choices available. They are also asked to click on the *submit* button after entering the answer of each question. A link is provided to check the answers so that students can view the correct answer of each question (see Figures 3 and 4).

There are 35 independent laboratory experiments and 50 worked tutorial problems in total. These fully cover the first stage of the primary undertaking of basic electrical engineering.

QUESTION DESIGN

The question design panel consists of:

- Question number (sub-number if any).
- Question display.
- A text field/text area for typing /printing answers.
- Submit button.
- A link to check the answer or hint.

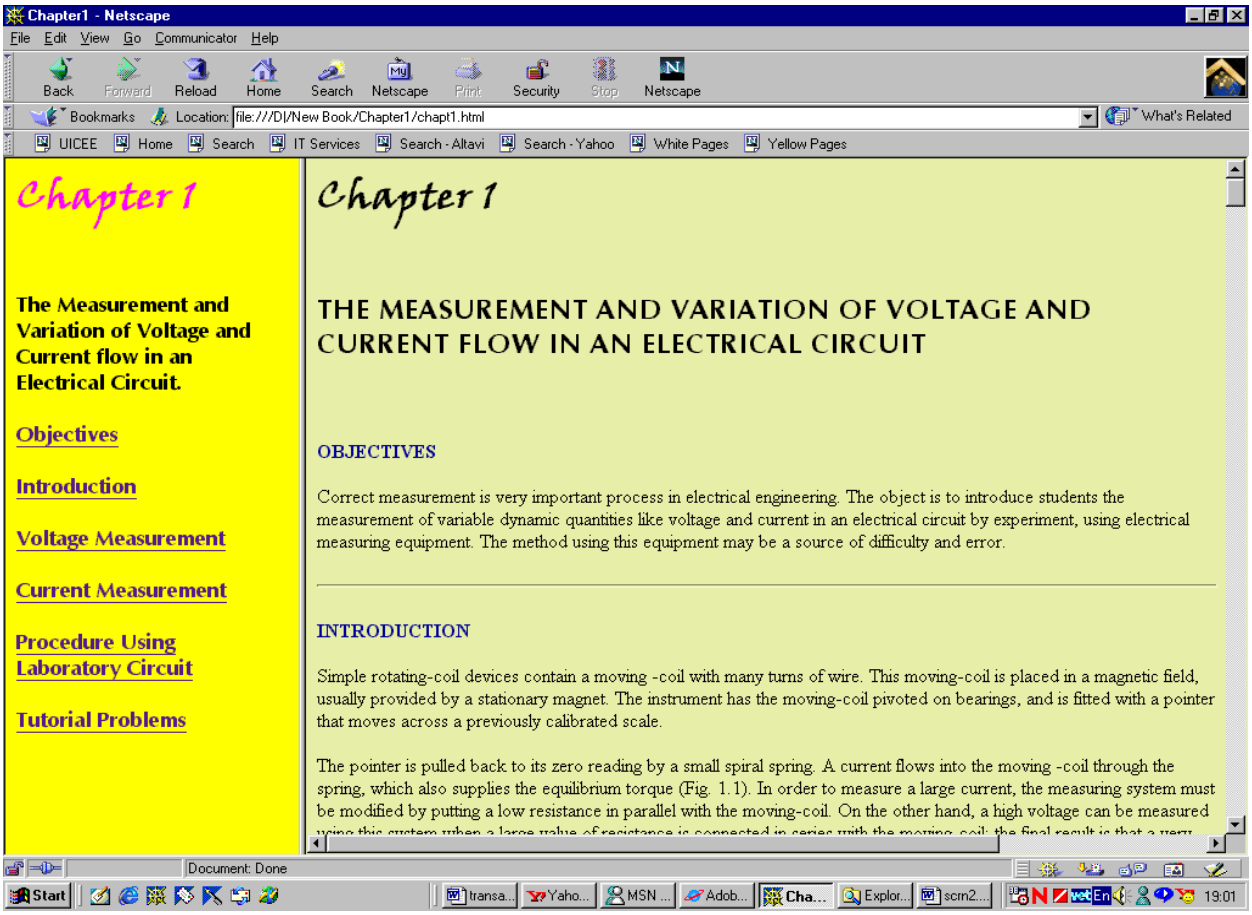

Figure 2: A Web browser showing the main page of Chapter 1.

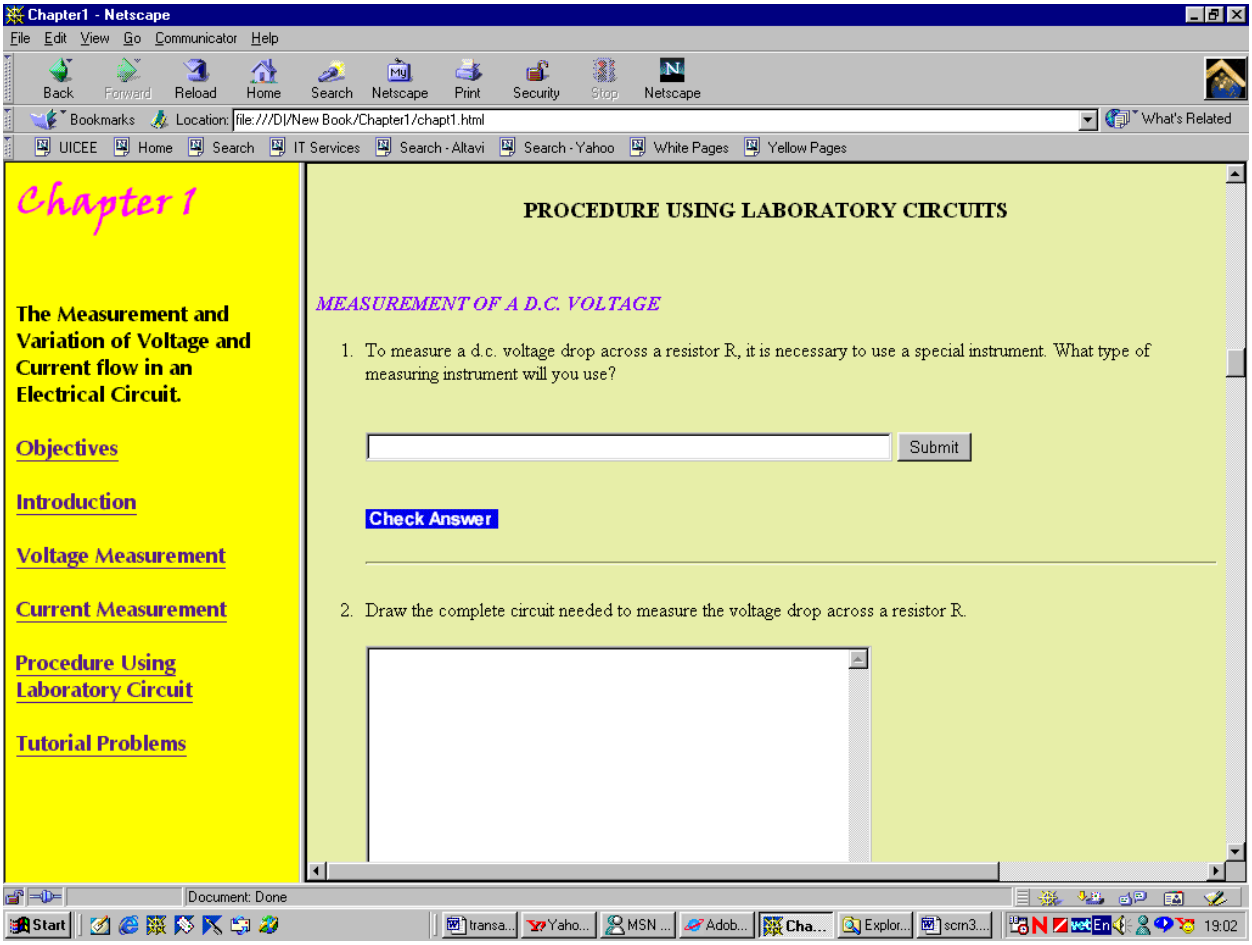

Figure 3: A window showing questions from a section of Procedure Using Laboratory Circuits.

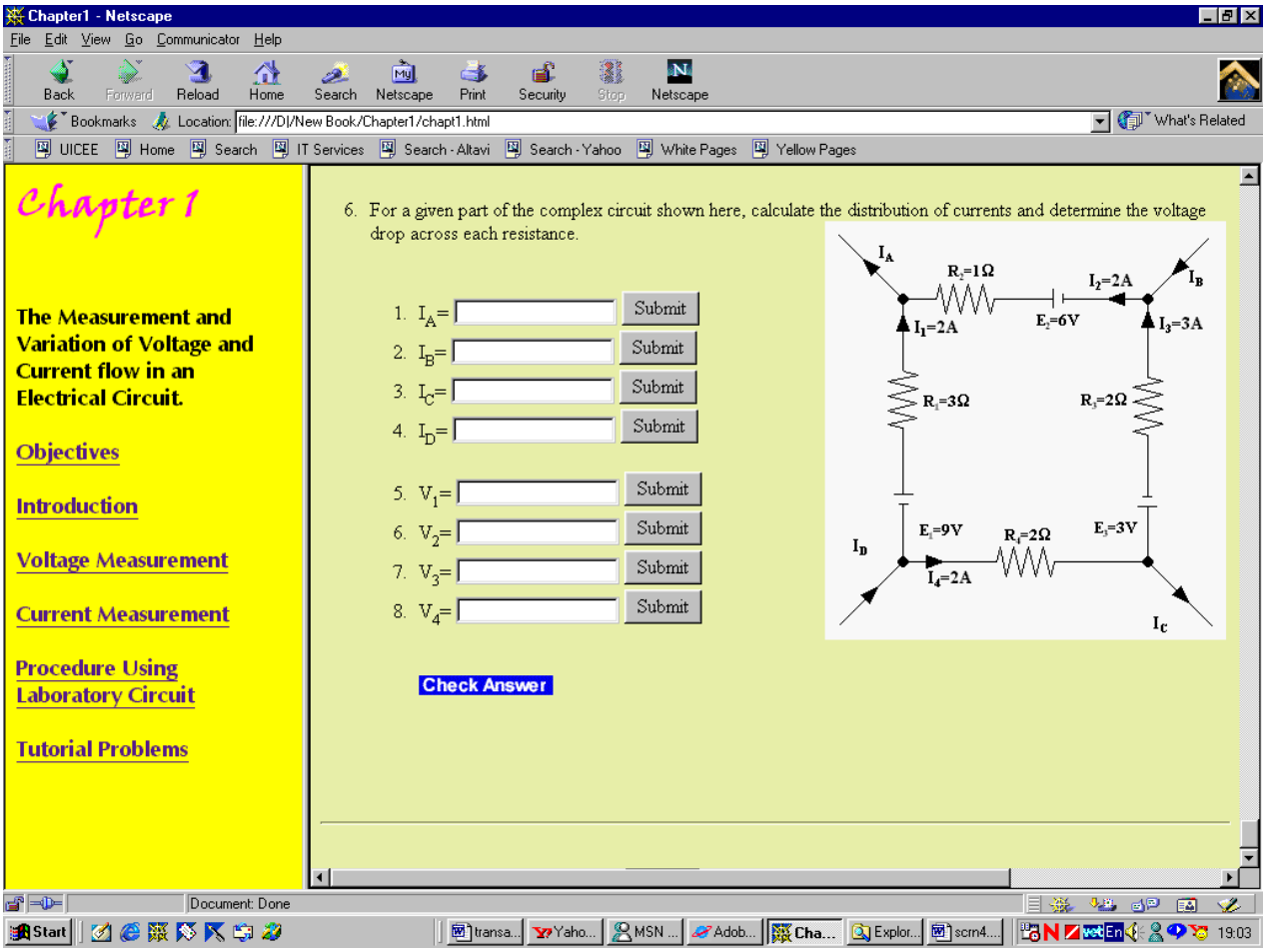

Figure 4: A Web browser showing questions from the section of Tutorial Problems.

The main purpose of designing a link to check answers is:

- To provide students with immediate relevant feedback.
- To provide tutors/instructors with quick feedback on student performance or summary data.

CIRCUIT DIAGRAMS

The most important form of communication in electrical engineering is through a circuit diagram. This is a two-dimensional drawing in which various components and connectors form a certain structure. A complex electrical circuit consists of number of loops (meshes) and electrical nodes (junctions).

In this project, all the circuit diagrams have been drawn using the special and flexible drawing software called *SmartDraw*. The advantage of this package is that one can use the available library source in order to draw some standard and frequently used components in circuit theory. The diagram can be saved with an extension .SDR, which is then exported to give an image with a .GIF extension. One such diagram is displayed in Figure 5.

FUTURE DEVELOPMENTS

Phase II: Database and Server Management

There will be a few essential changes made in the HTML pages in order to use it more interactively with students learning strategies. A few of them are:

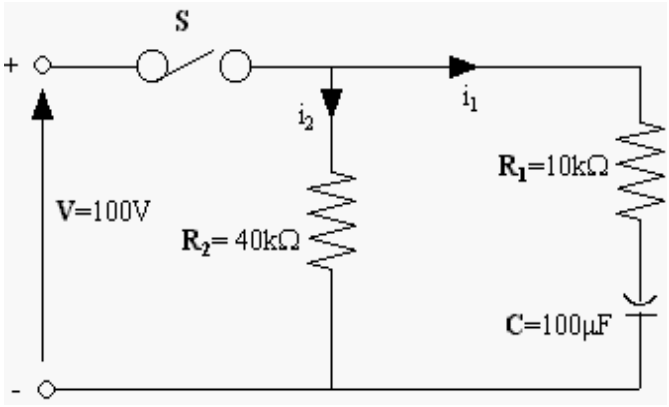

Figure 5: Circuit diagram with four components as a .GIF file.

- Access to the correct answers and hints is provided both from the main panel and from the pop-up window. This access is enabled only if the student has actually attempted the question.
- The original question, the students' answer, hints or correct answer will be visible on screen at once so that students can understand how the answer relates to the question.
- There will be also inclusion of additional comments and hints with explanatory notes for each question in order to provide extra guidance for the students.

DESIGN OF AN ASSESSMENT PROGRAMME

An assessment programme for the individual learners will be designed and implemented. The programme will include:

- Aptitude tests.
- Achievement tests.
- Automatic collection of data from students with score sheets.
- Observation protocols.
- Questionnaires.
- Reports.

Students will be asked to react to various questionnaires and achievement tests. Their responses will be collected, recorded and analysed for various parameters in learning methodologies. They will also be asked to make written comments in order to develop their score responses. This is an important requirement in the future development of the project, which is essential in collecting student feedback and to provide proper interaction.

CONCLUSIONS

A bibliographic search indicates that there is a lack of relevant comprehensive research concerning the efficiency of computer-assisted instructions used in engineering education. On the other hand, there is a large amount of computer-assisted instructions developed and implemented in engineering courses worldwide. However, the developers largely neglect the process of scientific measurement of the effectiveness and efficiency of their product. They may apply strict research methods and techniques to their engineering product, but grossly neglect to apply the same to the product used for educational purposes. Hence, the objective of the research proposed is to fill this gap.

More specifically, the authors intend to investigate and examine the efficiency and effectiveness of the computer-assisted learning approach applied to the online teaching of basic electrical engineering, facilitated by a set of computer-based instructions.

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