

Computer Base Training: On-line Simulation Model as Teaching Strategy

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Abstract: – We discuss the Complex methodic for performing Exercises in topics of the studied theoretical course. The methodic use Simulation Model as the most effective element of the training process. Simulation Models are used in two directions: first, as "Virtual Teacher" at all the stages of exercise performance (evaluation of theoretical knowledge, giving out tasks, checking the calculation results, etc.) and, second, as "Virtual Experiment" for modeling the process studied. This makes the teaching process to be maximally computerized allowing the distance learning, for example, via Internet or on-the-job learning. Such approach permits also to effectively react to the progress of science and technology at the moment of the topic studying. Realization of the proposed methodic is described by the example of one of the exercises in the topic "The RLC Circuit" of the course "Introduction to Circuit Theory" carried out at Center for Technological Education, Holon, Israel.

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1. Introduction

Exercises in the topics of the theoretical course conducted as practical studies represent an indispensable part of the university education. Interactive computer-base training systems play an important role in update methodics of teaching [1] - [6]. Under modern conditions, studying methodics including those by means of exercises should immediately respond to constantly innovating technologies and technical means realizing them. These methodics should contain means (elements) permitting to carry out speedy, flexible and necessarily effective reconstruction for scientific and technological novelties. As it would be shown later in the methodic is considered in the present report, the most flexible element providing for solving the task mentioned appears to be the Simulation of the technological problems studying as an effective means for deeper penetration into the essence of the phenomenon.

The process of studying technical subjects comprises, as a rule, three main components (studying stages): the study of course (lectures) and practice – experiments (laboratory works) and exercises (in the classroom or at home). In our report we are to deal with the problems of learning effectiveness increase in its practical part (Experiments and Exercises) relative to studying technical subjects and to division Exercises, in particular. Effectiveness of the methodic proposed by the authors could be better understood when studying modern technical courses which are based on rather complicated theories and equipment.

2. Concept of the Process Study Algorithm

Let us study the proposed concept for organization of practical studying methods.

In the general case Experiment Procedures should include the following stages:

- ◆ checking of general theoretical knowledge on the topic studied. In this case not only simple repetition of the information obtained at the lectures is important, but, what is more important, the determination of rigid connection between the theory and its introduction into practice could be established;
- ◆ doing exercises themselves (carrying out necessary calculations, plotting);
- ◆ checking the calculations results and presentation of the results.

In this case Simulation models are used in two directions: for modeling the actions of the teacher and for modeling the technological processes studied in the exercise.

In the latter case Simulation or "Virtual Experiment" represents a flexible element of the methodic permitting to provide for the deeper studying of practical aspects of the theory taking into account new achievements of science and technology in the field studied.

Due to the above said it is proposed to consider the Simulation procedure not only for illustrating the theoretical points but as a "Virtual Experiment" permitting to widen the possibilities of the exercise by application of modeling.

3. Method of the Process Study Algorithm

The described complex computer system for doing exercises using one of the exercises in topic "The RLC

Circuit" of the course "Introduction to Circuit Theory" as an example is based on programs for exercises performing and Simulation on the basis HP VEE (The Visual Programming Language), MATLAB 5 (The Language of Technical Computing) and MicroSim DesignLab 8.

3.1. Concept of the Process Exercise Algorithm

The aim of the exercise - obtaining practical knowledge of the course which includes fixation of definite theoretical knowledge and acquiring skills for their practical application. Definite stages in attaining the goal set forth are carried out by evaluation of

$$TR = TR_t + TR_c \quad (1)$$

theoretical knowledge within the framework of the course division studied in the exercise and practical solving of the corresponding problems. Such evaluation is determined as the sum of grades for theoretical knowledge and for doing the exercises:

In this case the first of these grades is determined according to formula:

$$TR_t = \sum_j w_{ij} Sel(A_{ij}) \quad (2)$$

Where w_{ij} - "weight" of j-answer in total grade;

$Sel(A_{ij})$ - function of choosing the right i-

answer (A_{ij}) out of the list proposed;

$$A_{ij} = \begin{cases} 0 - \text{answer} - \text{false}; \\ 1 - \text{answer} - \text{true}. \end{cases}$$

Grade for doing the exercise is represented as a sum of grades for exercise performed throughout all the problems in the task:

$$TR_c = \sum_p TR_c^p \quad (3)$$

Where the grade per one task is determined according to the following formula:

$$TR_c^p = \sum_j w_c^p Sel(A_{cij}^p) \quad (4)$$

In this formula "c" - indication of grade for exercises performed, "p" - problem number. Other designations are analogous to those in formula (2).

3.2. Process Exercise Algorithm

The concept described is used as the basis of the algorithm for complex computer model of the experiment given in Fig.2.

In studies connected with teaching methodics not only the course contents and method of its presentation is important but method of its visual presentation as well. It is especially important for methods connected with Simulation.

Program realization of the algorithm given is illustrated as the sequence of working windows formed by programs developed by the authors (see Figs. 3 a, b, c, d).

Fig.3a gives the main working windows of the program for modeling the process of theoretical knowledge checking ("Virtual teacher"). In the upper left corner of the drawing the first program window is shown in which the student gets acquainted with the general knowledge of the subject, character, stages of its performance, etc. Immediately under windows containing theoretical questions and lists of proposed answers to each of them. Left window in this group is the the window there is a group of main window containing the windows of input Name and No passport of the student and buttons for checking. Input of personal data mentioned is provided for creating special individual files for grades storage per each stage of exercise performance and checking the previous stages. Each window containing a question and proposed list of answers can also contain brief theoretical "prompts" (as shown in the Figure). In these case the "prompt" shouldn't be considered as decrease in requirements to students' knowledge. Their aim is to direct the student's attention to different aspects of the problem studied, to protect him from simplified, one-sided approach. Three lower left windows correspond to unsatisfactory theoretical knowledge, three lower right windows - to satisfactory ones. Middle window in this row contains the task, and the window under it includes a prompt for the next stage. In our example the next stage is fulfilled by a traditional method as well as by using MATLAB 5 (see five upper windows in Fig. 3b).

At this stage the student obtains additional knowledge on modern Language of Technical Computing. In this case depending on time allocated for the stage, the student could be offered a development of the full program in MATLAB language or improvement or correcting of the ready program but unfinished or that with specially introduced errors. The right group of upper windows in Fig.3b contained the following as an example: fragments of the program, calculation results and resulting plots.

Three lower windows in Fig.3b correspond to three cases of second program reaction ("Virtual teacher") made by us in HP VEE language as well, for student's introduction of No Passport into a special window in the main window of the program. In this case information in the left window corresponds to the case of student's absent-mindedness, in the right one - to the case of non-fulfilling of the previous stage and in the middle one - to the case of satisfactory fulfillment of the previous stage (in our example - the stage of theoretical knowledge checking).

Fig.3c represents an upper left window of the program mentioned giving the list of task parts and a list of proposed results of their performance. In case the calculation results appear to be unsatisfactory, the student gets information on the errors and proposal to return to calculations (two right upper windows in the figure). In case the results are satisfactory, the student gets grades and corresponding encouragement with

prompt for the next stage (two lower windows in the figure).

Fig.3d shows the windows of the Simulation program for the problem to be solved ("Virtual Experiment"). The upper window represents Simulation Program in HP VEE language, two lower windows in language MicroSim.

The common structure of the proposed computer-base training system includes as links the mentioned above individual files (fig. 4). Files represent individual Database, the storied test results of performed stages and other service data.

The attention should be also drawn to the fact that using of the Simulation Model is not only limited by its application for practical mastering of the theoretical course studied. The student also gets knowledge on Simulation possibilities and its effectiveness with real designing of radiotechnical devices and communication systems. This, in its turn, will permit to use Simulation advantages in practical activities for analysis of existing complex devices and systems as well as for development of new ones.

4. Conclusion

The article proposes the methodics of introducing Simulation elements in the teaching process simultaneously for computer adaptation of the material studied in the learning process as well as the quality of the virtual experiments.

Multiple checking of the methodics described and program complex for exercises performance developed by the authors on its bases in the Center for Technological Education, Holon, Israel, has certified the effectiveness of proposed changes in traditional teaching methodics.

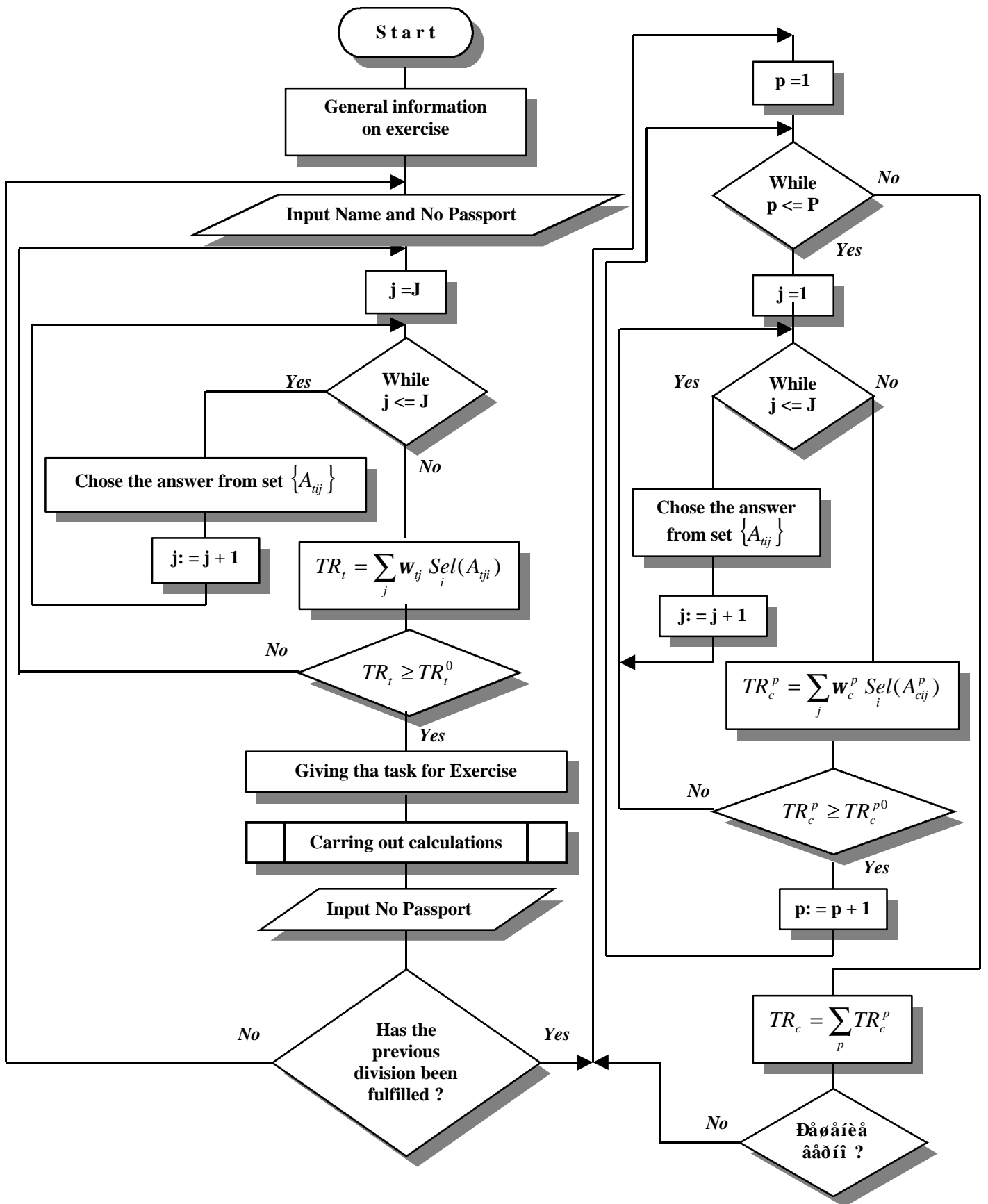
Reference:

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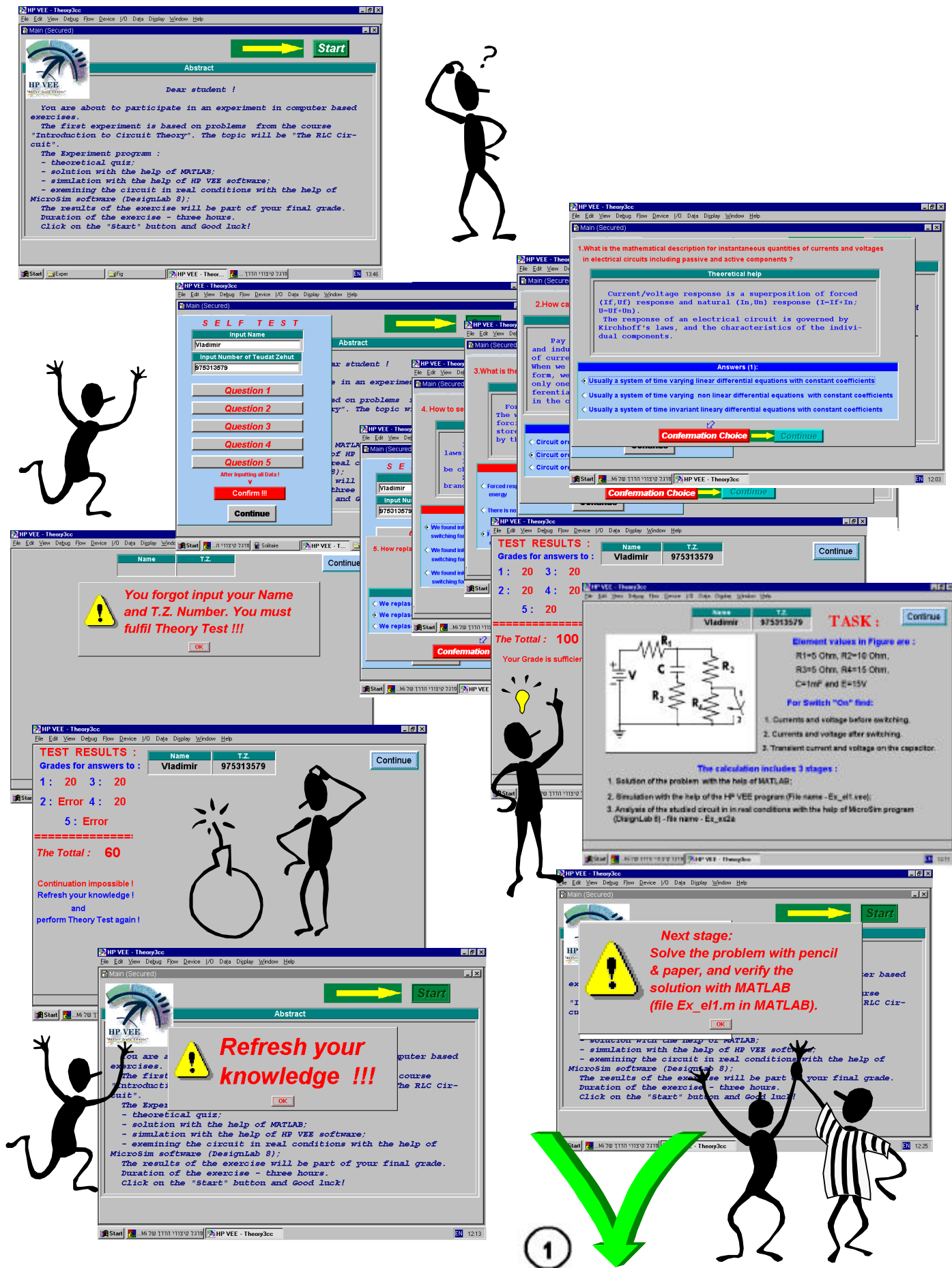


Fig. 2, a The Result of fulfilling the program complex (Start)

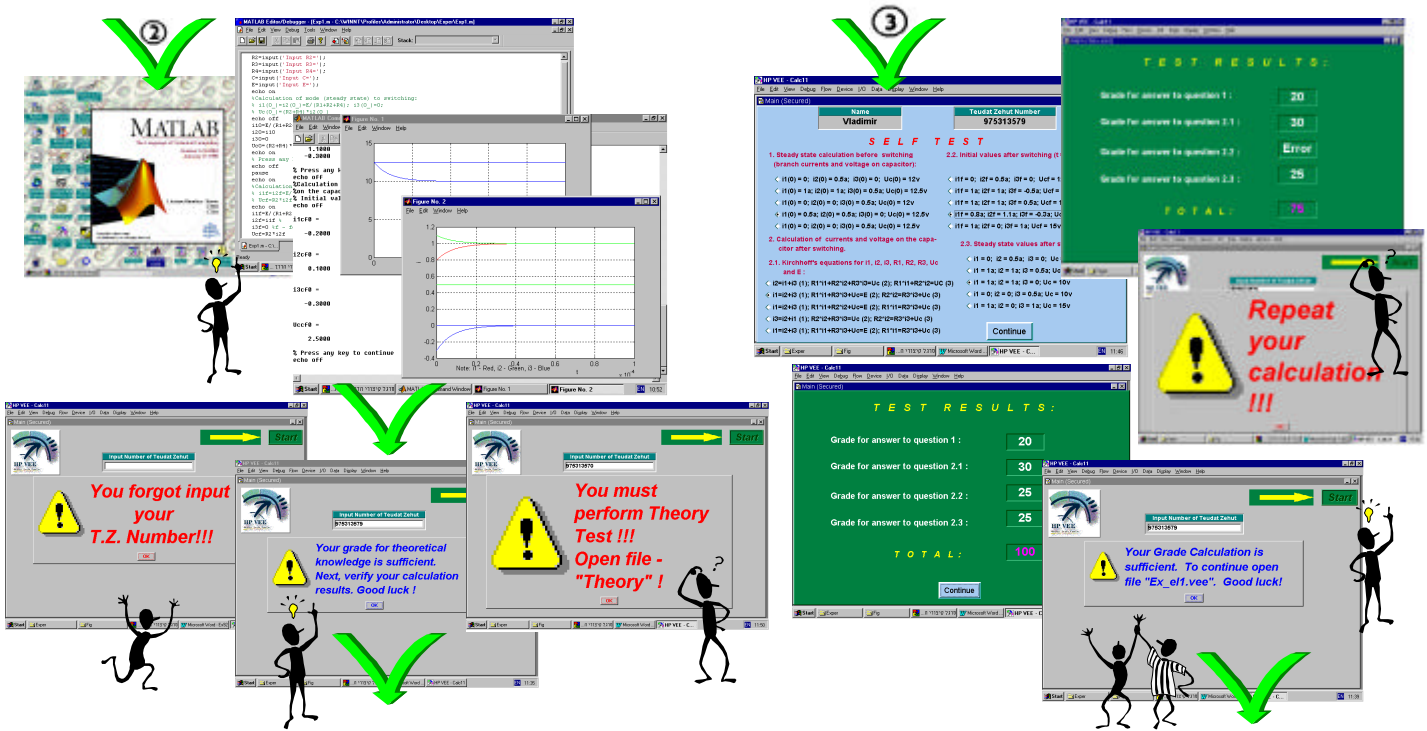


Fig. 2, b,c. The Result of fulfilling the program complex (continuation)

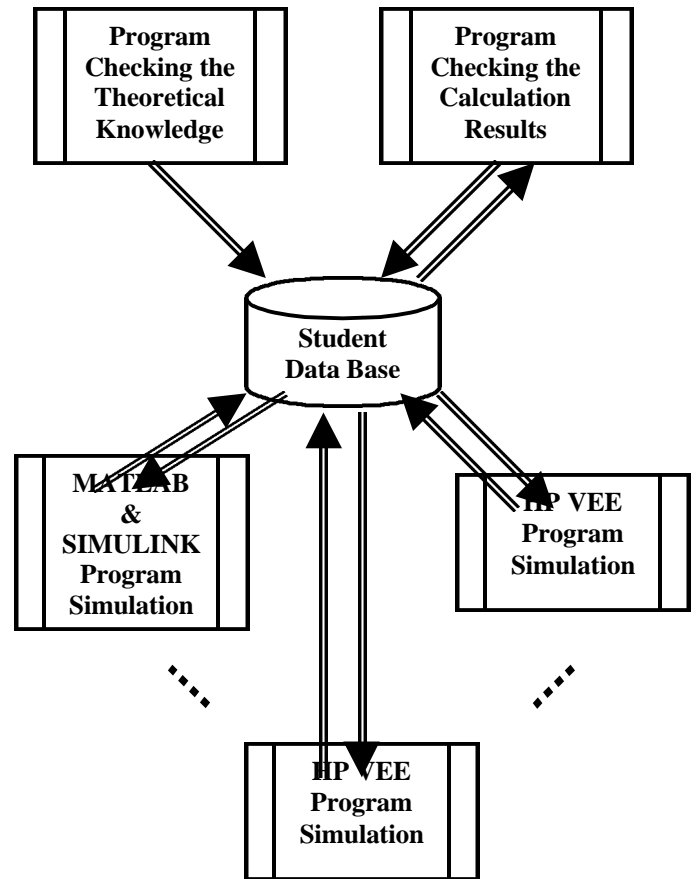
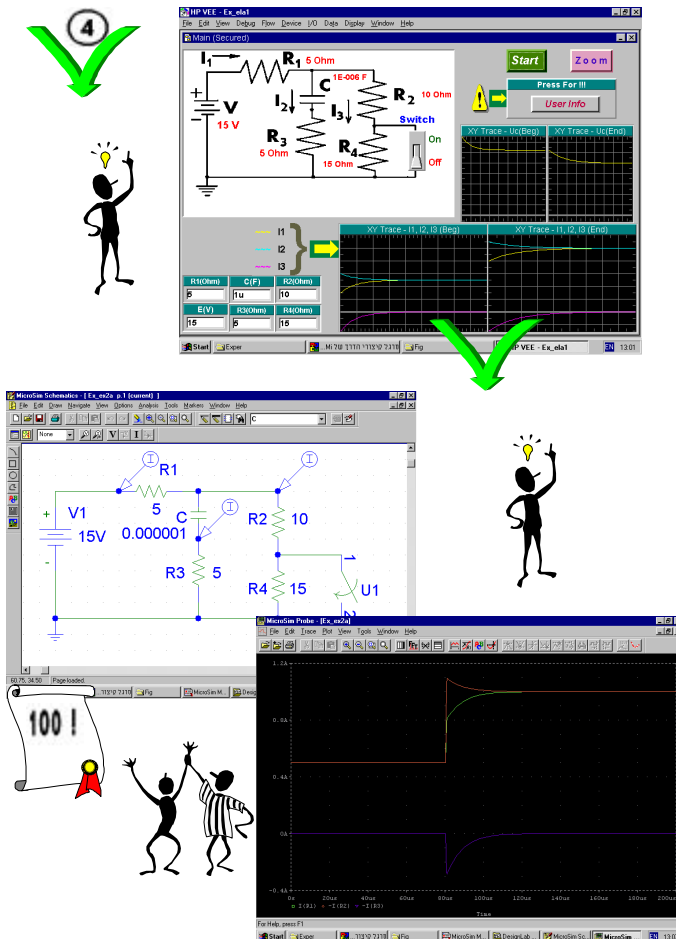


Fig. 2, d. The Result of fulfilling the program complex (End)

Fig. 3. Flow chart of the Interactive
Computer-Based Training System

Computer Base Training: The Topic: "The Circuit Theory" The Course: "Introduction to RLC Circuit"

The image displays several screenshots from the HP VEE Theory3cc software interface, illustrating the progression of a computer-based training program for "The Circuit Theory" course.

Abstract: The program introduces the student to the experiment, mentioning the use of MATLAB, HP VEE software, and MicroSim software (DesignLab 8). It states that the results of the exercise will be part of the final grade and that the duration is three hours.

SELF TEST: A form for inputting the student's name (Vladimir) and T.Z. Number (975313579). It contains five questions, each with a "Confirm!!!" button.

Warning: A yellow warning icon and text: "You forgot input your Name and T.Z. Number. You must fulfil Theory Test !!!".

TEST RESULTS: A table showing grades for answers to five questions:

Question	Grade
1	20
2	20
3	20
4	20
5	20

The total score is 100, and the grade is sufficient.

TASK: A circuit diagram with a voltage source V , a capacitor C , and resistors R_1, R_2, R_3, R_4, R_5 . The task asks for currents and voltages before and after switching, and transient current and voltage on the capacitor. The calculation includes 3 stages: solution with MATLAB, simulation with HP VEE, and analysis with MicroSim.

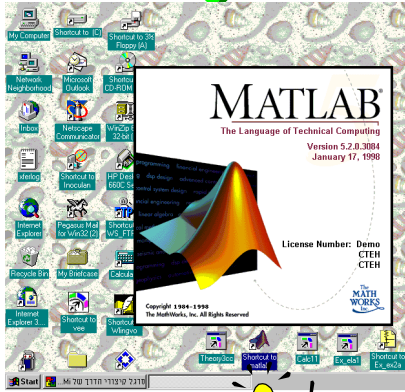
Warning: A yellow warning icon and text: "Refresh your knowledge !!!".

Final Warning: A yellow warning icon and text: "Refresh your knowledge !!!".

Final Success: A large green checkmark with the number "1" and a stick figure celebrating.

Fig. 3, a The Result of fulfilling the program complex (Start)

**Computer Base Training. The Topic: "The Circuit Theory"
The Course: "Introduction to RLC Circuit" (continuation)**



```

R2=input(' Input R2=');
R3=input(' Input R3=');
R4=input(' Input R4=');
C=input(' Input C=');
E=input(' Input E=');
echo on
%Calculation of mode (steady state) to switching:
% i1f=11000; %E/(R1+R2+R3+R4); %i2f=1000;
% Ucf=
echo off
% Press any key to continue
echo off
%Calculation of the capacitor
%Calculation of initial value
echo off
% Ucf=
echo on
i1cf=11000;
i2cf=1000;
i3cf=C;
UcfF=
% Press any key to continue
echo off
    
```




Fig. 3, b The Result of fulfilling the program complex (Continuation)

Computer Base Training: The Topic: "The Circuit Theory"
The Course: "Introduction to RLC Circuit" (continuation)



HP VEE - Calc11

Main (Secured)

Name	Teudat Zehut Number
Vladimir	975313579

S E L F T E S T

1. Steady state calculation before switching (branch currents and voltage on capacitor):

- $i_1(0) = 0; i_2(0) = 0.5a; i_3(0) = 0; U_c(0) = 12v$
- $i_1(0) = 1a; i_2(0) = 1a; i_3(0) = 0.5a; U_c(0) = 12.5v$
- $i_1(0) = 0; i_2(0) = 0; i_3(0) = 0.5a; U_c(0) = 12v$
- $i_1(0) = 0.5a; i_2(0) = 0.5a; i_3(0) = 0; U_c(0) = 12.5v$
- $i_1(0) = 0; i_2(0) = 0; i_3(0) = 0.5a; U_c(0) = 12.5v$

2. Initial values after switching ($t = 0$):

- $i_1f = 0; i_2f = 0.5a; i_3f = 0; U_c f = 12v$
- $i_1f = 1a; i_2f = 1a; i_3f = -0.5a; U_c f = 12v$
- $i_1f = 1a; i_2f = 1a; i_3f = 0.5a; U_c f = 12.5v$
- $i_1f = 0.8a; i_2f = 1.1a; i_3f = -0.3a; U_c f = 12.5v$
- $i_1f = 1a; i_2f = 0; i_3f = 1a; U_c f = 15v$

2.1. Kirchhoff's equations for $i_1, i_2, i_3, R_1, R_2, R_3, U_c$ and E :

- $i_2 = i_1 + i_3$ (1); $R_1 \cdot i_1 + R_2 \cdot i_2 + R_3 \cdot i_3 = U_c$ (2); $R_1 \cdot i_1 + R_2 \cdot i_2 = U_c$ (3)
- $i_1 = i_2 + i_3$ (1); $R_1 \cdot i_1 + R_3 \cdot i_3 + U_c = E$ (2); $R_2 \cdot i_2 = R_3 \cdot i_3 + U_c$ (3)
- $i_1 = i_2 + i_3$ (1); $R_1 \cdot i_1 + R_2 \cdot i_2 + U_c = E$ (2); $R_1 \cdot i_1 = R_3 \cdot i_3 + U_c$ (3)
- $i_3 = i_2 + i_1$ (1); $R_2 \cdot i_2 + R_3 \cdot i_3 = U_c$ (2); $R_2 \cdot i_2 = R_3 \cdot i_3 + U_c$ (3)
- $i_1 = i_2 + i_3$ (1); $R_1 \cdot i_1 + R_3 \cdot i_3 + U_c = E$ (2); $R_1 \cdot i_1 = R_3 \cdot i_3 + U_c$ (3)

2.2. Steady state values after switching:

- $i_1 = 0; i_2 = 0.5a; i_3 = 0; U_c = 10v$
- $i_1 = 1a; i_2 = 1a; i_3 = 0.5a; U_c = 12v$
- $i_1 = 1a; i_2 = 1a; i_3 = 0; U_c = 10v$
- $i_1 = 0; i_2 = 0; i_3 = 0.5a; U_c = 10v$
- $i_1 = 1a; i_2 = 0; i_3 = 1a; U_c = 15v$

Continue

HP VEE - Calc11

Main (Secured)

TEST RESULTS:

Grade for answer to question 1 :	20
Grade for answer to question 2.1 :	30
Grade for answer to question 2.2 :	Error
Grade for answer to question 2.3 :	25
TOTAL:	75

HP VEE - Calc11

Main (Secured)

Input Number of Teudat Zehut: 975313579

Repeat your calculation !!!

Start

HP VEE - Calc11

Main (Secured)

TEST RESULTS:

Grade for answer to question 1 :	20
Grade for answer to question 2.1 :	30
Grade for answer to question 2.2 :	25
Grade for answer to question 2.3 :	25
TOTAL:	100

Continue

HP VEE - Calc11

Main (Secured)

Input Number of Teudat Zehut: 975313579

Your Grade Calculation is sufficient. To continue open file "Ex_e11.vee". Good luck!

OK

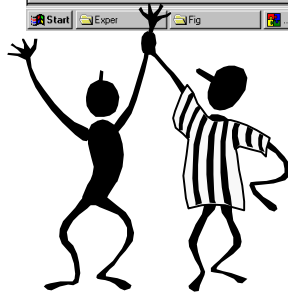


Fig. 3, c The Result of fulfilling the program complex (Continuation)

*Computer Base Training: The Topic: "The Circuit Theory"
The Course: "Introduction to RLC Circuit" (ending)*

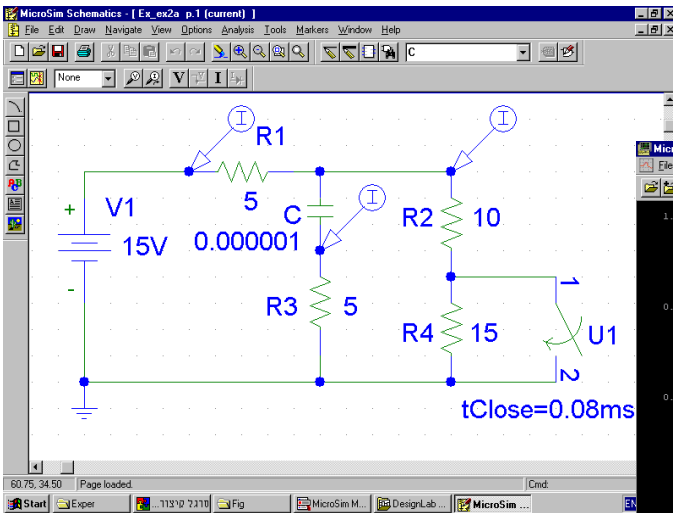
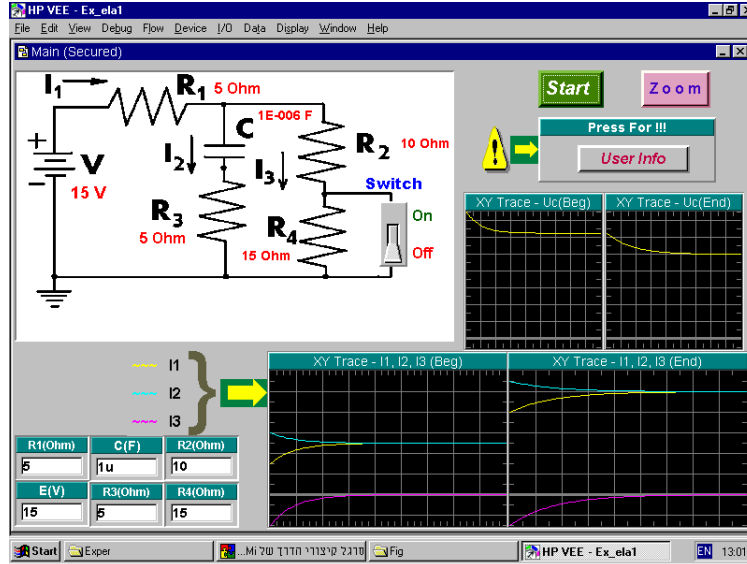


Fig. 3, d The Result of fulfilling the program complex (End)

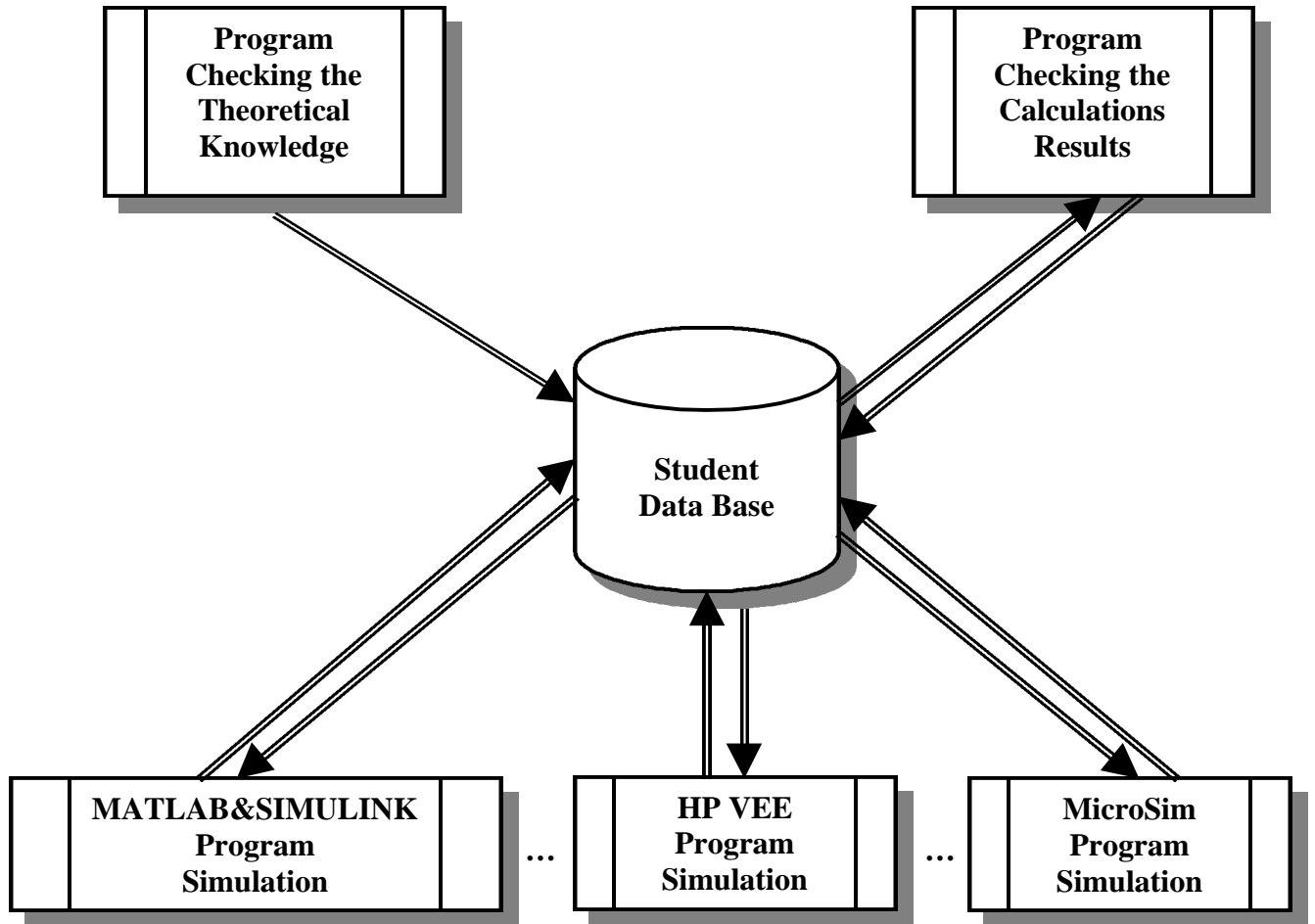


Fig. 4 Flow chart of the Interactive Computer-Based Training System