Innovative technologies in course Electrical engineering and electronics

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Abstract. Department of Electrical Engineering and Nondestructive Testing, NRU "MPEI", has been working on development Electronic Learning Resources (ELRs) in course Electrical Engineering and Electronics for several years. This work have been focused on education intensification and effectiveness while training bachelors in nonelectrical specializations including students from Thermal and Atomic Power Engineering Institute. The developed ELRs are united in a tutorial module consisting of three parts (Electrical Circuits, Electrical Machines, Basics of Electronics): electronic textbook and workbook (ETW); virtual laboratory sessions (VLS); training sessions (ETS); personal tasks (PT); testing system that contains electronic tests in all course subjects and built-in verification of a student's work results in ETW, VLS, ETS, PT. The report presents samples of different ELRs in html format and MathCAD, MatLAB Simulink applications, copyrighted programs in Java2, Delphi, VB6, C++. The report also contains the experience description, advantages and disadvantages of the new technologies. It is mentioned that ELRs provide new opportunities in course studying.

1. Introduction

Authors have been working at the development of electronic learning resources for computerization of engineering education since the time computers appeared in MPEI. There were programs for laboratory work supporting (task presentation, verification of experiments results, report data recording), check of calculated tasks, computer tests at the beginning. It became clear after ELRs using in class that ELRs development and realization for all types of classes provides bigger opportunities. The report present modern condition of computerization of the course with the tutorial module developed in department of Electrical Engineering and Nondestructive Testing, NRU "MPEI".

2. ELRs for lectures

Lecture class should be equipped with the PC and slide projector. Lecturer uses electronic materials in html, Word, PowerPoint, pdf formats. These materials contain lecture notes, parts of ETW as well as lecture presentations (self-developed programs, circuit simulation programs and structural modeling programs files). Lecture text is available for students at course site before the lecture and during the semester right down the final exam. It allows to provide to student more information and quality.
Presentations help to present information in clear dynamic view. Lecturer has the opportunity
to correct lecture content for specific request.

3. Electronic textbook and workbook
Students can also use electronic textbook and workbook (ETW) available at course site in html format.
ETW contains full material of each section, theme, chapter and article including examples and tasks. Built-in scripts allow to check the values of student calculations. In local network ETW is connected with the electronic training sessions (ETS) and virtual laboratory sessions (VLS).

2nd edition of 1st [1] and 2nd volumes [2] of three-volume textbook created in department of Electrical Engineering and Nondestructive Testing were published by Urait publishing house in 2016. The 3rd volume Basics of Electronics will be published in 2017. Electronic versions of these textbooks were also prepared by publishing house.

4. Electronic training sessions
ETS class should be equipped with PCs and slide projector. Students use MathCAD files, containing text areas for tasks and schemes, input text fields for students' results, hidden sections for comparing students' results and predefined values, automatic comments to the comparison. MathCAD tools are used for plotting graphs. Student can record the file in html format at his USB flash drive for homework. ETS allows to use database to create personal tasks for each student, that makes the competitive atmosphere and increases the student productivity.

5. Virtual laboratory sessions
Three virtual laboratory sets were developed. They are electrical circuits (steady-state modes), electrical machines, basics of electronics. Each laboratory set has individual software specifically designed for different studying objects. This software consists of two parts - virtual experiment application (VEA) and simulation program application (SPA).

VEA for Electrical circuits section of the course is created as Java2 application [4]. After filling personal data (name, group number, number in group list) student has the ability to input the homework results and check each input value. The automatic comments (yes/no) are provided for all input values while checking. Checking results log in form of errors quantity and result score and can be viewed by the student. In most cases checked value should be equal to experiment value. After that student begins to model experiment. Student runs copyrighted circuit simulation program [3] created in VB6. Student designs the model of the scheme using symbols of circuit elements (voltage sources, resistors, inductors, capacitors, ammeters, voltmeters, wattmeters), or loads prepared scheme file. In last case the elements' parameters are the purpose of experiments so their values are unknown. Student can obtain virtual instruments' data at the model like in real laboratory after filling all required data. Student can process the results in VEA and input these values for checking than required. Simulation program contain table for fixation all experiment data. Student carries out the number of experiments varying any element parameter in simulation program. Two columns in table can be chosen as y-axis and x-axis. The automatically scaled graph Y(X) will appear in new window of simulation program. Student insert screenshots of VEA window and SPA window for electronic report preparation.

Three VLS were developed for Electrical machines section of the course. They are DC motor, asynchronous motor [5] and synchronous motor. VEA was developed as MathCAD application. After filling personal data (name, group number, number in group list) student receive the type of engine for work and has the ability to input the homework results and check each input value. The automatic comments (yes/no) are provided for all input values while checking. After that student runs simulation program that has main window divided for panels. They are initial data set panel, mode parameters panel, control panel, the main mode parameters preview panel, graph panel. Initial data set panel should be filled with nominal engine characteristics. Mode parameter panel allows to change engine parameters during simulation by means of scrollbars with labels. Control panel allows to select engine parameters from database and start simulation process. The main mode parameters panel shows engine parameters
parameters during simulation. Graph panel shows graphs of engine characteristics during simulation. Student has the ability to choose engine type from database and carries out number of experiments varying engine parameters at mode parameter panel. Student monitors engine modes change during simulation process. After that student transfers observed from simulation program to VEA. Built-in tools for checking input values (at the same basis as Electrical circuits laboratory sets) make experiment quality estimation. Student prepare electronic report from VEA file in html format. Copyrighted SPA for DC motor was developed in VB6, for asynchronous motor in Java2, for synchronous motor in C++. Additional features can be obtained with Matlab Simulink model using[6]. They are improved visualization and model structure changing capabilities.

Four VLS were developed for basics of electronics section of the course. They are rectifiers amplifier with common emitter, op-amp application, logic devices. VEA for these laboratory sessions is made on the same basis as Electrical circuits laboratory sessions. Simulation program Electronics Workbench 3.0 was used as SPA. This simulation program has simple interface and rich feature set.

VLS allows to solve the problems of laboratories equipment obsolescence; set personal values of initial data for each student; extend the range of research problems; realize the experiments that can't be done in real laboratory (such as emergency modes, transient processes, high-frequency dynamic processes); raise the speed and precision of students' results checking; provide tools for automatization; increase quality of students reports; increase impartiality of students' work evaluation.

6. Computer personal tasks
There are nine personal tasks in syllabus of the course, that include tasks as calculations, graph plotting, questions without calculations. Students can view PT at the board in the laboratory or at the course site in html and Word formats, as well as MathCad for calculations. Tutors can check solutions and answers in MathCad file.

7. Computer tests
Copyrighted software for tutor was developed in MS Access. It allows to design, update and correct tests. Using this application the database with questions and tasks on all course topics was created (880 tasks).

Copyrighted software for student was developed in VB6 and it is installed in laboratory class. Tests are used for pre-examination of students.

8. References
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