The Development of Teaching Package for Power System Engineering

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***Abstract*- Power system engineering is one of the courses that is difficult to teach in the conventional method because it involves a number of mathematical equations especially with the undergraduate level at Technological University of Dawei (TU Dawei). One of the major constraints is the lack of the proper teaching tools related to the modern power system engineering. Therefore, the objective of this research is to develop the teaching package of power system engineering including computer aided power system analysis text book and power system engineering software user manual. To evaluate the quality of teaching package, firstly it is evaluated by 5 experts (3 experts from KMUTNB and 2 experts from TU Dawei). From the evaluation of teaching package by experts, it is observed that the developed teaching package is also at high level. In addition, the satisfaction evaluation of students for using the teaching package is determined as well. The results show that the satisfaction levels of student's opinions on the teaching package of power system engineering are very high level. Thus, it can be concluded that this package can be used for teaching power system engineering subject effectively.**

Keywords- Teaching package, Power System Engineering

I. INTRODUCTION

Technological University of Dawei was established since 2006. The electrical engineering curriculum is the study of power system field and applied for machine control in industrial factory. The curriculum has several subjects and tracks. In the curriculum, power system analysis subject is a fourth year course of undergraduate students which have the major subject in electrical engineering. This course is very difficult to teach effectively, because it involved more mathematical equations. One of the constraints faced in the teaching of power system analysis courses especially at undergraduate level is the non-availability of the practical power system for demonstration in the laboratory. This makes certain aspects of the course uninteresting to the students since it is full of complex mathematics that may be extremely laborious, error prone, and time-consuming to solve manually [1]. The electrical engineering students are required to complete an introductory course in power systems engineering. For the low learning achievement in the area of Power System Analysis, it is necessary to develop and enhance the appropriated instructional package of Power System Engineering course. Thus, it is not only necessary but also important to learn and teach in various mathematically subjects which are complicated formula. This Power System Engineering Package consists of two parts: 1) Computer Aided Power System Analysis Text Book and 2) Power System Engineering Software User Manual. For Computer Aided Power System Analysis subject, the contents cover offered, Basic principles of Power Systems, Per Unit System, Power Flow Analysis, Optimal Dispatch of Generation, Balanced Fault Analysis, Symmetrical Components, Unbalanced Fault Analysis and Power System Control. Correspondingly, Power System Engineering Software User Manual includes the topic of Power World Simulator, MATLAB Programming TORA Program, Optimization Toolbox, Genetic Algorithm Toolbox and Application of Power System Optimization.

Regarding Power World Simulator [2], that is applied by integrate computer-based examples, to solve the problems and otherwise to design projects in the text. This Simulator is ideally useful for teaching power system analysis, design and operation. For Power System Analysis, engineers use this simulation because of its interactive and the graphical designs are very attractive. With the use of the Power World Simulator, the students can achieve the goals of the curriculum related to the practical power system. And also they can solve the solution of Optimum Power Flow problem, Economic Load Dispatch problem, Fault Analysis and Transient Analysis for real-time visualization.

For MATLAB [3], it is a matrix-based software package and easy to solve problems in engineering, scientific,

 DOI:10.14416/c.fte.2017.11.079

computing, and mathematical disciplines. In addition, it can used to solve electrical engineering problems, such as power flow, optimization, short-circuit analysis, and stability analysis etc. The advantage of MATLAB is quick, easy analysis and verification for solving problem. GUI (also known graphical user interfaces) is easy to understand by providing simple structure such as menus, button lists, field objects etc. In addition, MATLAB Optimization Toolbox can be used to minimize or maximize various kinds of objective functions for satisfying various constraints with the different algorithms such as linear programming, nonlinear programming, mixed-integer linear programming, quadratic programming and nonlinear least squares programming [4].

Regarding the Genetic Algorithm and Direct Search Toolbox [5], it enhances the optimization performance in MATLAB by solving the problems that the traditional optimization techniques are difficult to solve and the problems are difficult to model mathematically. In general, it can be work with the computation of the objective function is the discontinuous, highly nonlinear, stochastic, unreliable or undefined derivatives.

For this reason, Power System Engineering course is very important for enabling students to have the better both learning outcome and motivation for their interesting in the electrical power industry.

II. PURPOSES OF THE RESEARCH

1) To develop the teaching package of power system engineering.

2) To encourage the student to use the various power system engineering tools (software and simulator) in parallel with the theoretical teaching that will be the reason for higher learning outcomes.

3) To evaluate the developed teaching package by the experts in the field of electrical power engineering from Thailand and Myanmar.

4) To evaluatestudent's satisfaction from Technological University of Dawei for using the developed teaching package.

III. RESEARCH METHODOLOGY

The first process starts from the studying of teaching and learning conditions of power system engineering subject including the curriculum observation. The next processed to develop the instructional package including both computer aided power system analysis text book and power system engineering software user manual. Subsequently, the teaching package will be evaluated by 5 instructors (3 experts from KMUTNB and 2 experts from TU Dawei and also applying to a sample group of 10 students at Technological University of Dawei by using questionnaires. Finally, the collected data will be analyzed and concluded.

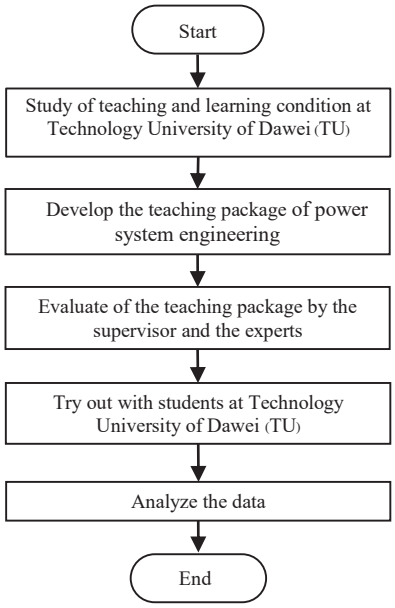


Figure 2. The basic flow chart of research methodology

IV. RESEARCH RESULTS

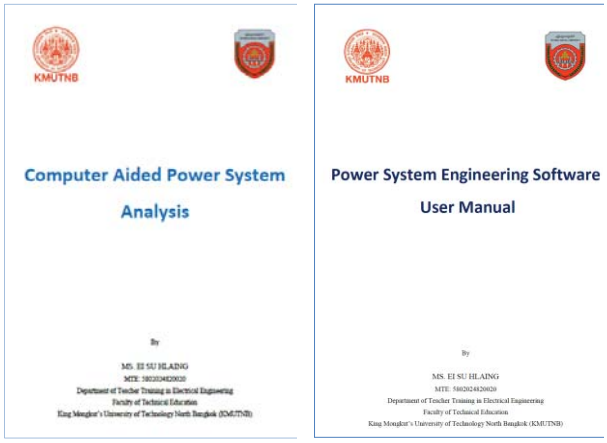
The results of this research consist of three main parts that are: 1) teaching package of power system engineering, 2) evaluation of the teaching package by the experts and 3) the level of student's satisfaction for using the proposed teaching package.

1) Teaching package of power system engineering

In this paper, the developed research tools consist of Computer aided power system analysis text book and Power System Engineering User Manual. Computer aided power system analysis text book, the student can get the idea of all theoretical parts regarding to power system analysis for example: Power Flow Analysis, Fault Analysis, and Economic Load Dispatch etc. Regarding Power System Engineering Software User Manual, the student can have the experience by using the program and simulation software in order to get better understanding about the power system analysis. In this part, we will

 DOI:10.14416/c.fte.2017.11.079

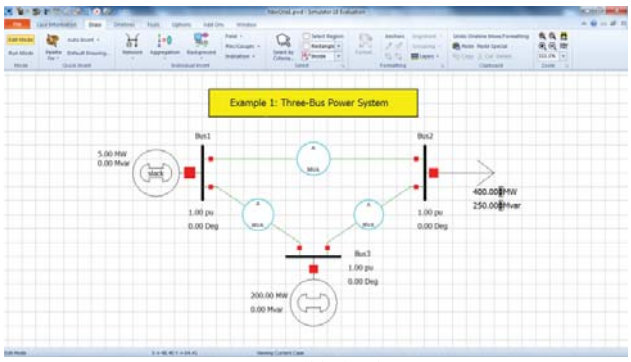
present very useful simulations in the area of power system engineering i.e. MATLAB Programming, Power World Simulator, TORA Program, Optimization Toolbox, Genetic Algorithm Toolbox. The example of teaching package can therefore be presented as shown in Figure 3.



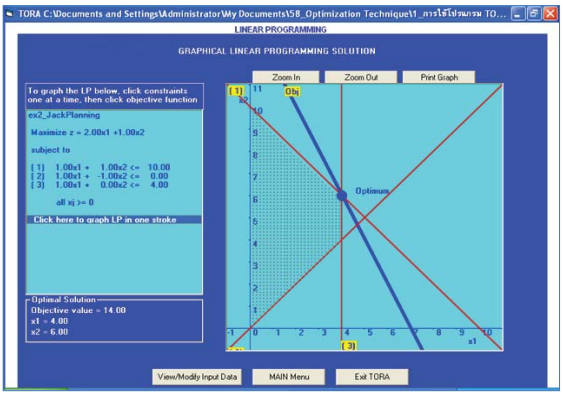
(a) Computer Aided Power System Analysis Text Book

(b) Power System Engineering Software User Manual

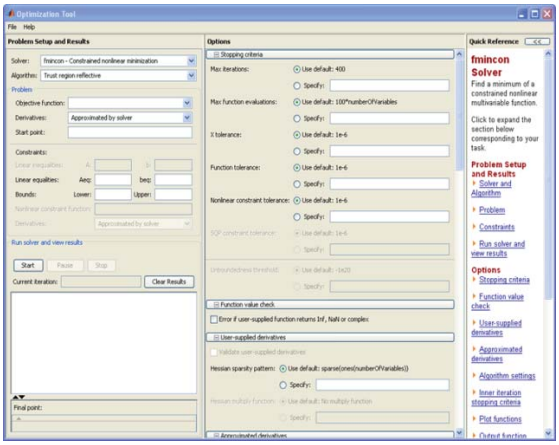
Figure 3. The developed teaching package



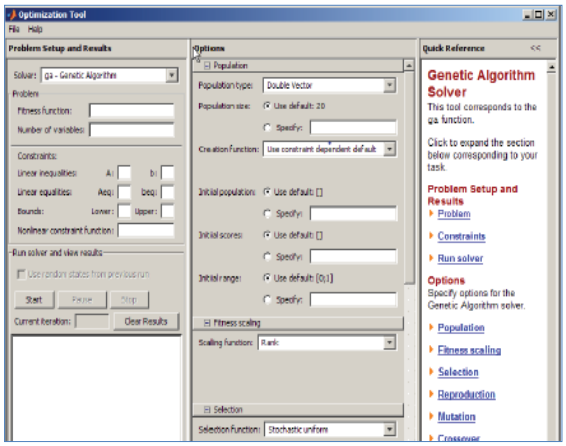
(a) Power World Simulator [6]



(b) TORA Program [7]



(c) MATLAB: Optimization Toolbox [4]



(d) MATLAB: Genetic Algorithm Toolbox [5]

Figure 4. The example of Power System Engineering Software User Manual

In addition, the simulation software mentioned cannot handle some kind of electrical power engineering problems. So, we can create our simulation software for students by using the MATLAB and also GUI (Graphical User Interfaces) to give the student to use our software simulation easily that can work together between GUI and MATLAB. Namely, GUI is the display of the main program that can input the problem parameters by using GUI. Then, the parameters can be calculated by Script M-files format of MATLAB. After that, the simulation result will send to GUI for displaying the simulation results. That can help the student in terms of increasing learning ability.

For this research, one of the applications of power system optimization that is Economic Dispatch Problem is adopted to implement. The systems consist of the standard 3-unit system with smooth cost functions given in [8]. In this case, the population number is 40 while, the maximum number of generations is 50 and the power demand is 975 MW. As reported in [1], the optimal solution is $8236.25.

 DOI:10.14416/c.fte.2017.11.079

Figure 6 illustrates the simulation results of genetic algorithm (GA) that can also provide the optimal solution ($8236.25). Moreover, the convergence curves with random initial conditions are illustrated in Figure 7.

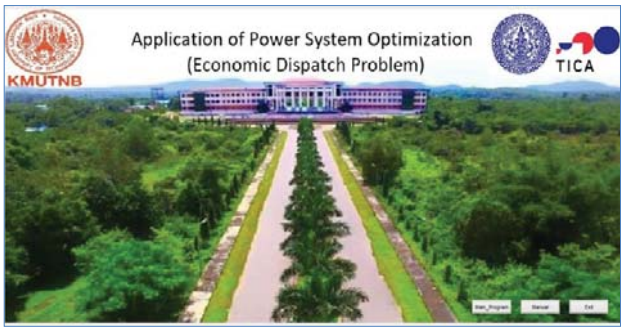


Figure 5. Main program for solving Economic Dispatch Problem

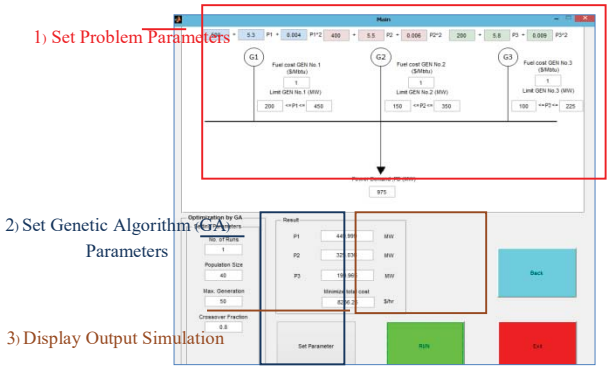


Figure 6. Input/output of the proposed program for Economic Dispatch Problem

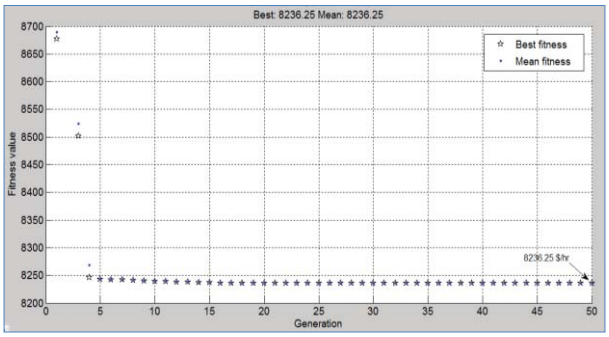


Figure 7. Convergence characteristics of the Genetic Algorithm Method for solving Economic Dispatch Problem

2) *Evaluation of the TEACHING package by the experts*

The qualities of research tools for power system engineering are evaluated by 5 experts (3 experts from KMUTNB and 2 experts from Technological University of Dawei (TU Dawei) who have experiences in teaching in the area of electrical engineering. Evaluations by five level of rating scale are assigned as the following. The evaluated results of teaching package can be illustrated in Table I.

TABLE I
The Results of Evaluation of The Teaching Package by 5 Experts

List of Assessment	Average	S.D.	Level
1.Usability	3.85	0.68	High
2.Functionality	4	0.72	High
3. Performance	4.05	0.27	High
Average	3.97	0.56	High

From the evaluation, it is observed that the developed teaching package is also at high level which the average is equal to 3.97 and the standard deviation is 0.56.

3) *Satisfaction evaluation of students for using the teaching package*

Not only the evaluation of the teaching package by the experts but also the evaluation of students' satisfaction for using the teaching package are adopted by using the population is 10 fourth-year students who registered in electrical power student at TU Dawei. The sample group was taught by using the developed instructional tools in power system engineering subject as shown in Figure 8. After learning all lessons, we measured students' satisfaction of usage of developed instructional tools using questionnaire. The questionnaires of students' satisfaction are evaluated with rating scale of 5 levels to analyze the quality of teaching package. The results of student's satisfaction evaluation will be shown in the Table II.

Figure 8. The teaching implementation at TU Dawei

 DOI:10.14416/c.fte.2017.11.079

TABLE II
THE RESULTS OF STUDENT'S SATISFACTION EVALUATION FOR USING THE TEACHING PACKAGE

List of Assessment	Average	S.D.	Level
1.Usability	4.70	0.44	Very High
2.Functionality	4.71	0.49	Very High
3. Performance	4.70	0.42	Very High
Average	4.71	0.45	Very High

From the table of student's satisfaction evaluation, it shows that the developed teaching package is at very high level of student's satisfaction, which the average is equal to 4.71 and the standard deviation is 0.45. Therefore, it can be concluded that the developed teaching package can be used for teaching Power System Engineering courses at TU Dawei.

V. CONCLUSION

In this paper, the development of the teaching package of power system engineering is proposed. The teaching package consists of computer aided power system analysis text book and power system engineering user manual. The teaching package aims at encouraging the student to use the various power system engineering tools (software and simulator) in parallel with the theoretical teaching. To evaluate the quality of the teaching package, 1) the evaluation of the teaching package by the experts and 2) the satisfaction of student's evaluation for using the teaching package were determined. From the evaluation by experts, the results showed that the developed teaching package can be used effectively it is observed that the developed teaching package is also at high level. In addition, the students satisfy the developed teaching package at very high level. Therefore, the teaching package can be applied for teaching in the field of power system engineering subject. For the future research, it is possible to include more practical power system problems or case studies with the teaching package and also investigate the effectiveness on students' learning performance.

VI. ACKNOWLEDGMENT

I would like to express my very great appreciation to my supervisor, Assoc. Prof. Dr. Pichet Sriyanyong for his valuable and constructive suggestions of this paper. I gratefully acknowledge the scholarship received from Thailand International Cooperation Agency (TICA).

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 DOI:10.14416/c.fte.2017.11.079