The Simulation Computer Based Learning (SCBL) for Short Circuit Multi Machine Power System Analysis

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Abstract-Strengthening Competitiveness of human resources become the reply of college as a conductor of high formal education. Electrical Engineering Program UNPAB (Prodi TE UNPAB) as one of the department of electrical engineering that manages the field of electrical engineering expertise has a very important part in preparing human resources (HR), Which is required by where graduates are produced by DE UNPAB, Is expected to be able to compete globally, especially related to the implementation of Asean Economic Community (AEC) which requires the active participation of graduates with competence and quality of human resource competitiveness. Preparation of HR formation Competitive is done with the various strategies contained in the Seven (7) Higher Education Standard, one part of which is the implementation of teaching and learning process in Electrical system analysis with short circuit analysis (SCA) This course is a course The core of which is the basis for the competencies of other subjects in the advanced semester at Development of Computer Based Learning model (CBL) is done in the learning of interference analysis of multi-machine short circuit which includes: (a) Short-circuit One phase, (B) Two-phase Short Circuit Disruption, (c) Ground Short Circuit Disruption, (d) Short Circuit Disruption One Ground Floor Development of CBL learning model for Electrical System Analysis course provides space for students to be more active In learning in solving complex (complicated) problems, so it is thrilling Ilkan flexibility of student learning how to actively solve the problem of short-circuit analysis and to form the active participation of students in learning (Student Center Learning, in the course of electrical power system analysis.

Key Word: Active Learning CBL, Short Circuit Analysis

1. Introduction

The electric power system that generally consists of a channel and load generator is a system that processes the empowerment and use of electrical energy. The need for electrical energy is a primary priority in supporting development activities in various aspects of life [1]. So Conducted several studies and studies that are analyzed to improve reliability in the process of empowerment and use of electrical energy. In operation, the power system can not be separated from interference, be it interference that is temporary or permanent disturbance. Interference in the power system consists of symmetrical disruption, asymmetric interference and open conductor disruption [2].
The complex power system implies that the system has multiple machines in the service of the load, so special handling is required in providing customer service continuity by maintaining, effectively handling disturbance conditions so that the distribution of electrical energy does not experience significant constraints. From this it is necessary to conduct a series of analysis of electric power system, one of which is a brief short-circuit analysis using a practical computer.

The learning model (CBL) is a form of computer-based learning model. Computers are used as a medium / tool to deliver materials and teaching materials in the learning process to be able to attract the attention of learners. The teaching materials to be delivered are developed using a learning development model that can be used to create computer-based learning. In the teaching materials, it has included material, questions, and feedback or tasks presented in a single program package. CBL learning model is a teaching and learning system that uses computer equipments as a tool of help together with its knowledge base (knowledge base), is the development of integrated information technology ie communication (interactive), audio, video, image appearance Packed with multimedia designations. With Benefits of using CBL learning model, among others: (A) Able to reduce training costs, (b) Flexibility of time, (c) Flexibility of learning speed, (d) Standardization of learning, (e) Effectiveness of learning, (f) Can store student data, lessons and ongoing learning process [2].

2. The Computer Based Learning (CBL) For Short Circuit Analysis.

The design of instructional media designed to produce an interactive learning media for protection system applied to industrial electrical system. In the sample paper has presented plot of relay coordination response curve for industrial system grid system 3 bus By using this package students get simulation experience as well as knowledge about Industrial applications. The created package has been able to complete the course activity and as a teaching tool for lecturers and students. Computing The program is designed to help students avoid the boredom to calculate the industrial security system by replacing the method of calculation with a simulation dish. This approach can provide a very important stimulus in building self-learning concepts for students [3].

The simulated model built asks and directs them (the students) to provide space to discuss the results of short-circuit analysis on the outcomes of the project, (3) Report on simulation results in practical practical laboratory-models of their PSP simulation experiments in learning. And observing And measure Tingat motive Studying students from the PSP-based model of computer simulation experiments. Network modeling, power flow and short-circuit current analysis and Over Current Protection (OC) and coordination of protective relays have been presented using computer-assisted software in ETAP. In addition, students can visualize the results of observing domain errors with OC, distance and differential protection in software PSCAD / EMTDC. Protection for transformer equipment from Over Current (OC), simulation Over voltage and phase imbalance for induction motor device protection have been tested in practical experiment learning with the help of LabVolt electrical module. Experimental results from Study paper with title Enhancing Student Experience Learning System Power Protection using Computer based simulation with Practical Experiment development can be concluded learning design with computer help facilitated simulation using ETAP and PSCAD / EMTDC software for student students at Curtin University, Australia Conducted in the full semester of learning gets feedback given to the student With an indicator of student interest in Power System Protection (PSP) learning [4,5].
3. CBL Design in teching-learning

CBL-based interactive learning environment for short circuit analysis of electrical power systems is realized by four stages as shown in Figure 1. Other (1) Preparation of learning planning, by arranging the learning material structure in the form of horizontal matrix containing the contents about the expected competence, teaching materials Which will be delivered as well as indication of successful learning. The arrangement of this lesson plan will be socialized to the group of lecturers in the field of electrical power system expertise which becomes The same standard of learning plan among lecturers In a field relevant to the electrical systems analysis course (2). Conduct construction of the matrix Z model matrix arrangement of a multi-machine interconnection system which will be arranged in a symmetric short circuit settlement program and the asymmetric short circuit. (3) The results of step 2 (2) further develop CBL-based learning modules and compose CBL-based SCL job-sheets used by learners in learning Solve SCC problem. (4). Completion of cases with data obtained in real terms. To complete CBL learning with project based learning content in the sense that learners are directed to conduct research related to SCC conducted at the time of learning. Development of this learning model Foster interest in learners by participating actively in the learning process of teaching SCC

![Figure 1. Design CBL model](image)

Teaching and Learning Process of short circuit interaction analysis of power systems developed by innovation Lecturing system that is not only done in the lecture room, but developed by implementing the practical learning in the computer laboratory, basically the course is the subject of theoretical studies. However, the development of an interactive CD is completed. CBL learning model for schematic SCC study is shown in fig.1
For Practical Computer Based Learning Device [6], illustration of power system diagram is given in figure 2.

![Figure 2. One line diagram of Electric Power system](image)

The line diagram of the electric power system in Fig. 2 will be formed in the reactance diagram, as shown in Fig. 3 below:

![Figure 3. Admittance Diagram](image)

From the picture of the admittance diagram figure (3) is prepared the equation:

\[ I_1 = V_1 y_{10} + (V_1 - V_2) y_{12} + (V_1 - V_3) y_{13} \]  
\[ I_2 = V_2 y_{20} + (V_2 - V_1) y_{12} + (V_2 - V_3) y_{23} \]  
\[ I_3 = V_3 y_{30} + (V_3 - V_1) y_{13} + (V_3 - V_4) y_{34} + (V_3 - V_2) y_{23} \]  
\[ I_4 = V_4 y_{40} + (V_4 - V_3) y_{34} \]

Equations (1) through (4) can be simplified to be

\[ I_1 = (y_{10} + y_{12} + y_{13}) V_1 - y_{12} V_2 y_{13} V_3 + 0.0 V_4 \]  
\[ I_2 = -y_{13} V_1 (y_{20} + y_{12} + y_{13}) V_2 y_{23} V_3 + 0.0 V_4 \]  
\[ I_3 = -y_{13} V_1 - y_{13} V_2 + (y_{30} + y_{12} + y_{23} + y_{34}) V_3 + y_{34} V_4 \]  
\[ I_4 = 0.0 V_1 + 0.0 V_2 y_{34} V_3 + (y_{40} + y_{34}) V_4 \]
Can be arranged into Y Bus matrix and generate bus impedance matrix: \( Z_{BUS} = Y_{BUS}^{-1} \)

Recognize the massive short-circuit symmetrical short-circuit impedance through a series of conventional analyzes and computer-based testing to derive practical and efficient ways of determining the value of short-circuit power circuit breakdowns.

4. Case Study (Simulated System Model)

System 10 bus as shown below with data as follows

![Figure 4. 10-bus interconnection power system](image)

| ITEM | MVA RATING | VOLTAGE RATING | \( X_1 \) | \( X_2 \) | \( X_0 \) |
|------|------------|----------------|----------|----------|----------|
| G1   | 100        | 25 kV          | 0.20     | 0.20     | 0.05     |
| G2   | 100        | 13.8 kV        | 0.20     | 0.20     | 0.05     |
| T1   | 100        | 25/230 kV      | 0.05     | 0.05     | 0.05     |
| T2   | 100        | 13.8/230 kV    | 0.05     | 0.05     | 0.05     |
| 1-2  | 100        | 230 kV         | 0.10     | 0.10     | 0.30     |
| 2-3  | 100        | 230 kV         | 0.10     | 0.10     | 0.30     |
| 1-6  | 100        | 230 kV         | 0.10     | 0.10     | 0.30     |
| 2-7  | 100        | 230 kV         | 0.40     | 0.40     | 0.80     |
| 3-9  | 100        | 230 kV         | 0.40     | 0.40     | 0.90     |
| 6-8  | 100        | 230 kV         | 0.10     | 0.10     | 0.10     |
| 8-9  | 100        | 230 kV         | 0.40     | 0.40     | 0.60     |
| 7-10 | 100        | 230 kV         | 0.40     | 0.40     | 0.90     |
| 9-10 | 100        | 230 kV         | 0.40     | 0.40     | 0.80     |

Matrix \( Z \) modeling bus is used to input the reactance data on \( M \). Matlab to obtain Positive sequence, Negative sequence and Zero sequence, Impedance Matrix with equation \([7,8]\) 

\[
Z_{rel} = [V_{rel}]^{-1}
\]
5. Result simulation

SCC Simulation for 11 Bus System Data Input on M. Matlab Files and Enter Faulted Bus No. -> 8
Enter Fault Impedance Zf = R + j*X in complex form (for bolted fault enter 0). Zf = 0.1, Balanced three-
phase fault at bus No. 8. Total fault current = 6.3869 per unit  Bus Voltages during fault in per unit:

| No. | Voltage | Angle   | From | To   | Current | Angle   |
|-----|---------|---------|------|------|---------|---------|
| 1   | 0.8187  | -11.5749| G    | 1    | 1.2861  | -50.3057|
| 2   | 0.7801  | -15.2615| 1    | 2    | 1.2861  | -50.3057|
| 3   | 0.7466  | -19.1233| 2    | 3    | 0.6141  | -50.3057|
| 4   | 0.7311  | -21.1824| 2    | 11   | 0.6719  | -50.3057|
| 5   | 0.7033  | -25.5573| 3    | 4    | 0.6141  | -50.3057|
| 6   | 0.6910  | -27.8702| 4    | 5    | 0.6141  | -50.3057|
| 7   | 0.7356  | -20.5678| 4    | 6    | 0.6141  | -50.3057|
| 8   | 0.6378  | -50.3057| 5    | 6    | 0.6141  | -50.3057|
| 9   | 0.6570  | -36.7585| 6    | 8    | 2.6371  | -50.3057|
| 10  | 0.6449  | -42.3209| G    | 7    | 2.0230  | -50.3057|
| 11  | 0.6633  | -34.6346| 7    | 6    | 2.0230  | -50.3057|

6. Conclusion

Based on the research results can be concluded as follows: The electrical system model is formed
into the R impedance matrix R equation using M. Matlab facilitates practical analysis of the case of short
circuit of electric power system Simulation and analysis results obtained short circuit interruption on bus 8
for the system dialialiais respectively; Ifault 3 phase = 6.3869 pu, Ifault for one Phase = 8.5011 pu,
Ifault ; Between phases = 3.87 pu Preparation of computer-assisted short-circuit analysis tools in learning
(Computer Based Learning) in practical, efficient and fast can be utilized by students of electrical
engineering program UNPAB in electrical power system analysis analysis for material Short Circuit
Analysis.

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