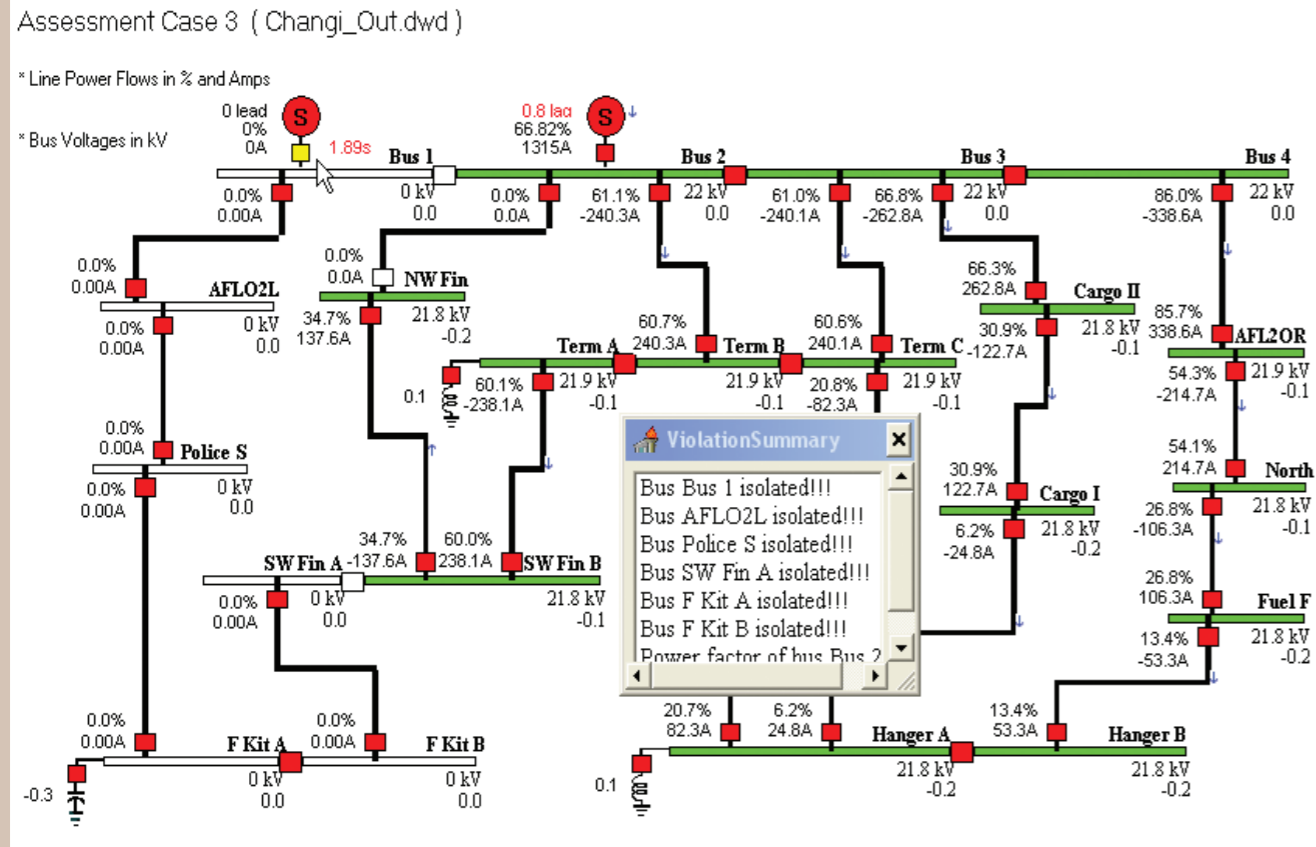
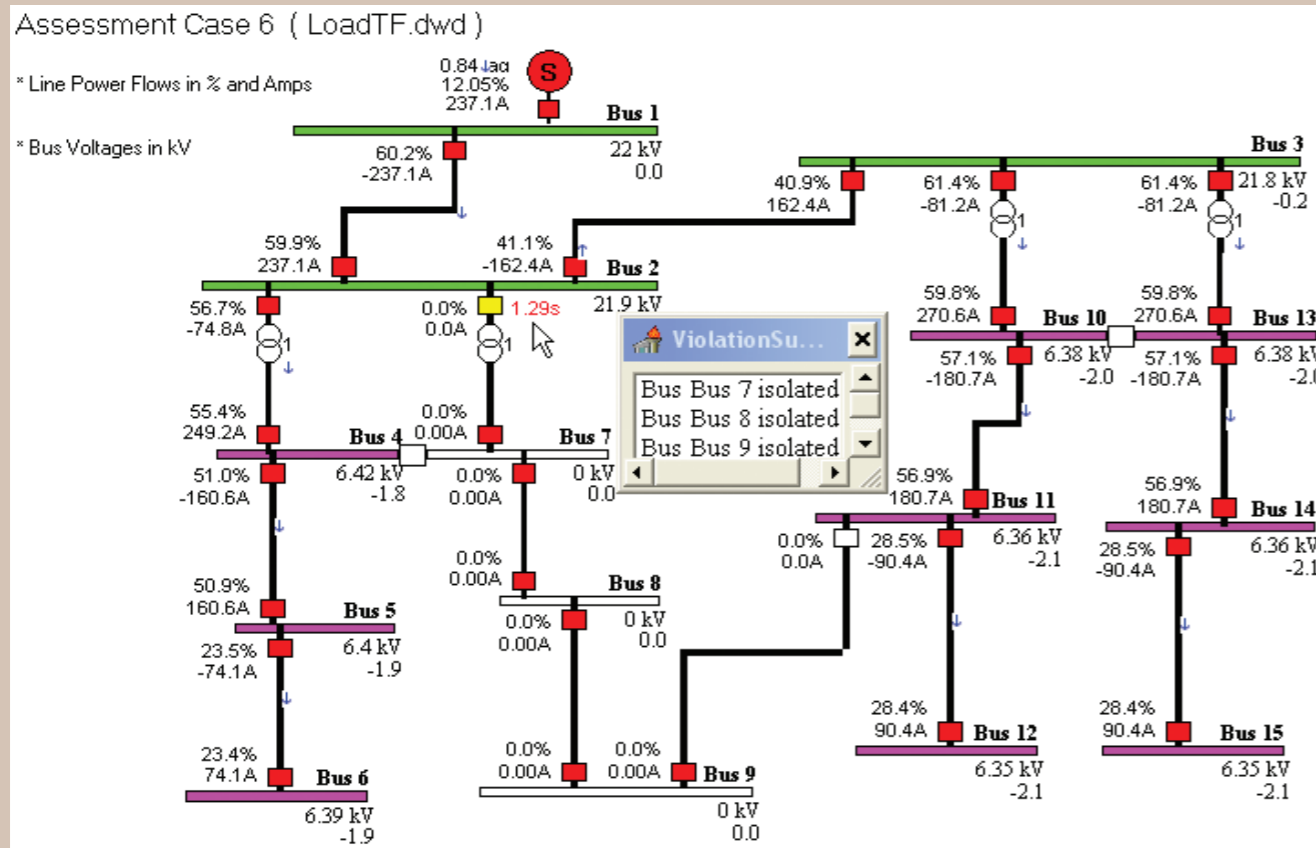


VipSut

Visually Interactive Power Distribution System Simulator for Undergraduate Teaching



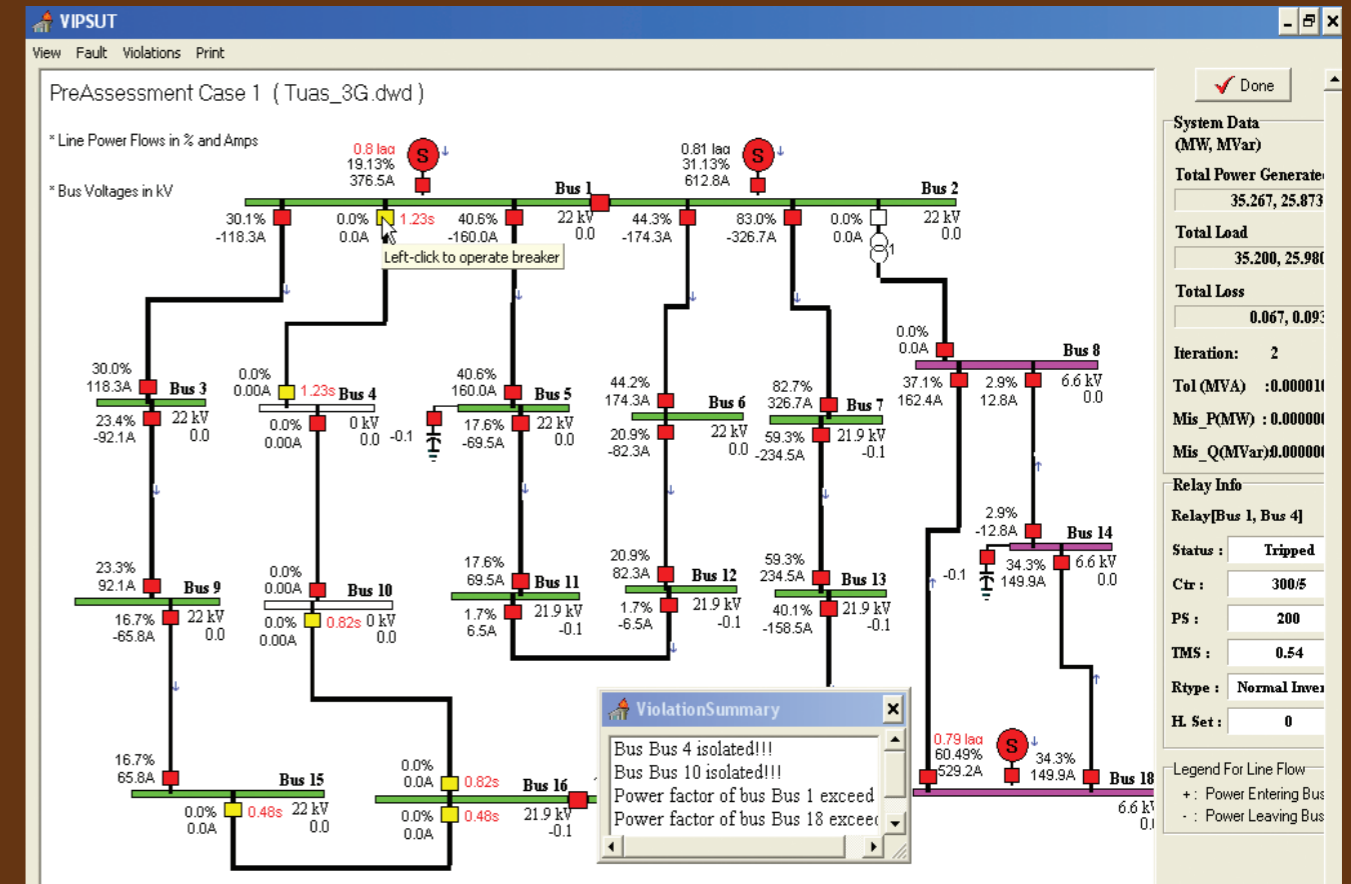
Source Breaker at Bus 1 Tripped at 1.89 Seconds Resulting Six Dead Substations and the Breaker at NWFin to Bus 2 is Out of Service



Breaker from Bus 2 to Bus 7 Tripped at 1.29 Seconds Resulting Three Dead Substations

VipSut

Visually Interactive Power Distribution System Simulator for Undergraduate Teaching



Pre Assessment Case 1 with Breaker Tripping Times in Seconds and Four Violations

ASSESSMENT REPORT

VIPSUT ASSESSMENT RESULTS

CRITERIA	D-PTS/OCCUR	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Total D-PTS
Supply Interruption	-1	1	0	0	0	0	0	-1
Breakers Trip	0	0	0	0	0	2	0	0
Generation Reactive Limit Violation	-1	0	0	0	0	0	0	0
Dead Bus	-4	1	0	0	0	0	0	-4
Overloaded Line	-1	0	0	1	0	1	0	-2
Percentage Load Reduction	-1 per 3%	0.00 %	0.00 %	3.00 %	0.00 %	5.00 %	0.00 %	-3
Voltage Violation	-2	0	0	0	2	0	0	-4
Generator PF Limit Violation	-1	0	0	1	0	0	0	-1
Fault Reconnected	-2	0	0	0	0	1	0	-2
Parallel Source Error	-2	0	0	0	0	0	0	0
Block breakers	-4	0	0	0	1	0	0	-4
GRADE		B	Dist	A	D	B	Dist	D

Results: Print Total Demerit Pts: -21 Close

Users: Student A : Tan Yan Sin Student B : Teo Shih Yew Date : 1/21/2009 Time : 1:22:04 PM
Group ID : 8 Supervisor : Prof. Teo Cheng Yu

Assessment Report Showing Grading Criteria and Number of Errors with a Grade for Each Case

Visually Interactive Power Distribution System Simulator for Undergraduate Teaching (VipSut)

VipSut was developed by a Professor in the university to teach his undergraduate power engineering students and for the training of engineers in power utilities. It is a new attempt to teach power engineering interactively using a microcomputer and to make the subject more interesting and challenging. It was designed for students to familiarize themselves with the interconnected electrical system and the associated protective scheme, as well as the possible fault and overloading conditions. VipSut provides a hands on exercise for logical thinking to identify the type of abnormal conditions such as fault and overloading. The student can isolate the fault and work out the appropriate actions to restore power supply in a distribution system.

This integrated simulator is interactive and can be operated as if operating from a remote SCADA control centre. Appropriate sets of scenarios can be specified by the instructor for different levels of exercises. The performance of each student or engineer is evaluated automatically through error logs and demerit points which are then converted to a grade of A B C or D.

1 INTEGRATED LOAD FLOW CALCULATION

Once a network is loaded or after each student's control action, load flow will be calculated automatically and each overcurrent relays will be modeled. The corresponding breaker will trip if the load current in any circuit exceeds the relay settings. Once a breaker trips, load flow calculation will be repeated. Active and reactive power flows of each circuit and the voltage magnitude and angle at each bus will be updated and graphically displayed on the single line diagram.

2 INTEGRATED FAULT CURRENT CALCULATION

The user or the instructor may apply a fault at any node or any circuit. VipSut captures the network topology and calculates the fault current distribution. The calculation is repeated whenever any breaker trips which alters the network configuration. At each stage, VipSut determines whether the fault has been isolated and if so, it stops the fault current calculation and activates the post-fault load flow.

At each cycle of fault current calculation, overcurrent relays are modeled and the operating time of each relay is calculated based on the fault current in each circuit. The relay which has the lowest operating time trips the corresponding breaker. The current and time settings of each relay can be viewed or adjusted during runtime.

3 VISUAL USER INTERFACE

VipSut utilizes all standard Window facilities such as pull down menus, pop-up windows, symbolic icons and various visually interactive dialogue boxes, etc. It is arranged such that all the menus, icons and dialogue boxes are self-documented. Once a network is loaded, the student may:

- ◆ View a list of real-time network violation.
- ◆ View circuit flow in MW/MVAr or ampere/percent.
- ◆ View voltage displayed in kV or in per-unit.
- ◆ View loading displayed in MW/MVAr or ampere/pf.
- ◆ View or change relay settings of any breaker.
- ◆ Operate (open, close or block) any breaker.
- ◆ Adjust reactive compensation at any node.
- ◆ Adjust MW output at any incoming source.
- ◆ Adjust voltage magnitude at any incoming source.
- ◆ Adjust transformer tap-changer position.
- ◆ Shed load or restore load in any node.
- ◆ Activate a fault (cleared by unit protection) at any line or node.
- ◆ Activate a fault (cleared by back-up protection) at any line or node.

4 PRE-ASSESSMENT EXERCISE

Six cases of supply interruption due to fault or overload on different networks are given in the pre-assessment exercise. These six cases are prepared by the instructor and stored in a pre-specified file. For each case, the type of fault and fault location are hidden and will not be revealed. Network violations such as dead bus, overloaded circuits, power factor violation, voltage violation and/or supply interruption will be highlighted. The student's fault diagnosis, actions in restoration, and ways to resolve each network violation will be logged and assessed. Based on a set of criteria, an assessment report with a grade will be displayed at the end of each case and an overall grade will be given for all the six cases. Students may select any case in any sequence. This module allows students to go through each case as many times as required for them to learn and to prepare themselves for the assessment module.

5 ASSESSMENT

The final assessment module would require the

instructor to login by entering a password and each student can only run through this module once, similar to an examination. Based on another pre-specified file, VipSut generates another 6 cases similar to the pre-assessment module but on different networks, running continuously from case 1 to case 6. The overall grade generated at end of the assessment will be recorded as the grade of the particular student for this module.

6 BUILT-IN INSTRUCTOR CONTROL

VipSut provides built-in features for the instructor to specify the six cases in the pre-assessment module and another 6 cases in the assessment module. The scenario in each case is created by one or a combination of several events on each selected network as follows:

- ◆ A line fault isolated by backup protection.
- ◆ A busbar fault isolated by backup protection.
- ◆ One or a number of circuits overloaded due to load increase.
- ◆ One or a number of breakers out-of-service and open.
- ◆ Network violation on voltage and power factor.
- ◆ A particular transformer failure.

7 TRANSPARENT GRADING SCHEME

At the end of each case, VipSut displays a table showing the types of error made, demerit points for each error and a grade for that particular case. There are six types of error logged only at the end of each case and five types of error logged immediately once the student made a mistake. The instructor may adjust the number of demerit points for each type of error and the conversion from the total demerit points to an appropriate grade in a pre-specified file.

8 FIELD TESTED

MIPSUT, the preliminary version of VipSut has been used successfully at Nanyang Technological University, University of Bath, Singapore Polytechnic, Monash University, Hongkong Polytechnic University, PUB Utility Training Centre, University of Dundee, Swinburne University of Technology and Curtin University.

9 RELATED PUBLICATIONS

- [1] Gooi H. B., Teo C. Y., "A Project-oriented Power Engineering Curriculum", IEEE Transactions on Power Systems, Vol. 10, No. 1, PP 27-33, 1995
- [2] Teo C. Y., "A Comprehensive Software Simulator for Teaching of Power Distribution Systems" International Journal of Electric Engineering Education, Vol. 30, PP 254-268, 1993
- [3] Teo C. Y., Gooi H B, "Artificial Intelligence in Diagnosis and Supply Restoration for Distribution Network", IEE proceedings on Generation Transmission and Distribution, Vol. 145, No. 4, pp 444-450, 1998
- [4] Teo Cheng Yu, "Teaching of Power Engineering Through E-Learning with Laboratory Automated Assessment", ICEE, International Conference on Engineering and Education, March 2009

10 LICENSE AND FEE

VipSut is available under a license for a single-copy price of Singapore dollars \$6,800. Multiple copies and site license discounts are available.

11 TECHNICAL SUPPORT

Support and update are provided for one year. You may e-mail to cyteo@ntu.edu.sg for technical support or any inquiry. Free demo can be downloaded from www.byte-power.com and site visit for demo can also be arranged.

12 HOW TO ORDER

Make bank cheque in Singapore dollar payable to Byte Power Publications and post to 10H, Braddell Hill, #23-30, Singapore 579727. VipSut will then be delivered in a CD with an instructor guide.

