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An Interactive Power System Analyzer With Graphics Display For Educational Use

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graphics terminals) can presently be supported. Portions of the package have also been successfully run on an IBM PC.

The full attributes of the package are described in the paper and several examples are given. A typical case would be an induction motor driven by an ac voltage controller (Fig. 1). The startup torque and speed transients for a low inertia motor are shown in Fig. 2a and 2b.

Reference

[1] R. W.-Y. Cheung, "The Basis Transformed State Space Approach for the Analysis of Power Semiconductor Circuits, M.A.Sc. thesis, University of Toronto, 1983.

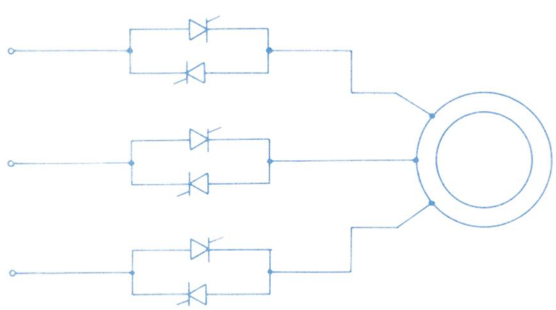

Fig. 1. Induction motor supplied through a 3-phase thyristor ac voltage controller.

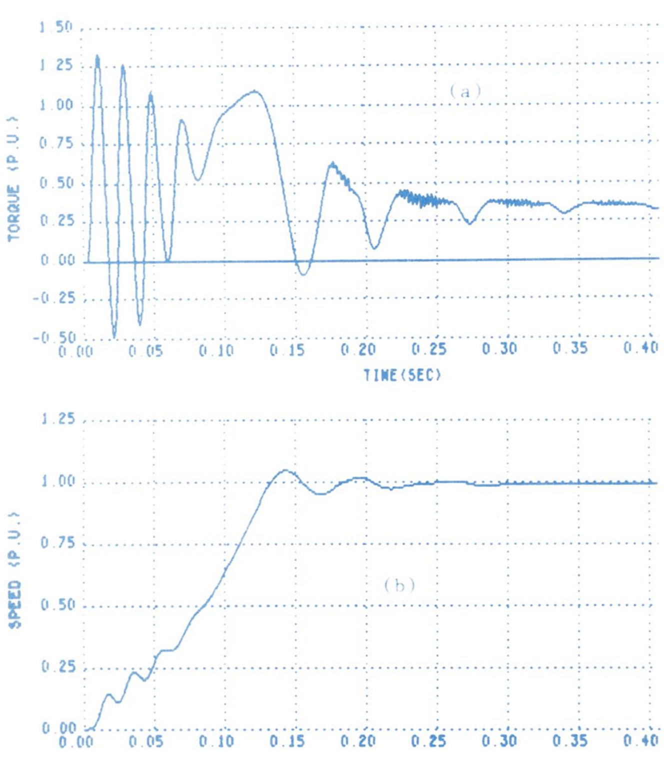

Fig. 2. Startup torque (a) and speed (b) transients for the drive of Fig. 1.

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An Interactive Power System Analyzer with Graphics Display for Educational Use

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Abstract—The paper presents a student-oriented power-system analyzer with an interactive graphics display. Its capabilities include studies of (1) load flow, (2) load and generation, (3) voltage level control, (4) economic dispatch, and (5) contingency and planning analysis. Power network configurations of up to 30 buses can be presented clearly on one screen. The interactive nature of this program makes such studies effective and easy to use. With the support of a computer with graphics software and many graphics terminals, this program can be a useful teaching tool for power system studies.

The object of this work is to produce a computer/graphics facility for power-system studies that the junior and senior students can use. The computer available for student use is the IBM 4381, which is linked with an interactive graphics system. The Tektronix 4014 display terminal is a CRT storage display device with an enhanced resolution of 4096*3120. This system is supported by many software packages including TCS, which has been chosen for this study.

The power-system analyzer is designed to include the following features:

1. *Interactivity*

   The most common outstanding feature of this analyzer is that it is interactive. The potential saving in time by achieving the solution within a few seconds rather than a few hours or days is important.

2. *Easy graphics display*

   Two kinds of graphics displays are used. For a small system, an automatic display mode is available. No graphics data are needed. For a large system, the graphics display is built step by step by moving a crosshair and pressing a function key.

3. *Flexibility*

   The configuration of any power system is not constant, especially that used for power-system studies. Therefore a power-system analyzer should reflect this flexibility; i.e., any combination of buses and lines should be allowable, and any subsequent alterations should be easy to make. These are done by simple cursor movements and keystrokes in response to prompts from the analyzer.

Every effort has been made to facilitate easy use of the analyzer. The student can complete his study by just following the instructions appearing on the screen; i.e., the user is prompted for the next data item to be entered. Basic data such as the number of buses, number of lines, line impedances, etc., are entered interactively in free format in order to help avoid mistakes. After the execution of the base case, the student can observe the power network and associated data. Four "change cases" are then provided for further studies as described below.

Load and Generation Studies

After execution of the base case the student may want to change the load and/or generation data of a bus. The new data can be entered from the keyboard, and the load flow program is executed again.

Voltage Level Control

The bus voltage magnitude is not expected to deviate from the rated voltage by more than 5 percent. However, sometimes bus voltages may be lower than 0.95 per unit or above 1.05 per unit due to system demand variations. The student can control the voltage level by adjusting the reactive power of the generators and by adding (subtracting) capacitance to (from) load buses.

Economic Dispatch

A power system containing more than one generator unit can provide a specified load demand in an infinite number of generation combinations. Only one of the schedules gives the ''best'' economic operation of the system. During the course of the analysis, the student is first provided with the base case, and then prompted to input the coefficients of incremental cost curves for each generator. The Lambda-Iteration 6 and Bisection method are used. The computer prompts the user to supply an estimated lambda, and possible maximum and minimum lambda values. Finally, through the execution of the economic dispatch program, an optimal generation schedule is computed and presented to the student.

Contingency and Planning Studies

The loss of a transmission line may create an emergency situation. The student can simulate these contingencies and then try to find a solution to correct this situation. A line can be added by entering line data for a planning study. The contingency case of losing a generator unit can be simulated under the load and generation studies facility.

This program has been dimensioned for 30 buses and 50 lines. It has been tested on power systems of up to 25 buses and 35 lines. Programmers familiar with the FORTRAN language and the TCS instructions will have no difficulty in developing any additional software for the power-system analyzer.

Finally, from a teaching point of view, the program can offer students a graphical presentation of more challenging power systems. The interactive features save time. The ability to display a 25-bus system on a screen will undoubtedly make those studies more effective and less limiting. With the support of the IBM system and the many Tektronix graphics terminals available, this program provides the university with a very useful teaching tool in power-systems engineering.

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An Assessment of Personnel Needs and Supply in Electric Power Engineering

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Abstract—The health of any engineering industry is gauged in part by an assessment of its personnel needs and supply as well as the qualifications of the engineers involved. This assessment should be done not only in the short term (i.e., next 3–5 years), but also in the long term. This paper is a qualitative and quantitative assessment of the personnel needs and supply in the electric power industry. Problems related to personnel quality and, perhaps, long term supply have been identified.

Approximately 5 percent of Electrical Engineering students in the United States are committed to power engineering. This figure had exhibited a significant downward trend since 1971. This downward trend is also observed in the commitment of Electrical Engineering university faculties. While the data do not indicate disturbing consequences in the short term, there is a serious problem foreseen in the long term. The concern is not relegated to the raw number of graduates in power; there is a potential problem related to the flexibility of graduates. Applications of digital technology are especially important: new hires must be conversant with this technology, they must be willing to learn and study the requirements of power applications, and they must be qualified to solve problems of digital analysis and control.

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Application of Relational Database to Computer-Aided-Engineering of Transmission Protection Systems

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This paper describes the role of the database management system in a package of computer-aided-engineering (CAE) software designed to assist protection engineers. The engineering of transmission protection systems, especially the coordination of relays, involves the manipulation of large quantities of data. Naturally, computers have been employed, typically to compute large numbers of fault currents or for ''batch'' approaches to finding relay settings as in [1]. In these efforts, the large data sets have been organized using traditional file structures.

Rather than batch approaches, we believe that protection engineers need interactive CAE tools, particularly for the tedious task of coordinating relays [2, 3]. We also believe that the large quantities of data involved are much more manageable if formal database management methods are used. In our work, these methods have indeed yielded the expected benefits of (1) ease of user understanding of the data, (2) independence of the data organization from its application and (3) increased productivity in software development. The last benefit is a direct result of the second. By being able to use the data in its ''natural'' organization, the programmer is relieved of continually reorganizing data for specific programs.