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Simulation Tools for Power Electronics-"An Overview"

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ABSTRACT: This paper presents various simulation tools for educational and professional purposes in the area of power electronics. Power Electronics based circuit is used in power system, Electrical drive, FACTS Controllers etc. Simulation tools for Power Systems, FACTS devices are also listed here. The application of simulation software and program provide a powerful tool in the technology of electrical & electronics. Simulation tools provide saving of time, cost, require less space and have better and speedy optimization analysis. Due to above mentioned advantage it would be desirable to replace designing and testing type prototype hardware by simulation software.

Keywords: Simulation Software, MATLAB, PSIM

Nomenclature

FACTS- Flexible AC Transmission System
HVDC- High Voltage Direct Current
GUI- Graphical User Interface
GASP- General Activity Simulation Program
MATLAB- Matrix Laboratory
SIMULINK- Simulation Link
PSIM- Power Simulator
PSPICE- ***Personal Computer Simulation Program with Integrated Circuit Emphasis.***

I. INTRODUCTION

Nowadays computer simulation has been an important tool in teaching. With simulation, one can test new concepts immediately without the need to order components and assembling which might be time-consuming and expensive. The power electronics and electric drive system is one of the most important courses for undergraduate student of electrical engineering and electronics engineering. Teaching a power electronics and electric drive system course is, however, challenging, since the field is quite broad and includes fundamentals from a wide variety of areas of engineering. On the other hand, compared with the past, owing to the increasing courses for the students, teaching time of every course is reduced.

In order to overcome this challenge, the computer simulation has been an important tool to simplify teaching and to introduce student to solve real-world engineering problems. Computer simulation of power electronic circuit allows the students to understand what are the advances in simulation tools, how equations are formed and solved, why only particular methods are employed for the simulation of power electronic circuits etc. Students are also allowed to vary the circuit parameters, to understand the operation of the power electronic circuits and to examine the effect of these changes in the electrical variables. This process is equivalent to the creation of a virtual laboratory where the computer screen replaces the oscilloscope in a real laboratory environment.

II. SIMULATION TOOLS

Computer simulation is an indispensable tool for designing a model of a real or hypothetical physical system, producing the model on a digital computer

through a program and evaluating the execution results. Simulation software gives the accurate replicate of all physical effect that exists in the real world. Simulation provides a way in which alternative design or plan can be estimated without having to experiment with an actual system, which may be quite expensive, involve a great deal of time and impracticable. Simulation tools range of specialized computer programs operating in real-time or non-real-time modes, to customized general purpose modeling environments [1]. By means of a suitable choice of simulator elements, even the inexpert user will be able to customize his package to incorporate future device developments. Several software packages and platforms are used in the building of simulation models for educational and research purpose. Nowadays computer simulation has been an important tool in teaching. The gradual development of digital computer enhances the accuracy and utilities of simulation softwares in the area of space, biomedical, electrical, electronics, computer science, mechanical engineering, civil engineering and technology. However, our discussion is limited to software used in the field of power electronics for teaching & research purposes**.** Simulation tools available for Power Electronics are-MATLAB/SIMULINK, PSpice, PSIM, CASPOC, SABER, ANSYS Simplorer, SIMSEN, MICROCAP, Scilab, Octave, KREAN. Simulation tools for Power Systems and FACTS Controllers are- MATLAB/SIMULINK, RTDS, PSCAD/EMTDC, Matdyn, PAST, NETOMAC, ETAP, PSpice, MiPower, MATPower, EDSA, SCADA.

Nowadays simulation tools are equipped with realistic portrayal of actual conditions of a system in a real time. This makes simulation results capable of giving a highly reliable forecast of later behavior. Good simulation tools must have following features:

(i) Simplicity (ii) Comfortable and user friendly.(iii) Freedom to choose the right models for the elements.(iv) Ability to correct errors.(v) Accuracy of the system solutions should be up to mark especially when sensitive power electronics FACTS devices are introduced.(vi) Instinctive user interface.(vii) All FACTS devices & controller should be included in components library. (viii) Adequate ability to model large power systems. (ix) Output of simulation execution should be within the constraints.

III. SIMULATION TOOLS FOR POWER ELECTRONICS

A. MATLAB and SIMULINK

MATLAB was developed by Mathswork in 1984 [4]. MATLAB is a high level programming language having an interactive environment for visualization & technical computation, and SIMULINK, an interactive tool for modelling, simulating, analyzing and designing dynamic systems. SIMULINK offers a set of tools that can be used to build systems from the Library of built-in blocks. It is also allows creation of custom blocks that can incorporate C/C++, FORTAN, JAVA or MATLAB code. These features make MATLAB/SIMULINK an attractive choice for power systems related research. The current version of MATLAB is R 2013 a.

The features of MATLAB/Simulink for the simulation & modelling of power system & power electronics circuits is discussed in [5, 6].

MATLAB and Simulink based material on power electronics is available in books [7, 8, 9, 10].

B. PSIM

PSIM is a simulation package specifically designed for Power Electronics and motor control. PSIM provides fast simulation and friendly user interface. The basic PSIM package consists of three programs: circuit schematic program, PSIM Simulator, and waveform display program SIMVIEW. PSIM can interface to MATLAB/SIMULINK to access complete mathematical power of Matlab [12].

Sameer Khader *et al.* [13] present the comparative study of PSIM & Matlab/Simulink software tools for power electronics and electric drives courses. Consideration attention has been paid by [14] to consider PSIM in power electronics.

C. PSPICE

It is an analog & digital simulation software program for Microsoft Windows. It is a modified PC version of SPICE. It finds wide application in analog & digital systems. It has analog & digital libraries which contain components such as NAND, NOR, gates, Flip-Flops, operational amplifier etc. It is a circuit analyzer employed for the analysis of non-linear DC & transient, Fourier series, linear AC & noise analysis [15]. The latest version available is PSPICE v.10.

Rashid *et al.* [16, 17] throw light on the simulation of power electronic & electric drive systems using Spice and Pspice.

D. CASPOC

CASPOC simulator is used for modeling and simulation of power system, power electronics, and electric drives [18]. It also finds application in Mechatronics and electrical machine. CASPOC use the drag and drop blocks for creating modeling and simulation and has the fastest simulation performance on Window 1995/98.It can also coupled with electromagnetic software and physics simulation tools.

O. Apeldoorn [19] shows the applications of different simulation tools such as PSPICE 6.2, CASPOC, Simplorer 3.2, Matlab/Simulink, SIMSEN etc. in different fields of engineering from economical point of view. Use of these simulation tools for simulation of power electronic devices is also discussed. The uncovered subject material on power electronics and drive using CASPOC is available in books [20, 21].

E. SIMSEN

It is digital simulation software used for the analysis of power system, adjustable speed drives & a hydraulic system [22]. In 1992 Simsen was developed. The latest version available is Simsen 2.3. The main features of Simsen are:Graphical input & output, Independent of network size.

(i) Calculation with SI & per unit outputs.
(ii) Calculation of stable initial conditions.
(iii) It enables to study the dynamic behavior of power electronics converter (such as VSI, CSI, cycloconverter etc.), electrical machines & components of power systems.

F. SABER: Simulation

software SABER is used for modeling, simulating & analyzing physical systems [23]. It has wide range applications in analog/power electronics, power system & Mechatronics. Main features are:

(i) Easy to use.
(ii) Provides flexibility & reliability.
(iii) Robust design methods.
(iv) Verify the behavior of physical systems (i.e. Electrical, mechanical, hydraulic etc.).
(v) Offers a graphical IDE (integrated development environment) for generating virtual prototypes of power system networks.

G. ANSYS Simplorer

It is a multidomain, multitechnology simulation software used to simulate and investigate complete power electronics and electronics based control system. It can integrate system based modeling technique and modeling language within the same schematic [24].

V. CONCLUSION

This paper presents and overview the user friendly and widely used different types of simulation software with their unique features and application used in power electronics. Every software has its own unique features and property to provide the simulation output. By selecting the suitable simulation software desired output can be easily obtained. Simulation software's explain above can be used as a major educational tool in the teaching power electronics and electrical drive courses of UG and PG, in additional too conducted research in these fields.

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