

Power Electronics Teaching at EFEI

Valberto Ferreira da Silva

José Antonio Cortez

José Manuel Esteves Vicente

Paulo César Rosa

Luiz Eduardo Borges da Silva

Carlos Alberto Mohallem Guimarães

EFEI/ IEE/ DET- DON - Cx. Postal 50 - 37500- 000 - Itajubá, MG - Brasil

Tel.: +55- 35- 6291180 - Fax: +55- 35- 629- 1187

E-mail: pcrosa@iee.efei.br

Abstract- *Power electronics at EFEI (Federal Engineering School at Itajubá) is a 7th period course taken by electrical engineering level undergraduate students. In the graduate level, there is also a course, in order to give necessary basis to develop theses. Lab classes are offered using developed modules as a result of research made, mainly, by undergraduate students. The projects are fruits of scientific initiation research sponsored by government agencies.*

As examples, some developed modules have been: thyristor firing module, IGBT transistor drive system, bipolar transistor drive system, analog PI regulators, digital and fuzzy PI regulators using data acquisition system, electrical machines drives, AC/DC/AC workbench, thyristorized and transistorized chopper circuits.

These prototypes became the course more attractive to the students due to the practical results obtained. In fact, a good laboratory is fundamental for teaching power electronics and more and more the students are encouraged to develop research in this area.

Keywords: Power electronics teaching; Laboratory; Prototypes

Introduction

Semiconductors are nowadays widely used in industry, becoming possible the control of machines and processes. After 1970 the use of semiconductors have been more and more disseminated in industry, mainly, thyristors and power transistors. The last ones have rated current and voltage increased for applications in large power. In fact, their switching control is simpler and there is no need of forced commutation auxiliary circuits for the blocking process, like the thyristors.

So, is concluded that Power Electronics teaching is very important nowadays because the semiconductors are intensively used in industry applications.

Power Electronics Teaching at EFEI

The course of Power Electronics is presented in the 7 th period. There are three theoretical classes and two practical

classes during the week. After the theory, there are always lab classes and the students can consolidate the theory learning.

Laboratory Potential

The lab classes are taken in the Power Electronics laboratory that has five workbenches accommodating one-two students each. Some resources of the laboratory are:

Power Electronics Workbench

Consisting of diode and thyristors six pulse Graetz bridges, thyristor-firing module, 220-[V] three-phase alternating current (AC) power supply and +/-110 [V] direct current (DC) power supply.

There is also in each workbench a three-phase autotransformer, a DC machine, an induction machine and a synchronous machine, connected in the same shaft, with the respective terminals accessed in the workbench frontal panel.

Thyristor Firing Module

The module is able to fire six thyristors connected in Graetz configuration. The dedicated integrated circuit TCA 780 (Siemens-Icotron) has been used to provide the pulses. Also, there is a 555 monoestable stage, an optocoupler TIL 111 isolated stage and, finally, the transistors amplification signals (BC 548, BD 135). All stages are connected in cascade.

IGBT and Bipolar Transistor Drive Circuits

There are drive circuits to fire IGBT and bipolar power transistors. In the case of IGBT drive circuit, the dedicated integrated circuit IR 2110 (International Rectifier) has been used to supply the transistor base-emitter voltage.

Thyristorized and Transistorized Chopper Circuits

A DC/DC converter chopper circuit has been developed to control DC electrical machines. The used switches have been thyristors and IGBT transistors.

Digital and Analog Regulators Circuits

A Portable Computer (PC) and data acquisition system using PCL 711 card (Advantech Co), have been used to implement digital PI (proportional-integral) and fuzzy regulators. Also, there is an analog system with PI regulators that has gain and time constant adjusted separately. These regulators are mainly used in the current and speed control loops of the electrical machines.

Electrical Machines Drive Systems

All the machine types (DC, synchronous and asynchronous), can be controlled using digital and analog regulators, as described in III.5.

Workbench PWM AC Drive System

The workbench equipped with circuitry and software was developed to verify the performance of AC-motor drives, using typical PWM modulation modes.

HVDC Six and Twelve- Pulse Simulators

There are two HVDC simulators, the first one is a six-pulse converter and the second one is a twelve-pulse converter.

The British Government has donated the first equipment and according to the experience obtained by its commissioning, a second one has been built.

Industry Equipments

There are also industry equipment in the laboratory, such as a single phase semi-controlled converter for DC motor drives (Tectronic), a current source inverter (CSI) for AC motor drives (Tectronic), a dual converter used in four quadrant DC motor drives (Siemens) and PWM AC motor drives (vector and scalar control methods) (Siemens - ABB - Toshiba).

Industry Consulting and Training

Power Electronics courses are offered by the FUPAI foundation (Industry Helping and Research Foundation) to industry technicians and engineers. The courses are offered in Itajubá and also in the industry environment.

Consulting have been also made, helping this way, to solve detected industrial problems.

Conclusion

The importance of the research employing undergraduate and graduated students is evident in Power Electronics teaching. The interest of the students in strongly increased when the theory is confirmed by lab classes. The partnership University-Industry can be encouraged with the participation of students in the projects. Also, the government research support is important to propitiate the development of applied research in the University.

References

- [1] Silva, V.F.; Silva, L.E.B.; Cortez, J.A.; Rosa, P.C.; Rezek, A.J.J.. "Industrial Electronics" EFEI, 1993.
- [2] PCL 711 - Data Aquisition Card Manual Advantech Co., Taiwan, 1993.
- [3] TCA 780 - Manual (Siemens – Icotron Application Notes).
- [4] IR2110 - Manual (International Rectifier) Application Notes.