

Cooperation with the University of Limoges on Teaching the Discipline "Designing Devices on Microcontrollers and FPGAs"

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Abstract—The paper analyzes the cooperation of the Department of Microprocessor Technologies and Systems of the Kharkiv National University of Radio Electronics with ENSIL-ENSCI University of Limoges in the direction of educational activities related to the design of devices on microcontrollers and programmable logic integrated circuits. The results of the fruitful cooperation of universities regarding the implementation of training aimed at training specialists in the field of development of digital devices are shown.

Keywords—NURE, ENSIL-ENSCI, University of Limoges, Department of MTS, training, exchange of experience, FPGA, VHDL, Matlab, design, digital scheme, goals of sustainable development.

I. INTRODUCTION

Cooperation of the Kharkiv National University of Radio Electronics (NURE) with institutions of higher education and institutions of other countries is based on the principles of the priority of national interests, the development of the educational and scientific potential of the university, the systemic and mutually beneficial nature of cooperation, the conclusion of contracts with foreign legal entities and individuals regarding student education, training of scientific personnel, internships, conducting scientific and research works, etc.

The internationalization strategy of NURE, which is an integral part of NURE's development strategy, is aimed at: ensuring sustainable development, promoting the achievement of sustainable development goals, strengthening academic positions, improving the quality of education and competitiveness at the national and international levels.

The internationalization strategy of NURE is designed to prepare students for the future realization of potential in the

global world and to teach them to be competitive in the labor market.

II. THE COOPERATION

The Department of Microprocessor Technologies and Systems (MTS) of the Kharkiv National University of Radio Electronics trains specialists in the field of designing devices on microcontrollers and field programmable gate arrays circuits (FPGAs) [1-5]. The main task of the fundamental department of MTS is to strengthen the quality of training of professional engineering personnel in accordance with European standards in the field of microprocessor technologies and systems [6-10].

Since 2018, the Department of MTS has been cooperating with ENSIL-ENSCI University of Limoges (Limoges, France) on the development and coordination of educational materials for the discipline "Device Design on Microcontrollers and FPGAs". The discipline "Designing devices on microcontrollers and FPGAs" includes three modules [11-15]:

- The module "Modeling digital signals using Matlab and VHDL" aims to study the mathematical principles of digital signal processing and master the basic algorithms used for the analysis and synthesis of digital signal filtering devices.
- The "Microcontrollers" module is aimed at: studying programming of modern STM32F4xx microprocessors produced by the ST company for programming on C++ language, in-circuit debugging of the microprocessor- based software controlled electronic system. Considerable attention is paid to learning the programming language, working with

different software, the STM32Cube packages and the IAR Embedded Workbench for ARM software for writing and debugging programs, as well as the use of these microprocessors in digital systems for transmitting and processing information.

- The FPGA module aims to study the architecture and programming of modern Artix-7 of Xilinx FPGA family (Fig. 1), the VHDL digital device design language, and debugging methods and tools using Vivado CAD software as well as the use of FPGAs for the development of digital signal processing systems.

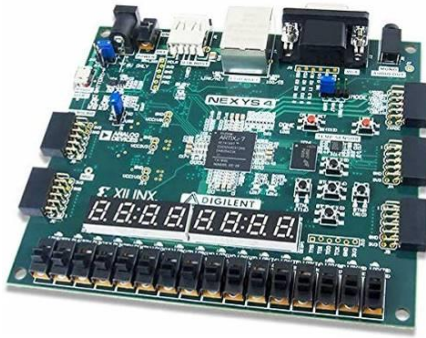


Fig. 1. Nexys 4 DDR Artix-7 FPGA Trainer Board.

The following disciplines are studied at ENSIL-ENSCI University of Limoges:

- "Digital Circuit Design" aims to: study FPGA architecture, VHDL programming, combinational and synchronous circuits on a Digilent Basys 3 training board containing Artix 7 FPGAs (Fig. 2) and Xilinx Vivado software.
- "Systems on a crystal (SoC)" aims to: study the structure and architecture of embedded systems, the basics of SoC, the advantages of API using PicoBlaze VHDL.
- "Introduction to analog and digital filtering" aims to designing filters in the continuous time domain, designing filters in the discrete time domain (digital filters) using Matlab.



Fig. 2. Artix-7 training board from Digilent Basys 3.

Both collaborating parties carefully and carefully approached the choice of hardware and software, on the basis of which the training programs are built. In all parts of the courses mentioned, we see market leaders - Matlab from MatWorks, STM32 from ST.com, Artix 7 from Xilinx. In all these cases, players in their segments have held more than 35% of their respective markets for a long time. The use of software processors PicoBlaze and MicroBlaze allows

students to be trained as specialists for companies that create advanced electronics using modern and worthy examples.

Within the framework of cooperation between universities, there is a regular exchange of experience in the direction of designing digital devices, modernization of the content of educational disciplines, the content of laboratory-practical classes, participation in conferences and forums et.

The discipline "Designing devices on microcontrollers and FPGAs" is studied in the set of general and special professional training for students of the first (bachelor's) level of higher education of the university faculties: Faculty of Automatics and Computerized Technologies; Faculty of Information Radio Technologies and Technical Information Security; Faculty of Electronic and Biomedical Engineering; Faculty of Information Communications. The discipline is studied by students of the following specialties: 171 Electronics, 172 Electronic communications and radio engineering, 173 Avionics, 174 Automation, computer-integrated technologies and robotics, 175 Information and measurement technologies, 163 Biomedical engineering, 125 Cyber security and information protection.

NURE students who studied the discipline "Designing devices on microcontrollers and FPGAs" have the opportunity to participate in the selection for studies under the program "International semester at ENSIL-ENSCI University of Limoges for NURE students.

Students of NURE as partners of the academic exchange can apply for [16]:

- for the "international semester" (course in English);
- for the "classic academic semester" (course in French);
- internship.

The maximum length of stay for exchange students at the host university is one academic year or an equivalent period. Continuation must be approved by both universities.

NURE students admitted to ENSIL-ENSCI under the exchange program within the framework of the "classical" academic semester can study in the "Electronics and Telecommunications" and "Mechatronics" specialties. They can also register for the international semester.

The study program at the host university will be determined by the exchange students in agreement with the academic supervisors of the host and sending universities. Academic evaluation is carried out in accordance with the rules of the host university, languages, knowledge of digital device design, circuitry, etc. Both universities participate in the competitive selection process [16].

Both partner universities facilitate the exchange of students for internships. Transfer and accumulation of subjects during the internship, which can replace practical training (or graduation projects), are agreed according to the credits (ECTS) of the host university. The subject of the internship is determined by the host university and will be confirmed by the referring university. A student applying for an internship must have a sufficient level of English/French.

The selection of students to participate in the program "International Semester at ENSIL-ENSCI University of

Limoges for NURE Students" takes place on a competitive basis, which includes: average score for studies, level of knowledge of a foreign language, knowledge of designing digital devices, circuit technology, etc. Both universities participate in the competitive selection process.

As a result of the cooperation between NURE and ENSIL-ENSCI, dozens of students have been trained and are currently studying under the "international semester", "classical academic semester" and internship programs. Scientific and pedagogical workers of NURE were also involved in international programs and research. Despite the difficult situation in Ukraine caused by the Russian-Ukrainian war, fruitful cooperation between partner universities continues even now.

III. CONCLUSIONS

International activity in the system of higher education and science was and remains an important component of the functioning of our university. In the conditions of globalization, full-fledged activity of higher education institutions is possible only thanks to their internationalization. Globalization of higher education contributes to achieving the goals of sustainable development.

The cooperation of Kharkiv National University of Radio Electronics with ENSIL-ENSCI University of Limoges demonstrates the high level of training of students of the second (bachelor) level of higher education in the field of designing devices on microcontrollers and programmable logic integrated circuits. What contributes to the successful study of NURE students under international exchange programs with the ENSIL-ENSCI university.

The participation of students, graduate students, scientific and pedagogical workers of NURE in programs of international training, internships and scientific research contributes to the achievement of the following goals: integration of higher education into the European space; exchange of best practices and experience in the fields of education and science; modernization of the higher education system; digitization of education and management; improving the quality of higher education and the effectiveness of scientific research; increasing the competitiveness of the educational and scientific community; development of professional skills and personal qualities of program participants.

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