Politehnica University of Bucharest
Faculty of Electronics, Telecommunications and Information Technology

COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	Politehnica University of Bucharest
1.2 Faculty	Faculty of Electronics, Telecommunications and Information Technology
1.3 Department	Department of Applied Electronics and Information Engineering
1.4 Domain of studies	Electronic Engineering, Telecommunications and Informational Technologies
1.5 Cycle of studies	License (engineering)
1.6 Program of studies/Qualification	Applied Electronics

2. Course identification information

2.1 Name of the course				Programable Electronic Systems (SEP)			
2.2 Lecturer				Prof. Dr. Ing. Vasile Lazarescu			
2.3 Instructor for practical activities				As. Drd. Cosmin Danisor			
2.4 Year of studies	IV	2.5 Semester	7	2.6 Evaluation type	Examination (written)	2.7 Course choice type	Compulsory

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week, out of which	4	3.2 course	3	3.3 practical activities	1
3.4 Total hours in the curricula, out of which	56	3.5 course	42	3.6 practical activities	14

Distribution of time	hours
Study according to the manual, course support, bibliography and hand notes	24
Supplemental documentation (library, electronic access resources, in the field, etc)	3
Preparation for practical activities, homeworks, essays, portfolios, etc.	5
Tutoring	0
Examinations	4
Other activities	0

3.7 Total hours of individual study	36
3.9 Total hours per semester	78
3. 10 Number of ECTS credit points	5

4. Prerequisites (if applicable)

4.1 curricular	Microprocessor Architecture

	Microcontrollers Digital Signal Processing
4.2 competence-based	Basic HW/SW microprocessor architecture knowledges, assambly programming languages basics, digital signal processing algorithm implementation on the programming logic systems (proficiency in LabVIEW)

5. Requisites (if applicable)

5.1 for running the course	Not applicable, according to current PUB regulations.
5.2 for running of the applications	Compulsory presence at laboratory classes, according to current PUB regulations.

6. Specific competences

Professional competences	C3. - Applying knowledge, basic concepts and methods related to architecture computing systems , microprocessors , microcontrollers, programming languages and techniques; - Description of the operation of a computer system, the basic principles of the architecture of microprocessors and microcontrollers for general use ; - Use of general purpose programming languages and application-specific microcontrollers and microprocessors ; - Projects involving hardware (processors) and software (programming)
Transversal competences	The thorough analysis of the daily issues and the ability to the identify the problems for which well-known solutions are already available, thus solving the professional tasks Completing team projects with realization of the project management and quality assurance

7. Course objectives (as implied by the grid of specific competences)

7.1 General objective of the course	- *for course*: Presentation of concepts concerning hardware and software architecture, design of the microelectronic systems using microcontrollers, general purpose microprocessors, digital signal processors and their use for implementing signal processing algorithms. Presentation of representative families of digital signal processors . Case studies: TMS320 families (Texas Instruments) - *for applications:* Study of the experimental kit with digital signal processor TMS320C3x, NI Speedy-33 (National Instr.). Hardware structure and the system programming mode with LabVIEW DSP program will be studied. The students will implement signal processing algorithms for uni –and

	bidimensional signals (signal synthesis, digital filtering, the realization of audio effects, modulation and demodulation AM, acquisition and displaying images, simulating a human-machine interface). Students will be involved in carrying component of the software and hardware using LabVIEW DSP graphical programming environment. Each work is accompanied by a set of questions for aquired knowledges level test
4.2 Specific objectives	Lectures and applications acquaints students with the structure and functioning of the systems made with programmable digital signal processors. The work also familiarizes students with implementation of signal processing algorithms on programmable systems. Are considered especially: - accumulation of knowledge on major hardware and software features of the digital signal processors; -knowledges accumulation on how choosing the appropriate microprocessor to solve a given task; - knowledges accumulation for designing and evaluating the performances of programmable systems (speed work, memory capacity, reliability, size, cost price); - familiarity with the design and programming mode of signal processing algorithms; - familiarity to use simulation programs for signal processing algorithms design and implementing simple processing tasks.

8. Content

8.1 Lectures	Teaching techniques	Remarks
Chapter 1- Introduction. Hardware and software digital signal processors features . Comparisons with other types of microprocessors. Classification. Variants. Systems with DSPs	Teaching is based on the usage of videoprojection (for communication and demonstration); the oral communication is based on frontal exposition and problems. The course materials are the course notes, handouts and proposed exercises (both theoretical and computer-based). All materials are available in electronic form on the course/lab site (www.nspg.pub.ro).	3 hours
Chapter 2- Fixed-point and floating-point number representation. The structure of the data path of digital signal processors with fixed-point and floating-point . Constructive and functional features		3 hours
Chapter 3- Memory architecture . Peculiarities of the Harvard architecture . Memory types. Functional features . Cache memory. Memory extention. Memory management . Virtual memory concept. Memory protection		3 hours
Chapter 4- Data addressing modes. Features of Addressing mode features used by digital signal processors .		3 hours

Comparisons with other types of microprocessors. Data format		
Chapter 5- The instruction set . Instruction types. Specific instructions for digital signal processors . Examples. Coding instructions . CISC and RISC architectures . The orthogonality concept		3 hours
Chapter 6- Operation control mechanisms: loops instruction execution, execution of interrupts, stack operation, jumps execution. Case studies		3 hours
Chapter 7- Features of the pipeline operation of digital signal processors (pipeline depth , interlocking, effects of pipeline execution for branching and interruptions). Advantages and limitations of pipeline operation		3 hours
Chapter 8- I/O system, embedded peripherals (ports, timers , A / D converters , etc.). Constructive and functional features. Case studies		3 hours
Chapter 9- Troubleshooting and power management facilities used by digital signal processors. The me**thod**ology of designing systems with digital signal processors and microcontrollers . Examples		3 hours
Chapter 10- TMS320 digital signal processors families (Texas Instruments) . Fixed-point processor and floating point processors . Case Study: TMS32010 family. Application examples		3 hours
Chapter 11- Digital control processors family TMS320C24x/28x . Hardware and software features. Areas of use. Examples: RFI digital filter, digital PLL circuit		3 hours
Chapter 12- TMS320C54x/55x digital signal processors. Features. Instruction set peculiarities. Applications		3 hours
Chapter 13- VLIW processors. Concepts of the VLIW architecture. The TMS320C62x/64x/67x DSP families. Features and applications.		3 hours
Chapter 14- TMS320C8x proce4ssors		3 hours

family. Features. Applications. Selection criteria for the processor in a given application . The current state and the prospects of digital signal processors		

Bibliography:

1. V. Lazarescu, Sisteme electronice programabile – Note de curs (2014, 2015)
2. V. Lazarescu, A. Dumitras, C. Radoi, Arhitectura microprocesoarelor, lito UPB, 1994
3. V. Lazarescu, Prelucrarea digitala a semnalelor, Ed. Amco Press, Bucuresti, 1994
4. Sen M. Kuo, Woon-Seng S. Gan, Digital Signal Processors: Architectures, Implementations, and Applications, Ed. Prentice-Hall, 2004
5. Michael Corinthios, “Signals, Systems, Transforms and Digital Signal Processing with MATLAB”, Ed. CRC Press, 2009
6. Phil Lapsley, Jeff Bier, Amit Shoham, DSP Processor Fundamentals. Architectures and Features, Ed. IEEE Press, NY, 1996
7. Digital Signal Processing Applications with the TMS320 Family, Texas Instruments, 1990, (http://www.ti.com)
8. Embedded Microcontrollers and Processors - vol. I si II, Intel, 1993, (http://www.intel.com)

8.2 Practical applications	Teaching techniques	Remarks
Work #1- Presentation of laboratory work . Integrated development environment study: Speedy - 33 (National Instruments) and DSP LabVIEW graphical programming language . Simple applications: A /D and D/A signal conversion, representation and display signals in time domain and frequency	Teaching is based on the usage of the computer to access the internet laboratory works (covering communication function and demonstration). The oral communication is based on frontal problems. Students simulate, implement, test and evaluate independently the same issues through continuee use of computer and software environment LabVIEW. Each paper contains a number of questions for determining knowledges level. The teaching materials are the theoretical and practical instructions from the lab guide.	2 hours
Work #2- Audio signal processing algoriths (signal generation, noise cancelling, digital filtering , adaptive filtering) with LabVIEW programming		2 hours
Work #3- Audio effects simulation (echo, reverberation) with digital methods. Simulation of an audio equalizer system with Speedy - 33 and LabVIEW		2 hours
Work #4- Amplitude modulation signals (MA) and demodulation. Simulation with LabVIEW		2 hours
Work #5- DTMF (Dual Tone Frequency Multy) signal generation for a phone device. Simulation in LabVIEW		2 hours
Work #6- Digital image processing basics: image acquisition, image display, using NI functions VI (Vision Images). Implementing a “objects counter” algorithm for an image.		2 hours
Final lab examination		2 hours

Bibliography

1) V. Lazarescu, Sisteme electronice programabile – Note de curs (2014, 2015)
2) *** www.nspg.pub.ro, Laboratory Guide
3) *** NI Speedy-33 User manual
4) *** Lina Karam, Naji Mounsef, EEE 101 SPEEDY-33 Experiments, Arizona State University

9. Bridging the course content with the expectations of the epistemic community representatives, professional associations and employers representatives for the domain of the program

Digital systems for signal processing have replaced traditional analog processing systems. Two factors contributed to the rapid expansion of the field: the advent of microprocessors and development of digital processing algorithms. Actually digital systems cover a broad spectrum of applications: medical, consumer electronics, telecommunications, robotics, measuring systems, command and control, transport, military, etc. In the " digital age " there is a strong demand for qualified engineers with specializations related to design, manufacture and use of digital systems and a solid foundation in electronics, systems and information technology so that they can maintain the pace of development of new hardware and application software.
The course curricula answers these developments and evolution trands, subscribed to the general framework of an European economy of services in the area of IC&T. The current technological advance of electronic devices enables unlimited application opportunities, ranging from consumer (smartphone and digital camera technology), medical (products and services for medical imaging), military (remote sensing applications), security (biometry and surveillance), industrial automation (quality inspection and control), robotics (man-machine interfaces) and many others.
This provides graduates with the appropriate skills and training needs of current qualifications, and a modern and competitive scientific and technical instruction, enabling them a quick employment after graduation, being perfectly framed within the Bucharest Polytechnic University policy, both in terms of content and structure, and in terms of skills and international openness offered to students.

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Weight in the final mark
10.4 Lectures	- knowledge of the fundamental theoretical notions; - knowledge of the solving of specific problems; - differential analysis of the theoretical methods.	- **mid term exam** (written), during the semester, held at a date fixed at the beginning of the course, about the middle of the semester. The subjects of the exam covers material taught partly up to the exam date. Partial exam can be repeated with final exam	30%

		- **Final exam** (written) at the end of the semester. Final exam covers topics from the material that was not required in the partial examination . Students may repeat partial exam topics with final examination of all matter. Both exam cover the entire course material, being a synthesis between the comparative theoretical knowledge and the explicitation of the theory via problems and exercises.	40%
		Course activity (active participation in lectures, present)	10%
10.5 Practical applications	Knowing how to achieve and operation of mainframe systems development with microcontrollers and digital signal processors ; - Knowing how to use the kit for demonstrations Speedy - 33 (NI) and DSP LabVIEW graphical programming language ; - Implementing signal processing algorithms	The **final lab exam** consists of a practical examinantion, during which the student must solve (implement, test, proof of functioning) a simple DSP algorithm with LabVIEW DSP program and Speedy-33 kit	20%
10.6 Minimal performance standard			
Solving a simple real problem for simulation and implementation (HW and SW) of an signal processing algorithm with the laboratory resources (signal display in time and frequency domain, A/D and D/A analog signal conversion and reconstruction, digital filtering for noise cancelling);			

Date,	Lecturer,	Instructor for practical activities,
………	Prof. Dr. Ing. V. Lazarescu	As.Drd. Cosmin Danisor
Date of department approval,		Director of Department,
…………….		Prof. Dr. Ing. S. Paşca