

## SYLLABUS

### 1. Data about the program of study

|                                      |                                                                         |
|--------------------------------------|-------------------------------------------------------------------------|
| 1.1 Institution                      | Technical University of Cluj-Napoca                                     |
| 1.2 Faculty                          | Faculty of Electronics, Telecommunications and information Technology   |
| 1.3 Department                       | Telecommunications Technologies and Systems                             |
| 1.4 Field of study                   | Electronic Engineering, Telecommunications and Information Technologies |
| 1.5 Cycle of study                   | Bachelor of Science                                                     |
| 1.6 Program of study / Qualification | Telecommunications Technologies and Systems                             |
| 1.7 Form of education                | Full time                                                               |
| 1.8 Subject code                     | TST-E55.20                                                              |

### 2. Data about the subject

|                                                 |                                       |              |   |                |   |                      |                                                                                |
|-------------------------------------------------|---------------------------------------|--------------|---|----------------|---|----------------------|--------------------------------------------------------------------------------|
| 2.1 Subject name                                | Digital Signal Processors             |              |   |                |   |                      |                                                                                |
| 2.2 Subject area                                | Theoretical area                      |              |   |                |   |                      |                                                                                |
|                                                 | Methodological area                   |              |   |                |   |                      |                                                                                |
|                                                 | Analytic area                         |              |   |                |   |                      |                                                                                |
| 2.3 Course responsible                          | Professor Eugen LUPU, PhD             |              |   |                |   |                      | <a href="mailto:eugen.lupu@com.utcluj.ro">eugen.lupu@com.utcluj.ro</a>         |
| 2.4 Teacher in charge with laboratory / project | Assoc. Professor Simina EMERICH, PhD, |              |   |                |   |                      | <a href="mailto:Simina.Emerich@com.utcluj.ro">Simina.Emerich@com.utcluj.ro</a> |
| 2.5 Year of study                               | IV                                    | 2.6 Semester | 8 | 2.7 Assessment | V | 2.8 Subject category | DS/DO                                                                          |

### 3. Estimated total time

|                                                                                   |     |                      |    |                          |       |
|-----------------------------------------------------------------------------------|-----|----------------------|----|--------------------------|-------|
| 3.1 Number of hours per week                                                      | 4   | of which: 3.2 course | 2  | 3.3 seminar / laboratory | 2     |
| 3.4 To Total hours in the curriculum                                              | 56  | of which: 3.5 course | 28 | 3.6 seminar / laboratory | 28    |
| Distribution of time                                                              |     |                      |    |                          | hours |
| Manual, lecture material and notes, bibliography                                  |     |                      |    |                          | 30    |
| Supplementary study in the library, online specialized platforms and in the field |     |                      |    |                          | 19    |
| Preparation for seminars / laboratories, homework, reports, portfolios and essays |     |                      |    |                          | 16    |
| Tutoring                                                                          |     |                      |    |                          | 2     |
| Exams and tests                                                                   |     |                      |    |                          | 2     |
| Other activities:                                                                 |     |                      |    |                          |       |
| 3.7 Total hours of individual study                                               | 69  |                      |    |                          |       |
| 3.8 Total hours per semester                                                      | 125 |                      |    |                          |       |
| 3.9 Number of credit points                                                       | 5   |                      |    |                          |       |

### 4. Pre-requisites (where appropriate)

|                |                                                        |
|----------------|--------------------------------------------------------|
| 4.1 curriculum | Microprocessors basics, Signal Processing, Programming |
| 4.2 competence | programming skills: assembly language, C               |

### 5. Requirements (where appropriate)

|                                                 |             |
|-------------------------------------------------|-------------|
| 5.1. for the course                             | Cluj-Napoca |
| 5.2. for the seminars / laboratories / projects | Cluj-Napoca |

## 6. Specific competences

|                          |                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Professional competences | <p><b>C4. Design, implementation and operation of data, voice, video and multimedia services. This is based on the understanding and the application of fundamental concepts in telecommunications and transmission of information</b></p> <p><b>C5. Selecting, installing, configuring and operating fixed or mobile telecommunications equipment. Equipping a site with usual telecommunications networks</b></p> |
| Transversal competences  | N / A                                                                                                                                                                                                                                                                                                                                                                                                               |

## 7. Discipline objectives (as results from the key competences gained)

|                         |                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 7.1 General objective   | Developing the competences regarding the use digital signal processors in signal processing applications                                                                                                                                                                                                                                                                           |
| 7.2 Specific objectives | <ol style="list-style-type: none"> <li>1. Understanding of main architectures of DSP</li> <li>2. Understanding basic DSP concepts and programming using Texas Instruments family TMS320 as reference</li> <li>3. To assess the requirements of a DSP for a specific application</li> <li>4. To develop applications on DSP platforms using assembly language or CCS IDE</li> </ol> |

## 8. Contents

| 8.1 Lecture (syllabus)                                                                                                                                                                                                                                                                                                                                                     | Teaching methods                                                                                                                       | Notes                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| 1. Course description. Evaluation mode. General features of digital signal processors (DSP) . Digital versus analog processing. Typical DSP algorithms . Other possible architectures to develop applications of digital signal processing ( ASIC , FPGA , ASSP , GPP ) . Families of digital signal processors company Texas Instruments ( TMS320). Applications on DSP . | Presentation,<br>heuristic conversation, exemplification, problem presentation,<br>teaching exercise, case study, formative evaluation | Use of .pptx presentation, projector, blackboard |
| 2. Parallelism in digital signal processing . Processing Architectures (von Neumann, Harvard, SISD, VLIW). The goals of parallelism. Special architectures in digital signal processing. Components and architectures used in digital signal processing.                                                                                                                   |                                                                                                                                        |                                                  |
| 3. Digital Signal Processing. Overview. Principles and algorithms.                                                                                                                                                                                                                                                                                                         |                                                                                                                                        |                                                  |
| 4. Introduction to digital signal processors. Texas Instruments TMS320 DSP families. Overview of TMS320C25. Pins and signals. The internal architecture.                                                                                                                                                                                                                   |                                                                                                                                        |                                                  |
| 5. TMS320C25 programming. Addressing modes ( immediate, direct, indirect). FFT algorithm. "Bit -reverse" addressing. C2x instruction set overview .                                                                                                                                                                                                                        |                                                                                                                                        |                                                  |
| 6. Application Development on C2x . Using timer and interrupt system. Sinewave Generators. FIR filters . Examples of implementation.                                                                                                                                                                                                                                       |                                                                                                                                        |                                                  |
| 7. First continuous assessment                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                        |                                                  |

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------|
| 8. TMS320C5x family . Enhancements to the C2x architecture. Areas of application .                                                                                                                   |                                                               |                                                         |
| 9. C5000 family overview. DSP for communications.                                                                                                                                                    |                                                               |                                                         |
| 10. TMS320C5416 processor . Architecture . Memory map . Interrupts System. Peripherals.                                                                                                              |                                                               |                                                         |
| 11. TMS320C5416 processor . The instruction set. Examples.                                                                                                                                           |                                                               |                                                         |
| 12. TMS320C55x family . Enhancements to the C54x architecture.                                                                                                                                       |                                                               |                                                         |
| 13. Performance digital signal processors . VLIW architecture presentation. TMS320C6X family . Overview .                                                                                            |                                                               |                                                         |
| 14. Second continuous assessment                                                                                                                                                                     |                                                               |                                                         |
| Bibliography                                                                                                                                                                                         |                                                               |                                                         |
| 1. Lupu, E. s.a <i>Procesoare digitale de semnal. Familia TMS320C2X.Prezentare si aplicatii</i> , Promedia 1997                                                                                      |                                                               |                                                         |
| 2. [***] TI User Manuals TMS320C2x, TMS320C5x, TMS320C54x, TMS320C62x                                                                                                                                |                                                               |                                                         |
| 3. [***] <a href="http://www.ti.com">www.ti.com</a>                                                                                                                                                  |                                                               |                                                         |
| 4. Nedeveschi, S. <i>Procesoare de semnal. Familia C5x.Curs</i> , UT Pres 1997                                                                                                                       |                                                               |                                                         |
| 5. Arsinte, R. – <i>Arhitecturi paralele și procesoare de semnal</i> , Ed. Politehnica Timișoara 2000                                                                                                |                                                               |                                                         |
| 6. Emerich S., Lupu E. <i>Procesoare digitale de semnal - Lucrări practice</i> Ed. Galaxia Gutenberg 2014                                                                                            |                                                               |                                                         |
| 7. [***] <a href="http://www.bdti.com">www.bdti.com</a>                                                                                                                                              |                                                               |                                                         |
| Course SLIDES: <a href="http://elupu.utcluj.ro/">http://elupu.utcluj.ro/</a>                                                                                                                         |                                                               |                                                         |
| <b>8.2 Laboratory</b>                                                                                                                                                                                | Teaching methods                                              | Notes                                                   |
| 1. Number representation and arithmetic for DSP. Q15 format.                                                                                                                                         | Didactic and experimental proof, didactic exercise, team work | Use of laboratory instrumentation, experimental boards, |
| 2. Simulation applications for the DSP family TMS320C2x.                                                                                                                                             |                                                               |                                                         |
| 3. SIDERAL TMS320C25 EVM                                                                                                                                                                             |                                                               |                                                         |
| 4. Applications development under CCS. C54xx Simulator.                                                                                                                                              |                                                               |                                                         |
| 5. System development kit TMS320C5416                                                                                                                                                                |                                                               |                                                         |
| 6. TMS320C5416 DSK application development system                                                                                                                                                    |                                                               |                                                         |
| 7. Final evaluation, recoveries                                                                                                                                                                      |                                                               |                                                         |
| <b>8.3 Project</b>                                                                                                                                                                                   | Teaching methods                                              | Notes                                                   |
| 1. Examples of topics: application development platform in CCS C5416, C5510, C5505, C5515; Development of DSP applications in MATLAB (64x, 67x). Theme setting, content and structure of the project | work monitoring, recommendation references                    | Use of laboratory instrumentation, experimental boards, |
| 2. Documentation gathering and study                                                                                                                                                                 |                                                               |                                                         |
| 3. Learning to use platforms and software tools                                                                                                                                                      |                                                               |                                                         |
| 4. Establishing organizational applications, application development                                                                                                                                 |                                                               |                                                         |
| 5. Application development on the selected platform                                                                                                                                                  |                                                               |                                                         |
| 6. Testing the application                                                                                                                                                                           |                                                               |                                                         |
| 7. Project defending                                                                                                                                                                                 |                                                               |                                                         |

**9. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field**

The discipline content and the acquired skills are in agreement with the expectations of the professional organizations and the employers in the field, where the students carry out the internship stages and/or occupy a job (in the field of Telecommunications Engineer; Electronics Design Engineer; Multimedia Applications Developer; System and Computer Design Engineer; Communications Design Engineer), and the expectations of the national organization for quality assurance (ARACIS).

## 10. Evaluation

| Activity type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 10.1 Assessment criteria                                         | 10.2 Assessment methods     | 10.3 Weight in the final grade |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------|--------------------------------|
| 10.4 Course                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | The level of acquired theoretical knowledge and practical skills | <i>Written Check</i>        | 60%                            |
| 10.5 Seminar/<br>Laboratory                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | The level of acquired knowledge and abilities                    | <i>Project + Laboratory</i> | 30%+10%                        |
| 10.6 Minimum standard of performance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                  |                             |                                |
| <p><b>Qualitative level:</b></p> <p><i>Minimal knowledges:</i></p> <ul style="list-style-type: none"> <li>✓ Knowledge of Texas Instr. processors architecture</li> <li>✓ Knowledge of main families of TI DSPs.</li> <li>✓ Knowledge of main Software IDE to develop applications</li> </ul> <p><i>Minimal competences:</i></p> <ul style="list-style-type: none"> <li>✓ To know the main architectural elements of DSP</li> <li>✓ To be able to develop applications on TMS320C2x or C5000 DSPs</li> <li>✓ To know to use the CCS IDE tool</li> </ul> <p><b>Quantitative level:</b></p> <ul style="list-style-type: none"> <li>✓ Perform all laboratory work</li> <li>✓ To defend the project</li> <li>✓ The exam, project and laboratory notes must be at least 5.</li> <li>✓ The final mark for the subject is calculated with the relation: <math>0.60 * \text{Exam score} + 0.15 * \text{Labs score} + 0.25 * \text{Prj score}</math></li> </ul> |                                                                  |                             |                                |

| Date of filling in: |              | Title Surname NAME                   | Signature |
|---------------------|--------------|--------------------------------------|-----------|
| 27.09.2021          | Course       | Professor Eugen LUPU, PhD            |           |
|                     | Applications | Assoc. Professor Simina EMERICH, PhD |           |

|                                                                                                                           |                                                                  |
|---------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|
| Date of approval in the Department of Communications<br>27.09.2021                                                        | Head of Communications Department<br>Prof. Virgil DOBROTA, Ph.D. |
| Date of approval in the Council of Faculty of Electronics,<br>Telecommunications and Information Technology<br>27.09.2021 | Dean<br>Prof. Gabriel OLTEAN, Ph.D.                              |