UNIVERSIDADE DO ESTADO DE SANTA CATARINA - UDESC

CENTRO DE CIÊNCIAS TECNOLÓGICAS - CCT

DEPARTAMENTO DE ENGENHARIA ELÉTRICA - DEE

SYLLABUS

I. IDENTIFICATION

Program:	Computer Engineering / CI6 Course in English
Course:	EL2PDS2I - DIGITAL SIGNAL PROCESSING
Class hours:	72 hours (54h Theoretical / 18h Practical)
Academic year:	2026/2
Schedule:	Tuesdays and Thursdays, 13:30 - 15:10
Professor:	Aleksander S. Paterno

II. SUMMARY

Processor families, Harvard architecture, parallelism in digital signal processing. Manufacturers and their main families. Internal architecture. Memory organization. Instruction types and addressing modes. Discrete-time signals and systems.

III. DIDACTIC PROGRAM

- Introduction to signals and systems in discrete time and processing.

- Representation of discrete time signals with Fourier Analysis.

- Analysis and Synthesis with Fourier Analysis in the Discrete domain.

- Algorithms for the Fourier Analysis (FFT, Goertzel, divide-and-conquer).

- Digital Signal Processors: architecture, memory organization, types of instructions and addressing modes.

- Digital Filters FIR and IIR.

- Techniques to design FIR filters (windowing, frequency sampling, Parks McClelland).

- Designing Digital Filters and their corresponding tools (convolution in frequency and time domain).

- Practical Problems: sampling, practical filtering and Fourier transform, windowing applied to data pre-processing.

IV. LEARNING METHODOLOGY

The Digital Signal Processing course will be offered using Project Based Learning (PBL) methodologies. Students will gather in pairs to discuss problems and will be supervised by the professor to indicate and work on solutions. Lectures will present the main contents of the course. Practical sessions will be organized using Google Colab (Python), allowing students to apply their knowledge and develop it further in a programming platform. Students will work cooperatively to develop DSP algorithms and pipelines for pre-processing data intended for Machine Learning models.

V. ASSESSMENT SYSTEM

The assessment will evaluate the course goals through a Project-Based Learning approach in pairs, divided into two main components:

- **Project Proposal and Pre-project in pairs (50% of the final grade):** Submitted by October 22nd. This proposal will define the problem, the dataset, and serve as the baseline so the subsequent PBL sessions can be directed to support the main project development.

- **Final Delivery and Oral/Written Presentation (50% of the final grade):** At the end of the semester, pairs will demonstrate their fully developed solution in a practical presentation open to the academic community.

VI. BIBLIOGRAPHY

- OPPENHEIM, Alan V.; SCHAFER, Ronald W. Discrete-Time Signal Processing. 3rd ed. Pearson.

- PROAKIS, John G.; MANOLAKIS, Dimitris K. Digital Signal Processing: Principles, Algorithms, and Applications. 4th ed. Pearson.

- LATHI, B. P. Linear Systems and Signals. Oxford University Press.

- VANDERPLAS, Jake. Python Data Science Handbook: Essential Tools for Working with Data. O'Reilly Media.

VII. COURSE SCHEDULE (2026/2)

Date	Day	Activity / Topic
04/08/2026	Tue	Course presentation and Learning Results. Google Colab setup.
06/08/2026	Thu	Introduction to discrete-time signals and systems.
11/08/2026	Tue	Signal simulation in Python (noise, real datasets).
13/08/2026	Thu	Practical offline signal processing. Introduction to Project 1.
18/08/2026	Tue	Signal representation with Fourier Analysis.
20/08/2026	Thu	Mathematical foundations and Analysis in the discrete domain.
25/08/2026	Tue	Algorithms for Fourier (FFT, divide-and-conquer).
27/08/2026	Thu	FFT application in Colab for feature extraction in ML.
01/09/2026	Tue	PBL Session: Frequency domain feature extraction.
03/09/2026	Thu	Analysis and synthesis with the Discrete Fourier Transform.
08/09/2026	Tue	DSP architectures, memory organization.
10/09/2026	Thu	Instruction types, addressing modes, and parallelism.
15/09/2026	Tue	Hardware vs. Software acceleration concepts for AI.
17/09/2026	Thu	Introduction to Digital Filters FIR and IIR.
22/09/2026	Tue	Filter characteristics and mathematical modeling.
24/09/2026	Thu	FIR filter design techniques (windowing).
29/09/2026	Tue	FIR filter design techniques (frequency sampling, Parks McClelland).
01/10/2026	Thu	Digital Filter Design in Python (SciPy Signal).
06/10/2026	Tue	Convolution in the time and frequency domains.
08/10/2026	Thu	Practical Problems - sampling, practical filtering.
13/10/2026	Tue	Windowing techniques on real-time data.
20/10/2026	Tue	Project Definition: DSP pipeline for an ML classifier.
22/10/2026	Thu	Project Proposal Submission and Dataset Definition.
27/10/2026	Tue	Directed PBL: Filtering fundamentals applied to proposed datasets.
29/10/2026	Thu	Directed PBL: Cleaning noisy datasets specific to the main projects.
03/11/2026	Tue	Theory and Practice: Advanced feature extraction pipelines.
05/11/2026	Thu	Directed PBL: DSP pipeline modeling for Machine Learning projects.
10/11/2026	Tue	Theoretical Assessment / Electronic Questionnaire.
12/11/2026	Thu	Directed PBL: Practical filtering and Fourier transform case studies.
17/11/2026	Tue	Theory and Project Activity: Fine-tuning transforms for the main project.
19/11/2026	Thu	Theory and Project Activity: Filter optimization and ML model integration.
24/11/2026	Tue	Directed PBL: Final adjustments on DSP pipelines for the main project.
26/11/2026	Thu	Project development with supervision.
01/12/2026	Tue	Oral/written presentation of the projects.
03/12/2026	Thu	Oral/written presentation of the projects.
Post-Semester		
08/12/2026	Tue	Final Exam (Exame Final).
10/12/2026	Thu	Final Exam (Exame Final) / Grade closure.