Universidad del País Vasco Euskal Herriko Unibertsitatea

ENGLISH FRIENDLY COURSES (EFC) 2024-2025
CAMPUS OF GIPUZKOA

https://www.ehu.eus/es/web/informatika-fakultatea/incoming_students
Coordinator: informatica.internacional@ehu.eus

In addition to the general offer of courses taught in English, some Centers offer for incoming students English Friendly Courses (EFC): subjects taught in Spanish or Basque, in which the syllabus summary; lecturer tutoring, examinations and/or papers are available in English.

English Friendly Courses taught in SPANISH:

FACULTY OF INFORMATICS (226)					
	COURSE	SEMESTER[1]	CREDITS	SCHEDULE[2]	LINK TO SYLLABUS
Bachelor's Degree in Informatics Engineering					
26018	Arquitectura de Computadores	1st	6	A	
26210	Servicios y aplicaciones en red	1st	6	A	
26213	Modelos Abstractos de Cómputo	1st	6	A	
26218	Minería de datos	1st	6	A	
26230	Métodos formales de desarrollo de software	1st	6	M	
26238	Interacción Persona Computador	1st	6	A	
26260	Procesado Digital de Sonido e Imagen	1st	6	M	
26022	Introducción a los Sistemas Operativos	2nd	6	A	
26241	Gestión Avanzada de Información	2nd	6	A	
26258	Electrónica Aplicada al Tratamiento de Datos	2nd	6	M	
Bachelor's Degree in Artificial Intelligence					
28268	Métodos Estadísticos Avanzados	1st	6	A	
28269	Razonamiento Automático	2nd	6	A	
26630	Señales y sistemas	1st	6	A	
28271	Aprendizaje Automático Avanzado	2nd	6	A	

[1] SEMESTER: 1st: September 2024 to January 2025
2nd : January 2025 to May 2025

[2] SCHEDULE: Morning (M)/ Afternoon (A): begins at 13.30.

Universidad del País Vasco Euskal Herriko Unibertsitatea

English Friendly Courses taught in BASQUE:

FACULTY OF INFORMATICS (226)					
	COURSE	SEMESTER [3]	CREDITS	SCHEDULE [4]	LINK TO SYLLABUS
Bachelor's Degree in Informatics					
26210	Sare Zerbitzuak eta Aplikazioak	1st	6	M	
26222	Bilaketa Heuristikoak	1st	6	M	
Bachelor's Degree in Artificial Intelligence					
28268	Estatistiska Metodo Aurreratuak	1st	6	M	
28269	Arrazoibide Automatikoa	2nd	6	M	
26222	Bilaketa Heuristikoak	1st	6	M	

[3] SEMESTER: 1st: September 2024 to January 2025
2nd : January 2025 to May 2025

[4] SCHEDULE: Morning (M)/ Afternoon (A): begins at 13.30.

Universidad del País Vasco — Euskal Herriko Unibertsitatea

COURSE GUIDE 2024/25

Faculty 226 - Faculty of Informatics **Cycle** .

Degree GINFOR20 - Bachelor's Degree in Informatics Engineering **Year** Second year

COURSE

26018 - Computer Architecture **Credits, ECTS:** 6

COURSE DESCRIPTION

In the subject Computer Structure (first year of the Informatics Engineering Degree) the students learnt the basic architecture of a Von Neuman computer. Computer Architecture starts from the learnt concepts and summarizes the main techniques used to achieve higher performance in computers.

In the first part we will analyse the cache memory as an element to improve the performance of the access to the information (instructions and data) stored in the memory system. In the second part we will analyse pipelined architectures, studying the hardware as well as the most commonly used compiler techniques to execute programs in an efficient way. Finally, the third part will concentrate on the analysis of the basic characteristics of parallel systems conformed with many computers, particularly we will concentrate on the shared memory systems: performance of parallel systems, synchronisation, task scheduling and parallel programming (OpenMP).

A further step from the acquired knowledge will be given in future year subjects (High Performance Processors and Parallel Computation Systems of the Computer Engineering speciality): on the one hand, advanced techniques to improve the performance of the processors (superescalar processors, multi-core architectures, vector machines and GPUS) and, on the other hand, distributed memory systems for parallel processing. These systems make use of massive parallelism using thousands of processors to diminish the execution time of complex problems.

Thereby the subject is an essential in the knowledge area. It is basic to be able to understand the next subjects of the speciality and it gives a general idea of the topic to students going to other specialities that will be very useful for their career.

Focusing on professional competencies, this subject gives to the students indispensable skills in computer system organization.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

The expected learning outcomes are:
1.To identify and analyze the design parameters of cache memories.
2.To analyze the influence of cache memory in the efficiency of the programs' execution.
3.To understand how the pipelined processors work
4.To analyze code optimisations to improve the performance of the processor.
5.To formulate and apply the concepts of parallelism in shared memory multiprocessors.
6.To program simple
parallel aplications facing some problems such as data hazards, synchronisation and load balancing.

Theoretical and Practical Contents

1.-CACHE MEMORY.
1.1.-Introduction: memory hierarchy.
1.2.-Main characteristics: size, content, way.
1.3.-Design parameters: mapping, replacement policy, write strategy.
1.4.-Assignments. Optional practical work.

2.-INSTRUCTION LEVEL PARALLELISM (ILP).
2.1.-Motivation: increasing the processors' performance.
2.2.-Design of a pipelined processor: DLX.
2.3.-Data and control hazards.
2.4.-Introduction to multi-cycle and superescalar processors.
2.5.-Compiler techniques for pipelined processors.
2.6.-Assignments.

3.-INTRODUCTION TO PARALLEL COMPUTING SYSTEMS.
3.1.-Introduction. Parallel computers. Flynn's classification. Performance/Efficiency.
3.2.-Shared memory machines: synchronization and load balancing.
3.3.-Programming multiprocessors: OpenMP.
3.4.-Development of a parallel application.

BASIC CONCEPTS OF C PROGRAMMING LANGUAGE

TEACHING METHODS

The first two topics of the subject will be taught using two types of classroom activities: master classes and exercise (practical) classes. Both of them will be performed in an active and collaborative way.

The third topic will combine master classes and exercise (practical) classes with laboratory sessions. A practical work, a functional software module and a report about the work carried out in groups will be compulsory in this topic to pass the subject.

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	40			20					
Horas de Actividad No Presencial del Alumno/a	40			50					

Legend:
M: Lecture-based
S: Seminar
GA: Applied classroom-based groups
GL: Applied laboratory-based groups
GO: Applied computer-based groups
GCL: Applied clinical-based groups
TA: Workshop
TI: Industrial workshop
GCA: Applied fieldwork groups

Evaluation methods

- Continuous evaluation
- End-of-course evaluation

Evaluation tools and percentages of final mark

- Percentages and assessed parts are specified in next section 100%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The subject has two assessment options: the final assessment and the continuous assessment.

a) Continuous assessment. This is the predetermined option and can only be used in the ordinary call. Active and continuous participation of the students is required: coming to contact lessons and laboratories, assignment and class work delivery, participating in assessment activities, practical works and presentations. When these conditions are not fulfilled the students will be assessed in final assessment.
The continuous assessment will be: written exams (72,5%), assignments (5%) and practical work (22,5%). In both the written exams and the practical work, the minimum mark required is 4 points.
In order to resign to the call, it is enough not to take the exam of the last topic.

b) Final assessment. This will be the option when the student is not in continuous assessment: written exam (80%) and practical work (20%). To pass the subject it is necessary to obtain at least 4 points in both the written exam and the practical work.
In order to resign to the call, it is enough not to take the final exam.

Students who, having fulfilled the conditions for being in the continuous assessment system, decide to opt for the global assessment, must inform via e-mail the lecturers responsible for the subject at the latest after the assessment of the second continuous assessment exam.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The only option for the extraordinary call will be final assessment.

MANDATORY MATERIALS

BIBLIOGRAPHY

Basic bibliography

1. Hennessy J.L., Patterson D.A.
Computer Architecture: A Quantitative Approach. (6. ed.). Morgan Kaufmann, 2019.
Konputagailuen arkitektura. Hurbilketa kuantitatibo bat. (4 ed.). UPV/EHU, 2008.
Arquitectura de computadores: un enfoque cuantitativo. (1. ed.). McGraw-Hill, 1993.
On-line information (slides, appendices...] in the following address: https://www.elsevier.com/books-and-journals/book-companion/9780128119051

2. Patterson D.A., Hennessy J.L.
Computer Organization and Design: The Hardware/Software Interface. (5. ed.). M. Kaufmann, 2013.
Estructura y diseño de computadores. La interfaz hardware/software. (4. ed.). Reverté, 2011.

3. Ortega J., Anguita M., Prieto A.: Arquitectura de Computadores. Thomson, 2005.

4. Stalling W.
Computer Organization and Architecture. Designing for performance. (8. ed.). Pearson, 2010.
Organización y Arquitectura de Computadores (7. ed.). Pearson - Prentice Hall, 2006.
http://williamstallings.com/COA/COA7e.html

5. Chandra R. et al.: Parallel Programming in OpenMP. Morgan Kaufmann, 2001.

6. Almeida F., Giménez D., Mantas J.M., Vidal A.M.: Introducción a la programación paralela. Paraninfo, 2008.

Detailed bibliography

- Culler D.E., Singh J.P.: Parallel Computer Architecture. A Hardware/Software Approach. M. Kaufmann, 1999.
- Chapman B. et al.: Using OpenMP. Portable shared memory parallel programming. The MIT Press, 2008.
- Pacheco P.S.: An introduction to Parallel Programming. M. Kaufmann, 2011.
- Nemirovsky M., Tullsen D.: Multithreading Architecture. Morgan & Claypool Pub., 2013.
- Hughes C.: Single-Instruction Multiple-Data execution. Morgan & Claypool Pub., 2015.
- Scott M.L.: Shared memory synchronization. Morgan & Claypool Pub., 2013.
- Sorin D.J., Hill M.D., Wood D.A.: A primer on memory consistency and cache coherence. M. & C. Pub., 2011.

Journals

Journals of the area: IEEE Computer, IEEE Micro, ACM...

Web sites of interest

Web pages of the manufacturers: INTEL, AMD, IBM, etc.
Other web pages: www.top500.org, www.openmp.org...

OBSERVATIONS

Universidad del País Vasco — Euskal Herriko Unibertsitatea

COURSE GUIDE 2024/25

Faculty 226 - Faculty of Informatics **Cycle** .

Degree GINFOR20 - Bachelor's Degree in Informatics Engineering **Year** Third year

COURSE

26210 - Network Services & Applications **Credits, ECTS:** 6

COURSE DESCRIPTION

This subject is taken in the third year, when the student must opt for one of the specialties. Anyway, this subject is compulsory for all students. Due to the importance that computer networks - especially the Internet - have nowadays, it is considered that all students should acquire basic knowledge about this area.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

In this subject, the basic requirements for developing applications in which the network plays a key role are studied. Besides, the most relevant network applications are also studied. The subject focuses on the part of application development that is linked to the existence of the Internet, giving special importance to the study of developments in TCP/IP. Models for the creation of network applications and interfaces for their development are studied.

Theoretical and Practical Contents

1 Network application design
2 Network application development
3 Network applications
4 Network application's security
5 Advanced tools for the development of network applications.

TEACHING METHODS

Being basically a practical subject, in the theoretical classes the main concepts are explained and the student then goes into greater depth following the references provided by the professor. Theoretical concepts are put into practice in the practical classes.

Students have to carry out two types of practical work in groups. 1) They do the practical work proposed in the laboratory classes, always supported by the professor. This practical component uses to be short (one session) and highly directed, without much margin for moving away from the objective.
2) Students have to carry out (mainly out of classroom) other more general practical work, using the main concepts taught in class in a wider and more realistic way. The goal of the practical work is to design a network application and the nature of the designed application must be agreed with the professor beforehand.

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	20			40					
Horas de Actividad No Presencial del Alumno/a	30			60					

Legend: M: Lecture-based; S: Seminar; GA: Applied classroom-based groups; GL: Applied laboratory-based groups; GO: Applied computer-based groups; GCL: Applied clinical-based groups; TA: Workshop; TI: Industrial workshop; GCA: Applied fieldwork groups

Evaluation methods

- Continuous evaluation
- End-of-course evaluation

Evaluation tools and percentages of final mark

- Percentages and evaluation methods are detailed in the following sections. 100%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

Students have to choose between two types of evaluation: continuous or overall. Initially, any student attending to classes is considered as enrolled in continuous evaluation, so attending to classes is a necessary condition in continuous evaluation.
Continuous evaluation is divided into three parts. In the first part, the students do a practical work in groups, mainly outside class hours, consisting on the design of a network application design. This represents 15% of the mark. Secondly, in the last theme the practical work done in the laboratory is evaluated. It represents 5% in the final mark. Finally, the remaining contents, both theoretical and practical, are evaluated by 3 written exams. In exams taken while it is possible to move on to global evaluation, it will be necessary to obtain a minimum grade of 3 points to remain in continuous evaluation.
The students that don’t meet the conditions to remain in continuous evaluation will automatically go to overall evaluation. The ones that do meet the conditions will definitively be evaluated in continuous evaluation unless otherwise requested through eGela within the period indicated by the teacher. In continuous evaluation waiving the call is not

possible, so students aiming to waive the call must go to global evaluation as explained before.
In the case of overall evaluation, the student has to take a written exam that represents 100% of the final mark. To waive the call it is enough not to take the exam.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

In this case the student must be evaluated by the overall evaluation. Its conditions are those described for the ordinary call.

MANDATORY MATERIALS

https://egela.ehu.eus/

BIBLIOGRAPHY

Basic bibliography

-Computer Networking: A Top-Down Approach, 8th ed. J.F. Kurose and K.W. Ross. Addison-Wesley 2008.
· 7th, 6th, 5th and 4th editions are also valid.
-TCP/IP Sareak, 3. argitaldia. JM Rivadeneyra. UEU 2009

Detailed bibliography

-Unix Network Programming, Vol 1, 2nd ed. W. R. Stevens. Prentice Hall 1998.
-Twisted Network Programming Essentials, 2nd ed. Abe Fettig and Jessica McKellar. O'Reilly Media 2013.
-Internetworking with TCP/IP Vol III: client-server programming and applications. D.E. Comer, D.L. Stevens. Prentice hall 2001.
-TCP/IP Guide. A Comprehensive, Illustrated Internet Protocols Reference. Charles M. Kozierok. No starch press. 2005. [http://www.tcpipguide.com/free/t_toc.htm]
-PYTHON programazio-lengoaia: oinarriak eta aplikazioak. Iñaki Alegria Loinaz, Olatz Perez de Viñaspre Garralda eta Kepa Sarasola Gabiola. UEU eta UPV/EHU 2016.

Journals

Web sites of interest

Sockets:
- Python: https://docs.python.org/3/library/socket.html
- C: https://beej.us/guide/bgnet/

RFC reports: https://www.rfc-editor.org/
W3 Consortium: http://www.w3.org/
Twisted: https://twistedmatrix.com/trac/wiki/Documentation

OBSERVATIONS

Universidad del País Vasco — Euskal Herriko Unibertsitatea

COURSE GUIDE 2024/25

Faculty 226 - Faculty of Informatics **Cycle** .

Degree GINFOR20 - Bachelor's Degree in Informatics Engineering **Year** .

COURSE

26213 - Abstract Computational Models **Credits, ECTS:** 6

COURSE DESCRIPTION

The main objective of "Abstract Computation Models" subject is to determine the computational difficulty of those problems that can be solved by a computer. This subject presents theoretical contents to distinguish whether a given problem is very difficult to compute or not. Morevover, we will see that there exist problems that cannot be solved by any computer. "Abstract computation models" subject complements the knowledge of the previous "Languages, Computation and Intelligent Systems" subject.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

Competences:
1) Know basic Computability Theory concepts
2) Be able to formalize Computability Theory concepts
3) Realize that there are limits beyond which algorithmic methods do not work
5) Develop intuition about non computable and intratable problems
6) Know some Complexity classes and the relationship among them
7) Learn techniques for determining the computational difficulty of problems

Theoretical and Practical Contents

1) Introduction. Turing machines. Church Thesis and Church Thesis extended. Asymptotic analysis. Big O Notation.

2) SAT problem. NP-complete problems. polynomial-time reductions. P versus NP question.

3) Techniques to deal with intractable problems. Aproximations. Randomness.

4) Limits of computation. More about undecidible problems.

TEACHING METHODS

Support material will be available in the eGela virtual classroom.

We will work with Python programming language in the laboratories.

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	40			20					
Horas de Actividad No Presencial del Alumno/a	60			30					

Legend: M: Lecture-based; S: Seminar; GA: Applied classroom-based groups; GL: Applied laboratory-based groups; GO: Applied computer-based groups; GCL: Applied clinical-based groups; TA: Workshop; TI: Industrial workshop; GCA: Applied fieldwork groups

Evaluation methods

- Continuous evaluation
- End-of-course evaluation

Evaluation tools and percentages of final mark

- Véase la explicación en el apartado inferior 100%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The subject has two different kinds of assessments: final (or overall) assessment and continuous assessment.

Continuous assessment

The student will voluntarily decide whether to take part or not in it, since it is offered exclusively for those students who can carry out continuous monitoring of the subject within the established dedication framework and can attend to presential activities.

Pre-enrolment in the continuous assessment mode will take place during the first week of the course. Pre-enrolment will become definitive after confirmation of the application by the student on established dates (around the 12th week of the

course, with approximately 70% of the continuous assessment already completed) and after partial performance verification by the teaching staff. If the student does not confirm his or her definitive enrolment in the continuous assessment on the abovementioned dates, it will be understood that he or she dismisses the enrolment.

The course is mainly focused on continuous assessment.

Continuous assessment will be evaluated by means of three written exams, with a weight of 30, 40 and 20% of the overall grade of the subject. Besides, a 10% of the grade will be determined by laboratory work.

Additionally, a minimum of a 30% grade must be achieved in each written exam and a minimum of 5 over 10 is required to pass the subject.

Final Assessment

This kind of assessment will be applicable to students who do not wish to take part in continuous assessment or those who do not meet the criteria continuous assessment.

In this case, a single written exam about the 100% of the subject must be performed. It will be carried out according to the official examination schedule of the Faculty. The minimum grade required in the final exam will be 5 out of 10.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

One single written exam about 100% of the subject in which the minimum grade is 5 out of 10.

MANDATORY MATERIALS

BIBLIOGRAPHY

Basic bibliography

John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman. "Introducción a la teoría de Autómatas, Lenguajes y Computación: 2ª edición". Pearson educación, 2002

Michael Sipser. "Introduction to the Theory of Computation: second edition". PWS Publishing Company, Boston, 2006.

Michael Sipser. "Introduction to the Theory of Computation: third edition". CENGAGE, 2013.

Susan.H. Rodger and Thomas.W. Finley. "JFLAP: an interactive formal languages ans automata package". Jones & Bartlett Publishers, 2006.

Detailed bibliography

Sanjeev Arora and Boaz Barak. "Computational Complexity: A Modern Approach", Cambridge University Press, 2009

Efim Kinber and Carl Smith. "Theory of Computing: a gentle introduction", Prentice Hall, 2001

J. IBAÑEZ; A. IRASTORZA; A. SANCHEZ. "LOS PROGRAMAS WHILE. Bases para una teoría de la Computabilidad". Informe interno. UPV/EHU / LSI / TR 5-96.

J. IBAÑEZ; A. IRASTORZA; A. SANCHEZ. "Técnicas básicas de computabilidad". Informe Interno. UPV/EHU / LSI / TR 3-2003.

J. IBAÑEZ; A. IRASTORZA; A. SANCHEZ. ""Algunas demostraciones de incomputabilidad usando la técnica de diagonalización". UPV/EHU / LSI / TR 8-2000.

Journals

Web sites of interest

http://www.jflap.org/

https://eu.udacity.com/course/intro-to-theoretical-computer-science--cs313

http://en.wikipedia.org/wiki/Theory_of_computation/

http://computational.complexity.googlepages.com/

OBSERVATIONS

COURSE GUIDE 2024/25

Faculty 226 - Faculty of Informatics **Cycle** .

Degree GINFOR20 - Bachelor's Degree in Informatics Engineering **Year** .

COURSE

26218 - Data Mining **Credits, ECTS:** 6

COURSE DESCRIPTION

This subject focuses on a field known as data mining or machine learning. It includes a series of techniques which, being based on artificial intelligence and classic statistics, have emerged strongly in the last decade for solving problems using large volumes of data. Its applications range from bioinformatics or finance to marketing-advertising, and also natural language.

Although the technological giants have been in the vanguard of this ‘data science - big data - data mining’ discipline for years, over the last few years more and more small- and medium-sized companies and institutions are becoming aware of the need to store data on their activities, and to analyse them to draw useful conclusions for their day-to-day operations. In the case of Euskadi, the machine tool sector and the term ‘Industry 4.0’ have increased the profile of our discipline.

The subject is closely linked to other computing subjects such as "Artificial Intelligence" and "Algorithm Design"; optional subjects include "Machine Learning and Neural Networks" and "Heuristic Search", plus others from other specialities related to database and computing systems.

Students will study the main data mining techniques and will become familiar with real programs.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

Main resuls of the learning process:
- knowledge adquisition on principal supervised classification techniques
- knowledge adquisition on principal non-supervised classification (clustering) techniques
- knowledge adquisition on principal techniques for classification models' evaluation
- skills on the use of principal software tools for learning and evaluation supervised and non-supervised classification models

Main data mining techniques will be studied, and the student will acquire skills in the use of free software which implements those techniques. The student will also show real data mining applications. Skills on the basic, international machine learning vocabulary will be acquired by the student.

Theoretical and Practical Contents

1. Introduction to data mining
Applications and success stories. Everything related to data mining as a discipline within the field of artificial intelligence

2. Distance-based classifiers: k-nearest neighbour
The intuitive nature of this classic method of data mining makes it ideal as the first technique of supervised classification. Its basic functioning will be studied, together with its main variants and parameters for use.

3. Techniques to evaluate and validate classifiers
Study of the main techniques for evaluating classifiers, with special emphasis on supervised classification methods and the estimation of success rates. Introduction to the main statistical tests for comparison between different classifiers.

4. Classification trees and decision rules
Study of these two algorithms, inspired by the philosophy of 'divide and rule', with special emphasis on the transparency and simplicity of its final models. Different growth and pruning options will be explained.

5. Classifiers based on Bayesian networks
Study of the basic theory underlying Bayes' theorem. Classification models of different complexity will be explained. We will examine the following applications of this type of classifiers: models for diagnosis and prognosis in medicine (evidence-based medicine, computational medicine).

6. Combination of classifiers
Study of the different techniques used to combine classifiers. The virtues of the consensus reached by classifiers will be highlighted.

7. Techniques for selecting variables
Study of basic concepts and techniques, both from the univariate and the multivariate points of view. Applications of this type of techniques: most important genes in an illness (a new area of bioinformatics).

8. Non-supervised classification (clustering)
Main clustering techniques. Describing the characteristics of this type of problem, differentiating them from the supervised ones. Practical examples: image segmentation, groups of foodstuffs based on their nutritional characteristics, segmentation of customers and targeted marketing and advertising.

9. Introduction to heuristic searches and genetic algorithms
Study of the best-known search technique: genetic algorithms. Usefulness in solving problems of selection of variables. Practical examples: design problems (aircraft, Meccano), composition of musical scores, travel agency problems.

10. Introduction to neural networks
Basic mechanisms of a neural network classification structure. Main neural network architectures. The subject is a motivation for a further course in the Faculty: "Machine Learning and Neural Networks"

TEACHING METHODS

Three lessons per week. One practical laboratory with computers (personal laptop, or provided by the Faculty), and two theoretical lessons.

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	40			20					
Horas de Actividad No Presencial del Alumno/a	60			30					

Legend:
M: Lecture-based
S: Seminar
GA: Applied classroom-based groups
GL: Applied laboratory-based groups
GO: Applied computer-based groups
GCL: Applied clinical-based groups
TA: Workshop
TI: Industrial workshop
GCA: Applied fieldwork groups

Evaluation methods

- Continuous evaluation
- End-of-course evaluation

Evaluation tools and percentages of final mark

- Written test, open questions 60%
- Exercises, cases or problem sets 40%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

A mid-exam, consisting of the 35% of the theoretical material (2'5 points of a total of 6), will be realized by mid-October. In case of having a sufficient mark in this exam, the final theoretical exam on January will only cover the 65% of the theory material (3'5 points of a total of 6). In this last January exam a minimum mark is needed to be able to pass the entire subject (1'5 points of a total of 3'5).

At least two deadlines will be announced to collect the practical laboratories developed by the student.

In order to pass the subject, it is needed to pass both parts: theory and practice.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

A final exam in January consisting in the 100% theoretical material.
If the student has not delivered the practical laboratories during the weeks of the course, those must be delivered to the teacher one week before the final theoretical exam.

In order to pass the subject, it is needed to pass both parts: theory and practice.

MANDATORY MATERIALS

"egela" system is used to guide the "day-per-day" of the course: material of the theoretical lessons, as well as the

formulation of the practica-laboratory sessions.

BIBLIOGRAPHY

Basic bibliography

- L. Gatto (2020). An Introduction to Machine Learning with R. https://github.com/lgatto/IntroMachineLearningWithR/
- H. Wickham, G. Grolemund (2017). R for Data Science. https://r4ds.had.co.nz/
- I. H. Witten, E. Frank (2016). Data Mining. Practical Machine Learning Tools and Techniques with Java Implementations. Morgan Kaufmann. (Fourth edition)
- B. Sierra (ed.) (2006). Aprendizaje Automático: conceptos básicos y avanzados. Prentice Hall.
- E. Alpaydin (2004). Introduction to Machine Learning. MIT Press.
- T. Mitchell (1997). Machine Learning. McGraw Hill.
- J. Han, M. Kamber (2006). Data Mining: concept and techniques. Morgan Kaufmann. (Second edition)
- Google Machine Learning courses -- curso de Aprendizaje Automático, Google: https://developers.google.com/machine-learning?hl=es-419

Detailed bibliography

- O. Pourret, P. Naïm, B. Marcot (2008). Bayesian networks: a practical guide to applications. Wiley.
- L.I. Kuncheva (2004). Combining Pattern Classifiers. Wiley.
- H. Liu, H. Motoda (ed.) (2008). Computational Methods of Feature Selection. Chapman & Hall/CRC.
- C.M. Bishop (2006). Pattern Recognition and Machine Learning. Springer.
- B. Liu (2006). Web Data Mining: exploring hyperlink, contents and usage data. Springer.

Journals

- Machine Learning Journal. Springer.
- Journal of Machine Learning Research. Electronic publication.
- Data Mining and Knowledge Discovery. Springer.
- Bioinformatics. Oxford University Press.

Web sites of interest

- WEKA software: http://www.cs.waikato.ac.nz/ml/weka/
- caret-R package for classification and regression: https://topepo.github.io/caret/
- scikit-learn, Machine Learning with Python: https://scikit-learn.org/stable/
- Datasets' benchmark repository (University of California Irvine): http://archive.ics.uci.edu/ml/
- A list of intuitive data mining applications, described in a divulgative style (updated by the teacher): http://www.sc.ehu.es/ccwbayes/members/inaki/DM-applications.htm
- LiO software for heuristic optimization: http://www.dsi.uclm.es/simd/SOFTWARE/LIO/

OBSERVATIONS

Universidad del País Vasco — Euskal Herriko Unibertsitatea

COURSE GUIDE 2024/25

Faculty 226 - Faculty of Informatics **Cycle** .

Degree GINFOR20 - Bachelor's Degree in Informatics Engineering **Year** Fourth year

COURSE

26230 - Formal Methods in Software Development **Credits, ECTS:** 6

COURSE DESCRIPTION

Formal methods make software development acquire a more scientific character and similar to other disciplines related to engineering, as well as promote the use of tools with solid foundations, as occurs in other well-established disciplines. These methods are called formal because they are based on mathematics, mainly on mathematical logic. Some years ago the industrial development of system using formal techniques was considered a complex theoretical exercise and unfeasible in real problems. However, the increasing complexity and importance of the computer systems ended up making patent the importance of construct reliable and safe systems, i.e. systems that lack errors or failures. Not only because of the terrible repercussions these failures can have in areas where security is critical, but also because of the economic and quality repercussions that affect companies. This, together with the fact that computer systems play an increasingly essential role in society (in particular, they are more and more present in the devices that we use every day) made the industrial world change its attitude. Thus, in the last decades, formal methods have gained a notable advance and their use in the industrial field has ceased to be the utopia that their detractors claimed. Currently there are large companies, such as Intel, IBM, Sony, Siemens, Amazon or Microsoft, which collaborate very actively both in the creation of tools to help formal software development, and in the application of these tools to obtain reliable industrial applications. In fact, this course uses a software development tool created by Microsoft: Dafny. Although the usefulness of formal methods, and their efficiency, in industrial developments are already proved, more work is still needed for most engineers to know and apply them. This work must be carried out by the universities that must include them in their academic content; by the teachers, who must be trained and researched in this area of knowledge; and by the students, who must have a more solid formation in mathematics and logic. This course contributes to this task of ensuring that the software engineer's work is true engineering, so that the end user receives reliable and safe products.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

The specific objectives of this subject are:
- Understand the importance of programming being a more scientific than craft activity.
- Know the history and motivation of formal methods of software development.
- Know the state of the art in the area of formal software development.
- Know the languages, methods and concrete tools of formal software development.
- Ability to handle languages and concrete tools of formal software development.

Theoretical and Practical Contents

Topic 1.- Introduction
Topic 2.- Mathematical Induction
Topic 3.- Introduction to the Dafny System
Topic 4.- Value Types
Topic 5.- Structural Induction and Datatypes
Topic 6.- Arrays and Framing
Topic 7.- Modules and Objects

TEACHING METHODS

We use different teaching metodologies. In classes, the conceptual contents of the subject will be presented and in the laboratories, practical problems will be solved using the Dafny tool, in an interactive way, in which the students use the tool at the same time as the teacher. Problems and exercises will be provided that students must develop individually, so that they can be aware of their learning level throughout the semester.

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	40			20					
Horas de Actividad No Presencial del Alumno/a	60			30					

Legend:
M: Lecture-based — S: Seminar — GA: Applied classroom-based groups
GL: Applied laboratory-based groups — GO: Applied computer-based groups — GCL: Applied clinical-based groups
TA: Workshop — TI: Industrial workshop — GCA: Applied fieldwork groups

Evaluation methods

- Continuous evaluation
- End-of-course evaluation

Evaluation tools and percentages of final mark

- Individual assignments 100%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

In order to pass the subject in continuous assessment, students must carry out three individual practical assignments in the laboratory that test their knowledge of the tools and techniques addressed in class. The percentage of the grade for each practical work is 30% for the first, 40% for the second and 30% for the third.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The global evaluation consists of carrying out individual practical work in the laboratory that is equivalent to the set of works carried out during the course for continuous evaluation.

MANDATORY MATERIALS

- Lectures slides.

- The on-line tutorial and the documentation of the Web page: https://dafny.org/

BIBLIOGRAPHY

Basic bibliography

- Documentación de la página Web:
https://dafny.org/

- K. Rustan M. Leino. Program Proofs. MIT Press, March 2023. ISBN 9780262546232

Detailed bibliography

- Jim Woodcock, Peter Gorm Larsen, Juan Bicarregui, and John Fitzgerald.
Formal methods: Practice and Experience.
ACM Computing Surveys, 41(4):19:1–19:36, October 2009.

- Jason Koenig and K. Rustan M. Leino. Getting started with Dafny: a guide. In Marktoberdorf 2011 lecture notes. (http://research.microsoft.com/en-us/um/people/leino/papers/krml220.pdf)

- K. Rustan M. Leino. Dafny: An Automatic Program Verifier for Functional Correctness. In LPAR-16, volume 6355 of LNCS, pages 348-370. Springer, 2010. (http://research.microsoft.com/en-us/um/people/leino/papers/krml203.pdf)

Journals

- ACM Transactions on Computational Logic
- ACM Transactions on Software Engineering and Methodology
- Applicable Algebra in Engineering, Communication and Computing.
- Formal Aspects of Computing
- Formal Methods in System Design
- Journal of Automated Reasoning
- Software Testing Verification & Reliability

Web sites of interest

- Dafny: a language and program verifier for functional correctness
https://dafny.org/

- Formal Methods and Software Technology - Interesting Conferences
http://user.it.uu.se/~bengt/Info/conferences.shtml

OBSERVATIONS

Universidad del País Vasco — Euskal Herriko Unibertsitatea

COURSE GUIDE 2024/25

Faculty 226 - Faculty of Informatics **Cycle** .

Degree GINFOR20 - Bachelor's Degree in Informatics Engineering **Year** .

COURSE

26238 - Human Computer Interaction **Credits, ECTS:** 6

COURSE DESCRIPTION

The "Human-Computer Interaction" subject is compulsory for students in the Software Engineering speciality in the Computer Science degree course, and optional for students of other specialities. You will need to have basic knowledge of Software Engineering, for example what a three-level architecture is or a software development cycle. During the term, the front end of a three-level web application will be developed.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

The subject aims at the student learning to: (1) analyse (apprehend/understand), discuss, evaluate and analyse user requirements in order to (2) analyse, design and evaluation systems that are usable, accessible and ergonomic in different environments and places in a structured and methodical way, (3) paying special attention to the different needs of different types of users with varying cognitive and psycho-motor (dis)abilities, (4) transmit and weigh up, in a collaborative manner with users, ideas, designs and applications for these systems.
In addition, we will work on other generic competences envisaged in the profile of the degree, in the document List_of_competences.pdf at http://www.ehu.es/documents/340468/516505/Lista+de+competencias.pdf, in particular the general competences : C3,C4, C5, C9 and C10 of the degree, as well as the specific competences IS1, IS2 and IS4 of the specialty of Software Ingeneering.

Theoretical and Practical Contents

Theme 1 Introduction. Basic concepts.
Theme 2 The human factor.
Theme 3 Devices for, and styles of, interaction.
Theme 4 Interface engineering. Architecture of Information.
Theme 6 Design techniques. New trends.
Theme 7 Interface evaluation techniques. Carry out a usability study. Measurements and analysis.

TEACHING METHODS

The subject involves three main types of activities, all based on presence-based classes (one-off and regular) and student participation: theory classes, practical sessions in the laboratory and other sessions for work and discussion in groups.
Based on active teaching methodologies, both in the theory classes and in the practical sessions, and with the aim of encouraging students to participate actively and gain satisfaction, activities based on teamwork and the presentation of solutions will be organised, followed by debates and the discussion of problems encountered in the practical work sessions.

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	40			20					
Horas de Actividad No Presencial del Alumno/a	40			50					

Legend:
M: Lecture-based — S: Seminar — GA: Applied classroom-based groups
GL: Applied laboratory-based groups — GO: Applied computer-based groups — GCL: Applied clinical-based groups
TA: Workshop — TI: Industrial workshop — GCA: Applied fieldwork groups

Evaluation methods

- Continuous evaluation
- End-of-course evaluation

Evaluation tools and percentages of final mark

- Se especifican a continuación en función del tipo de evaluación 100%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The assessment system for the subject offers two options: continuous assessment or exam and practical work -based assessment (final assessment).

1. Continuous assessment: based on one-off and regular attendance in class, presenting results, taking tests on the knowledge acquired and the performance of practical work (both individually and in groups). The grade is obtained from the following assessment results:
a. Development project (75% of the grade, compulsory): a project on the construction of a usable interface, throughout the term. Individual tests on the knowledge acquired will be set, and the mark will help towards the end-of-project grade.
b. Complementary work (25% of the grade): An evaluation of the summaries made from the course reading list and presentation of solutions, as well as participation in related debates.
2. Exam and practical work based- assessment (final assessment). Based on the established periods and procedures, with voluntary attendance in class. The final exam consists of two phases: one to assess the competences obtained in the course of the usable interface project (compulsory and done before the exam), and the other to assesses the level of knowledge shown in the subject. Both the practical work and the exam are individual and compulsory, and must be passed (with a mark of 5 for each one).

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The same requirements and assessment criteria as for the final assessment are applied. Pass grades are not carried over to the next year.

MANDATORY MATERIALS

Materials provided by the professor (notes, slides, definitions, articles, studies....).

BIBLIOGRAPHY

Basic bibliography

Interaction Design: Beyond Human-Computer Interaction, 3º ed. Preece, Rogers, Sharp, Wiley, 2011
Human-Computer Interaction 3rd edition. Alan Dix, Prentice Hall, 2004
Usability Engineering. Jakob Nielsen, AP Professional, 1993

Detailed bibliography

Designing the User Interface 4th edition ¿ Ben Shneiderman, Addison Wesley 2005

Journals

Web sites of interest

http://hcibib.org/
http://www.useit.com/
http://www.uie.com/articles/
http://www.usernomics.com/

OBSERVATIONS

COURSE GUIDE 2024/25

Faculty 226 - Faculty of Informatics **Cycle** .

Degree GINFOR20 - Bachelor's Degree in Informatics Engineering **Year** Fourth year

COURSE

26260 - Digital Processing of Audio & Video **Credits, ECTS:** 6

COURSE DESCRIPTION

PLEASE NOTE THAT THIS SUBJECT IS TAUGHT ONLY IN SPANISH, ALTHOUGHT IT IS ENGLISH FRIENDLY

This subject is an elective course of the 4th year of the Informatics Engineering Degree in the speciality Computer Engineering (taught during the first four-month period).

The subject is intended to introduce the student of Computer Science to both the theoretical and practical aspects of Digital Signal Processing. Therefore, the subject uses concepts learned in previous subjects in the areas of mathematics (complex numbers, sinusoidal, etc.) and programming.

In the professional field, the subject enables students to process digitally any type of signal (sound, image, information from sensors, time series, etc.) in multiple fields (audio-visual, industry, medicine, meteorology, etc.). In this way, it serves as a link to other areas such as Data Science, Big Data, Industry 4.0, Robotics, Physiological Computing, etc.

The fundamental objectives are:

- To introduce the student to the basic concepts related to Digital Processing: signals, systems, time and frequency analysis, filters.

- To deepen these concepts in the case of sound and image, and to show the methods used in digital systems to capture, process and produce this type of signals.

- To present practical applications of these techniques and alternatives for their implementation.

- To put into practice the concepts studied, applying them in the laboratory to real cases of sound (voice and music) and image processing, using MATLAB platform (other alternatives could be: SCILAB, Octave, Python…).

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

[LEARNING OUTCOMES]

The learning outcomes provided by the subject are the following:

- Knowing how to use digital signal processing software and critically interpret the results obtained.

- Being able to apply the mechanisms of transformation of continuous signals to digital signals: sampling and quantification.

- Know the main methods of calculating the Fourier transform and know how to apply them to digital signals.

- Knowing the main parameters of FIR and IIR digital filters, and knowing how to design and apply them to digital signals.

- Develop a specific task with autonomy using self-management and self-regulation techniques.

- Communicate their ideas and arguments in an understandable way and according to the established formal criteria.

- Value teamwork, accepting the potential of diversity as a learning opportunity.

- Carry out their tasks responsibly in order to achieve the objectives and the collective result.

Theoretical and Practical Contents

Theme 1
1.1 Introduction
1.2 Signals and systems Why digital processing?

Theme 2
2.1 Digital signals

2.2 Definitions and properties. Digitization. Basic signals and operations. Sound and image
2.3 Project. Introduction to a specific software for digital signal processing: Sound and Image

Theme 3
3.1 Time domain analysis
3.2 Usual operations. Windowing and short-term operations. Correlation
3.3 Projects. Time-domain analysis of sound and image signals

Theme 4
4.1 Frequency domain analysis
4.2 Starting idea. Fourier series and transform. Application to two-dimensional systems
4.3 Projects: Frequency analysis of sound and image signals

Theme 5
5.1 Filters.
5.2 LTI systems. FIR filters. Z transform. IIR filters. Non-linear filters.
5.3 Projects: Linear systems (FIR, IIR) and filter design.

Theme 6
6.1 Applications of digital signal processing.
6.2 Areas of application and examples.
6.3 Final projects: medium/high complexity projects in which acquired competencies in the subject are applied.

TEACHING METHODS

There are four types of activities:

- Autonomous study by the students of the material available in the virtual classroom for each subject in which the theoretical/practical concepts to be used are presented, as well as a proposal of exercises associated with them. In addition to directly accessible information, students can use bibliographic references as support material.

- Presentation and exercise classes in which, in a participative way, the theoretical/practical concepts of each topic are shared and the doubts associated with them are clarified, always emphasizing their usefulness and practical aspects. In these sessions, the initially proposed exercises ("on paper") will be shared in order to deepen the theoretical foundations. Exercises will also be proposed on each topic that the students will have to solve and that will be evaluated with the corresponding feedback.

- Development of specific projects in which the students (preferably in groups of 2) apply the theoretical/practical concepts learned to real cases of sound (voice and music) and image processing, using MATLAB, SCILAB, Octave, etc. For each of these sessions, a technical report of results must be submitted that will be evaluated with the corresponding feedback.

- Development of a final project (medium/high complexity level) in which the students (preferably in groups of 2) will apply the theoretical/practical knowledge previously learned in the course.
In order to facilitate student learning, specific projects will be monitored by providing feedback based on previously established and shared evaluation criteria. In this way, students are aware of their level of learning and take steps to improve it if necessary.

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	40			20					
Horas de Actividad No Presencial del Alumno/a	40			50					

Legend:
M: Lecture-based — S: Seminar — GA: Applied classroom-based groups
GL: Applied laboratory-based groups — GO: Applied computer-based groups — GCL: Applied clinical-based groups
TA: Workshop — TI: Industrial workshop — GCA: Applied fieldwork groups

Evaluation methods

- Continuous evaluation
- End-of-course evaluation

Evaluation tools and percentages of final mark

- The percentages and types of assessment are specified in the following sections 100%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The assessment systems considered are the continuous assessment system and the final assessment system. In the ordinary call, the continuous assessment system is the one that will be used in preference, as indicated in the current regulations of the UPV/EHU. The mark is calculated as follows:

- Theory: classroom exercises and written tests 50%.
- Practice: specific projects 35% and final project 15%. There will be individual written evaluations that will weigh the marks of the practical part.

For the final assessment mode, the students will have to submit the reports corresponding to the specific projects and the final project at least two weeks before the date of the ordinary call (date of the final theory test). In this case, the examination will weigh 60% and the practical part 40%. There will be an individual written evaluation that will weigh the overall mark of the practical part.

In order to pass the subject, in any modality, it is necessary to pass both the practical and theoretical parts of the subject separately.

Students who, fulfilling the conditions to continue in the continuous assessment system, decide to opt for the final or global assessment, must inform the teacher responsible for the subject by email before the beginning of the second week of the grouped timetable of the four-month period established in the centre's calendar.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

In the case of the extraordinary call, the final mark is calculated based on two parts:

- Theory (60%): Assessed by a knowledge test.

- Practical (40%): This is assessed on the basis of the technical reports corresponding to the specific and final projects, which must be submitted before the date of the theory test. There will be an individual written evaluation that will weigh the overall mark of the practical part.

In order to pass the course it is necessary to pass both parts (theoretical and practical).

MANDATORY MATERIALS

For the correct development of the subject it is required:

- a PC type personal computer.
- and specific software for signal processing (MATLAB, etc.), for the laboratory practices.

The centre provides both resources. In addition, students have the possibility of carrying out the practical projects on their own computers using the UPV/EHU's MATLAB corporate licence and free software (SCILAB, Octave, Python, etc.).

BIBLIOGRAPHY

Basic bibliography

J. G. Proakis, D.G. Manolakis: "Tratamiento digital de señales". Prentice-Hall, 1997.
R.G. Lyons: "Understanding Digital Signal Processing". Prentice Hall, 2010.
A. Lárez: "Procesamiento Digital de Señales: parte 1". Eleunion, 2022.
J. G. Proakis, D.G. Manolakis: Digital Signal Processing: Principles, Algorithms, and Applications. 4th Edition, Pearson Education, Inc., New Delhi, 2007.
A. V. Oppenheim, R. W. Schafer: "Digital Signal Processing". Prentice-Hall, 1988.
A.V. Oppenheim, R. W. Schafer: "Discrete-Time Signal Processing". Prentice Hall, 2009.
S. S. Soliman, M.D. Srinath: "Señales y Sistemas continuos y discretos", Prentice Hall, 1999.

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C. S. Burrus: "Ejercicios de tratamiento de señal utilizando MATLAB v4". Prentice-Hall, 1997.
B. Gold, N. Morgan: "Speech and audio Signal Processing: Processing and perception of speech and music", Wiley 2000.
J. R. Deller, J. G. Proakis: "Discrete-Time Processing of Speech Signals". MacMillan, 1993.

Journals

Digital Signal Processing (Elsevier)
Signal Processing (Elsevier)
IEEE Signal Processing Letters

Web sites of interest

www.mathworks.com
www.scilab.org
www.dsprelated.com
www.gnu.org/software/octave
www.scipy.org

OBSERVATIONS

Universidad del País Vasco — Euskal Herriko Unibertsitatea

COURSE GUIDE 2024/25

Faculty 226 - Faculty of Informatics **Cycle** .

Degree GINFOR20 - Bachelor's Degree in Informatics Engineering **Year** Second year

COURSE

26022 - Introduction to Operating Systems **Credits, ECTS:** 6

COURSE DESCRIPTION

*** PLEASE NOTE THAT THIS SUBJECT IS ONLY TAUGHT IN SPANISH/BASQUE ***

The subject "Introduction to Operating Systems" focuses on the functional description of operating systems, through its system calls interface, which presents it to the (systems) programmer as a virtual machine that largely hides the complexity of the underlying hardware. This training is complemented by other subjects in the Computer Engineering specialty of the Degree in Informaics Engineering: "Operating Systems" focuses on fundamental techniques and models in the design of operating systems, aimed at managing the different system resources, in order to understand the need for compromises in the design and configuration of the operating system; "Administration of Systems and Networks" focuses on presenting and developing the main aspects associated with the administration of computer systems, in an approach oriented towards the functions of the administrator and also regarding the user who makes use of this type of system; finally "Design of Operating Systems and Real Time", which is currently not taught, deals with the implementation of the system.

The skills and knowledge acquired in this course prepare students to work in system software/application development, code library design, and high-level programs that interact with the operating system. These skills can also be valuable in software design, development, and maintenance, and in understanding best practices and techniques for producing high-quality software. It gives the option to work in the field of software development for embedded systems, such as medical devices, automotive and consumer electronics. Finally, it is worth to say that this subject is the base of other advanced subjects in operating systems through which students can prepare to work in computer security and software development of operating systems.

The subject "Introduction to Operating Systems" is a compulsory subject included in the curriculum of the Degree in Informatics Engineering and is taught in the second year. For the good use of this subject, it is highly recommended to have passed "Computer Structure" and "Basic Programming", both taught in first year.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

At the end of the course, the students should be able to:
- Know the characteristics of the different types of operating systems such as time-sharing systems, distributed systems, real time, etc.
- Identify the interfaces provided by an operating system
- Develop Linux utilities for applications from its system call interface
- Manage the fundamental concepts of operating systems (files, access protection, processes, threads, communication and synchronization elements)
- Manage the functionality of its components (manage the process, memory, and input-output subsystems)

Other important aspects that are going to be promoted are the ability to find the information and tools necessary to solve the problems that arise, and the ability to accurately describe the functionality of the developed utilities, so that they can be used by other users or developers.

Theoretical and Practical Contents

Unit 1: Introduction
- Functional vision of an Operating System (OS)
- Functions and Interfaces of an OS
- Types of OSs according to their functionality (Evolution and Classification)
- Current market for OSs
- Lab: Basic Shell Tasks as User and Administration Interface

Unit 2: System call mechanism
- Operating Sytem's Support architecture (I/O)
- I/O routine call mechanism
- Resident routines
- OS access mechanism: system calls

Unit 3: Input-output and files
- Introduction to the concepts of Device Independence and redirection
- Operation modes on devices and files
- Organization of the file system. Namespaces, directories

- I/O "Buffering": libraries functions vs. system calls
- Advanced access to device properties
- System calls for I/O and C standard library functions
- Exercises on I/O and lab work

Unit 4: User management and security
- Multi-user systems
- Protection mechanisms
- Security-related system calls
- Exercises on user management and securiry and lab work

Unit 5: Memory management
- Loading and placement of programs in systems with one or more programs in memory
- Support for virtual memory systems: physical and virtual addressing
- Static and dynamic relocation. Reentrant code
- Static and Dynamic link libraries
- Calls to the operating system related to program loading and memory management
- Compilation practices, memory management, static and dynamic link libraries, and program loading

Unit 6: Process control
- Concept of execution flow and context. Context switching
- Multiprogrammed and multithreaded systems
- Concept of process (Unix model), states and transition graph
- Processes' scheduling and basic scheduling policies
- System calls and library functions related to process and thread control
- Practical work: process execution in background from the Shell, process monitoring, simple and multprogrammed shell, multithreaded examples

Unit 7: Communication and synchronization between processes and threads
- Concepts of concurrency, shared resource, race condition and exclusive access
- Critical sections of code. Basic mechanisms for exclusive access to critical sections
- Communication with message passing through mailboxes. Communication and synchronization via threads
- System calls related to communication and synchronization between processes and threads
- Resource management model based on the client-server scheme. Examples of resource managers (drivers)
- Practical work: communication and synchronization between processes (using pipes) and threads

TEACHING METHODS

This course is based on the functional vision of operating systems and the application programming interface (API). Therefore, although always based on the theoretical concepts that support it, it will have a large practical component. For this, various teaching methodologies will be used, from master classes to more active methodologies such as PBL (Project Based Learning) or pBL (Problem Based Learning) and laboratory activities.

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	40			20					
Horas de Actividad No Presencial del Alumno/a	50			40					

Legend:
M: Lecture-based — S: Seminar — GA: Applied classroom-based groups
GL: Applied laboratory-based groups — GO: Applied computer-based groups — GCL: Applied clinical-based groups
TA: Workshop — TI: Industrial workshop — GCA: Applied fieldwork groups

Evaluation methods

- Continuous evaluation
- End-of-course evaluation

Evaluation tools and percentages of final mark

- The percentages and types of evaluation are specified in the following sections. 100%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

CONTINUOUS ASSESSMENT

The evaluation systems that are contemplated are the continuous evaluation system and the final evaluation system. The continuous assessment system is the one that will be used preferably, as indicated in the current regulations of the UPV/EHU. The student who decides to opt for the final evaluation, must inform the teacher(s) within the terms and manner indicated in the current regulations of the UPV/EHU.

The continuous evaluation mode is based on the following three evaluation tests:
- Individual evaluation questionnaires: 60%
- Practical Works: report with the developed code, specifications, verification results of the practice proposals and interview: 30%
- (Others) Specific individual assessment questionnaires on the work carried out: 10%

To pass the subject it is necessary that the student:
- Completes and submits all assessment tests
- Gets at least 40% of the evaluation of each of the tests
- The final average mark with all the evaluation tests is at least 5 out of 10

FINAL EVALUATION

For those who do not follow the continuous evaluation, the following evaluation mechanism is foreseen:
- Final individual written test (theoretical questions, practical exercises, code analysis, design/programming of utilities...): 80%
- The realization and delivery of a practical work and an interview about it: 20%

To pass the subject it is necessary that each student:
- Completes and submits all assessment tests
- Gets at least 40% of the evaluation of each of the tests
- The final average grade with all the tests is at least 5 out of 10

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

In the extraordinary call evaluation will be similar to the final evaluation of the ordinary call:
- Final individual written test (theoretical questions, practical exercises, code analysis, design/programming of utilities...): 80%
- The realization and delivery of a practical work and an interview about it: 20%

To pass the subject it is necessary that each student:
- Completes and submits all assessment tests
- Gets at least 40% of the evaluation of each of the tests
- The final average grade with all the tests is at least 5 out of 10

MANDATORY MATERIALS

Subject eGela online classroom, Linux operating system (there will be access to Linux through a server), manuals, tools and C programs that will be provided through eGela (Moodle service from UPV/EHU).

BIBLIOGRAPHY

Basic bibliography

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Operating Systems: Three Easy Pieces - http://pages.cs.wisc.edu/~remzi/OSTEP/

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Detailed bibliography

Andrew S. Tanenbaum:
Modern Operating Systems (4th Edition), Prentice-Hall, 2014.

Mark Rochkind:
Advanced Unix Programming, Addison-Wesley, 2004.

William Stallings:
Operating Systems: Internals and Design Principles (Eighth edition), Prentice Hall, 2014.

Journals

Web sites of interest

www.linux.org: forums, tutorials and many other stuff about Linux

www.gnu.org: all about the gnu operating system

www.die.net: the Linux manual online

OBSERVATIONS

Universidad del País Vasco — Euskal Herriko Unibertsitatea

COURSE GUIDE 2024/25

Faculty 226 - Faculty of Informatics **Cycle** .

Degree GINFOR20 - Bachelor's Degree in Informatics Engineering **Year** .

COURSE

26241 - Advanced Information Management **Credits, ECTS:** 6

COURSE DESCRIPTION

"Advanced Information Management" is a compulsory subject within the Specialty of Software Engineering. This subject rests on aspects taught in "Web Systems" and "Databases". On the one hand, the knowledge on XML technologies seen in "Web Systems" is broadened. On the other hand, the new data management needs that go beyond the relational model are addressed.

The management of data has been and is, increasingly important in any organization.From the systems of files and databases, the current organizations have had to face new challenges as the volume, diversity and the means in which these data were transported, managed and produced increase. This subject familiarizes the student with these new information technologies.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

The topics to be discussed are outlined below.

Document exchange between organizations: the XML world and description standards
* See the options offered by the XML language for the organization of unstructured data as well as some available standards
* Understand the use of XML for data exchange in companies and do it through a prototype

Impact of object orientation on DBMS: the object-relational model
* Through the new versions of Oracle, understand and manage how the concepts of object orientation have permeated the definition and manipulation of databases.

Impact of "datafication", that is, the transformation of everyday objects into data that add to the sea of massive data that the Internet already houses, the product of our fingerprints through social networks or smartphones.
* Understand the concepts and opportunities of the BigData world
* Become familiar with noSQL databases.

Learning results will be worked on
- general: C1, C2, C3, C4, C5, C6, C7, C8, C9, C10 and C12
- more specific to Ing. Soft: SI1, SI2, SI3, SI4, SI5, and SI6

Theoretical and Practical Contents

1. Standards and XML technology for document interchange (XPath, XML Schema, Schematron, XQuery, xSQL)

2. Modelo Objeto-relacional (Oracle 10)

3. noSQL (MongoDB, Neo4j)

TEACHING METHODS

According to the eminently practical content of the subject, lectures are accompanied by weekly laboratories where students will check their understanding of the concepts taught through solving practical exercises. Student groups will be set to jointly develop a project that will involve the intensive use of XML technologies.

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	40			20					
Horas de Actividad No Presencial del Alumno/a	70			20					

Legend:
M: Lecture-based — S: Seminar — GA: Applied classroom-based groups
GL: Applied laboratory-based groups — GO: Applied computer-based groups — GCL: Applied clinical-based groups
TA: Workshop — TI: Industrial workshop — GCA: Applied fieldwork groups

Evaluation methods

- Continuous evaluation

- End-of-course evaluation

Evaluation tools and percentages of final mark

- Written test, open questions 90%
- Teamwork assignments (problem solving, Project design) 10%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The course has two modes of assessment: final (or overall) assessment and continuous assessment.

CONTINUOUS ASSESSMENT
Continuous assessment, to which students may take advantage of voluntarily, is offered exclusively to students who can carry out continuous monitoring of the subject within the established framework of dedication and attendance to face-to-face activities. Pre-registration in the continuous assessment mode will be carried out on the established dates. The pre-registration will become final after confirmation of the application by the student on the dates established (between 60% and 80% of the course) and after verification of partial performance by the teaching staff. If on the aforementioned dates the student does not confirm their final registration in continuous assessment, it will be understood that they renounce it.

Weight of each topic in the final note:
- XML: 65%
- Object-Relational: 15%
- noSQL: 20%

ASSESSMENT OF THE WHOLE
- Final exam: 90% The exam will consist of a part of basic concepts and practical written exercises.
- Practical work: 10%. To take the final exam of the overall assessment (in the ordinary or extraordinary call), the work of the XML project must have been submitted. A deadline for delivery will be set prior to the exam. To pass the course it will be necessary to pass each part (exam, practical work) separately.

NOTE: In case of return to confinement, the evaluation tests (both continuous and final) will be adapted to the new situation.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

Final exam: 100% The exam will consist of a part of basic concepts and practical written exercises.

NOTE: In case of return to confinement, the evaluation tests (both continuous and final) will be adapted to the new situation.

MANDATORY MATERIALS

Software to be used throughout:
- OXYGEN XML Editor
- ORACLE DBMS
- MongoDB DBMS noSQL
- Neo4J DBMS noSQL

BIBLIOGRAPHY

Basic bibliography

XML in a nutshell. E.R. Harold eta W.S Means. 2004, O’Reilly.

XSLT & XPATH. A guide to transformations. J.R. Gardner eta Z.L. Rendon. 2002, Prentice-Hall.

Definitive XML Schema. P. Walmsley. 2002, Prentice-Hall.

XQuery. P. Walmsley. 2007, O’Reilly.

XML Data Management. Native XML and XML-enabled Database Systems. A.B. Chaudhri, A. Rashid eta R. Zicari. 2003, Addison-Wesley.

Modern Database Management. J.A. Hoffer, R. Venkataraman eta H. Topi. 2012, Prentice-Hall.

Getting Started with noSQL. G. Vaish. 2013. Packt Publishing.

Detailed bibliography

Web Data Management. S. Abiteboul eta I. Manolescu. 2011, Cambridge University Press. (http://webdam.inria.fr/Jorge)

Journals

Web sites of interest

http://www.w3schools.com/

http://infolab.stanford.edu/~ullman/fcdb/oracle/or-objects.html

OBSERVATIONS

Universidad del País Vasco — Euskal Herriko Unibertsitatea

COURSE GUIDE 2024/25

Faculty 226 - Faculty of Informatics **Cycle** .

Degree GINFOR20 - Bachelor's Degree in Informatics Engineering **Year** Fourth year

COURSE

26258 - Electronics for Data Processing **Credits, ECTS:** 6

COURSE DESCRIPTION

The objective of this subject is to study the structure and functioning of the electronic elements that allow communicating digital systems, in particular a computer, with the outside world.
It begins studying the elements that capture and condition the signals of the real world. Next, the basic circuits for processing these signals are studied: analog, digital, analogue digital conversion, data acquisition cards and signal processing (DSP). This subject is completed with some practical simulation and design exercises using widely used programs in the field of electronic circuit design. All this will be very useful when dealing with topics such as: the design of integrated circuits, design of applications based on microprocessors, the study of signal processing or robotics, etc., object of other subjects of the degree.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

The expected learning outcomes are:

Be able to handle with the basic instrumentation of an electronic laboratory.
Be able to identify the appropriate sensor for the capture of a certain physical signal.
Be able to design a basic signal conditioning device (amplification and filtering).
Be able to simulate the operation of analog electronic circuits
Be able to design an analog to digital and digital to analog conversion circuit.
Be able to process information received from sensors with data acquisition systems.

Theoretical and Practical Contents

UNIT 0. Introduction: Interface with the real world.
UNIT 1. Acquisition of signals: sensors.
UNIT 2. Conditioning of signals: the operational amplifier and its applications.
UNIT 3. A / D and D / A converter circuits.
UNIT 4. Cards and data acquisition systems (DAQ).

TEACHING METHODS

Active methodologies of cooperative learning will be used, looking for the active participation of the students and the work in-group, something fundamental for the achievement of the desired competences in this specialty.
In addition to theory classes, practical laboratory sessions based on cooperative learning are proposed.
The content of the practical topics is developed in the laboratory, in-group.

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	40		5	15					
Horas de Actividad No Presencial del Alumno/a	50		10	30					

Legend:
M: Lecture-based — S: Seminar — GA: Applied classroom-based groups
GL: Applied laboratory-based groups — GO: Applied computer-based groups — GCL: Applied clinical-based groups
TA: Workshop — TI: Industrial workshop — GCA: Applied fieldwork groups

Evaluation methods

- Continuous evaluation
- End-of-course evaluation

Evaluation tools and percentages of final mark

- Written test, open questions 20%
- Multiple choice test 20%
- Exercises, cases or problem sets 35%
- Individual assignments 10%
- Teamwork assignments (problem solving, Project design) 15%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

In the first call, each student will be able to choose between two options: traditional evaluation by taking a final exam, or

continuous evaluation during the course. In principle, the preferred evaluation method is continuous evaluation. To continue in continuous evaluation, it is essential to obtain a grade greater than 4 out of 10 in each section evaluated, the student who, fulfilling the conditions to continue in the continuous evaluation system, decides to opt for the global evaluation, must inform the teacher responsible for the subject by email within 9 weeks before the date of the final evaluation. The student who does not meet the requirements to remain in continuous evaluation will automatically go to final evaluation.

Percentages and types of evaluation:

Exercises 15%
questions 20%
Laboratory 35%
attendance 10%
Tests 20%

Total: 100%

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The final exam consists on a written test in which the degree of knowledge of the subject, both theoretical and practical, treated in the subject will be evaluated

MANDATORY MATERIALS

Documentation provided by the teacher in egela.

BIBLIOGRAPHY

Basic bibliography

PÉREZ GARCÍA M.A. et alter, 2004. Instrumentación electrónica. (Thomson)

BOLTON W., 2001. Mecatrónica: Sistemas de control electrónico en la ingeniería mecánica y eléctrica. (Marcombo)

MINER G. F., COMER D. J., 1992. Physical data acquisition for digital processing: Components, parameters and specifications. (Prentice-Hall)

FRANK R., 2000. Understanding smart sensors. (Artech House Publishers)

SCHILLING D., BELOVE C., 1993. Circuitos electrónicos discretos e integrados. (McGraw-Hill)

SEDRA A.S., SMITH K.C., 2003. Microelectronic Circuits (5th Edition). (Oxford University Press)

Detailed bibliography

BISHOP R., 1999. Learning with LabVIEW. Addison-Wesley

HAMBLEY A.R., 1994. Electronics: A top-down approach to computer-aided design. (Prentice-Hall)

JONES J., FLYNN A., 1993. Mobile Robots. (Wellesley)

NORTON H.N., 1982. Sensores y analizadores. (Gustavo Gili)

Journals

IEEE Instrumentation and measurement magazine

IEEE transactions on instrumentation and measurement

IEEE Robotics and automation magazine

IEEE sensors Journal

IEEE signal processing magazine

IEEE transactions on circuit and systems II. Analog and digital signal processing

IEEE transactions on industrial electronics and control instrumentation

Revista española de electrónica (http://www.redeweb.com/index.php?option=com_frontpage&Itemid=1)

Electronic Design (http://electronicdesign.com/index.cfm?AD=1&)

Web sites of interest

National Instruments: http://www.ni.com/

National Instruments España: http://digital.ni.com/worldwide/spain.nsf/main?readform

LabVIEW: http://www.ni.com/labview/

Agilent technologies: http://www.home.agilent.com/agilent/home.jspx?cc=US&lc=eng

Operational amplifiers: http://www.allaboutcircuits.com/vol_3/chpt_8/index.html

OBSERVATIONS

Universidad del País Vasco — Euskal Herriko Unibertsitatea

COURSE GUIDE 2024/25

Faculty 226 - Faculty of Informatics **Cycle** .

Degree GIARTI20 - Bacherlor's Degree in Artificial Intelligence **Year** Second year

COURSE

28268 - Advanced Statistical Methods **Credits, ECTS:** 6

COURSE DESCRIPTION

The subject Advanced Statistical Methods is a second year subject of the Degree in Artificial Intelligence. It is an extension of the statistical methods covered in the first year of the degree. The previously introduced concepts are developed in more detain and the Bayesian paradigm is introduced. Moreover, the knowledge and skills obtained through this subject establish the basis for the understanding of the paradigms introduced in further years, in particular in the data analysis area.

An expert in Artificial Intelligence should be able to conduct a statistical analysis and to understand the underlying models, with the goal of proposing solutions in the domain of Artificial Intelligence.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

Understand the Bayesian paradigm in statistical inference

Buid statistical models that solve real-life problems

Draw conclusions justifying them by interpreting the data and evidences.

Learn to develop simple programs for the visualization and analysis of data in R

Theoretical and Practical Contents

1. Review of some probability concepts
   1.1 Random variables
   1.2 Joint, marginal and conditional distributions
2. Estimation
   2.1 Properties of the estimators
   2.2 Method of moments
   2.3 Maximum likelihood
   2.4 Non-parametric bootstrap
3. Introduction to Bayesian estimation
   3.1 Conjugate distributions
   3.2 Monte Carlo approximation
   3.3 Normal model
   3.4 Gibbs sampling
   3.5 Group comparison and linear regression
4. Statistical tests
   4.1 Parametric, non-parametric and permutation tests
   4.2 Multiple testing correction

TEACHING METHODS

In this subject we will promote the autonomous work of the student using computer and bibliographic resources that will help understanding the topic. Lectures with the conceptual contents of the subject will be complemented with exercises. The computation part will be covered with weekly computer sessions using R programming language.

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	40			20					
Horas de Actividad No Presencial del Alumno/a	60			30					

Legend:

M: Lecture-based — S: Seminar — GA: Applied classroom-based groups

GL: Applied laboratory-based groups — GO: Applied computer-based groups — GCL: Applied clinical-based groups

TA: Workshop — TI: Industrial workshop — GCA: Applied fieldwork groups

Evaluation methods

- Continuous evaluation
- End-of-course evaluation

Evaluation tools and percentages of final mark

- The assessment types and conditions are indicated below: 100%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The student can be evaluated under two types of assessments: continuous or final. The continuous assessment system is prioritized, as indicated in the regulation of the UPV/EHU.

If a student who meets the requirements of continuous assessment wishes to opt for the final assessment, he or she must inform the lecturers responsible for the subject in the following manner and within the following deadlines: via email once the written test of the 2nd fixed week has been graded.

Continuous assessment:
The continuous assessment involves practical individual and group works (15%), theory and exercises partial exams in the laboratory (85%).
The final mark will be the mean of the results obtained in all the evaluation items, provided that a minimum of 4 has been obtained in each one. The subject will be passed with an average mark of 5 or more.

Global assessment:
The global assessment involves a theory and exercises exam in the laboratory (100%). Not taking part in any of these exams will be considered a withdraw. The subject will be passed with an average mark of 5 or more.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The assessment in extraordinary examination will be the same as the global assessment:

The global assessment involves a theory and exercises exam that will take place in the laboratory (100%). Not taking part in any of these exams will be considered a withdraw. The subject will be passed with an average mark of 5 or more.

MANDATORY MATERIALS

There is no required material. The student will complete his/her material by following the classes.

BIBLIOGRAPHY

Basic bibliography

Leonard Held, Daniel Sabanés-Bové (2014) Applied Statistical Inference. Springer
Peter D. Hoff (2009) A First Course in Bayesian Statistical Methods. Springer

Detailed bibliography

Journals

Web sites of interest

OBSERVATIONS

Universidad del País Vasco — Euskal Herriko Unibertsitatea

COURSE GUIDE 2024/25

Faculty 226 - Faculty of Informatics **Cycle** .

Degree GIARTI20 - Bacherlor's Degree in Artificial Intelligence **Year** Second year

COURSE

28269 - Automatic Reasoning **Credits, ECTS:** 6

COURSE DESCRIPTION

"Automated Reasoning" is a second-year mandatory course of the Bachelor's Degree in Artificial Intelligence, taught in the second term.

In this course, we introduce the formal basis of:
A) Logical reasoning: reasoning is the ability to make inferences about some given knowledge, and automated reasoning is concerned with the building and use of computing systems that automate this process.
B) Knowledge representation: we consider the two most widely used logical formalisms, propositional logic and first-order logic.
Additionally, we use state-of-the-art software in a practical way and analyze some of the most important applications in Artificial Intelligence.

In this manner, we enhance and complete the knowledge introduced in some first-year subjects. More specifically:
1) "Discrete Mathematics", where some deductive reasoning systems for propositional and first-order logics are presented.
2) "Programming Methodology", where first-order logic is used as formal specification language.

Along with this subject, the problem of knowledge representation is also addressed in two other second-year courses of the second term, although from different viewpoints: "Databases" and "Artificial Intelligence". Further, some other reasoning methods are studied in the course "Artificial Intelligence", such as rule-based systems.

The knowledge presented in this course serves as a basis or is completed in higher courses of the degree, like "Database Design" (third year) , "Development of Big Data Applications" (third year), "Knowledge-Based Systems" (fourth year) and "Advanced Techniques in Artificial Intelligence" (fourth year).

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

* Knowledge representation using formal logic languages.
* Proving a conclusion from the given assumptions by the application of mechanical formal system.
* Model and counter-model generation for logical statements.
* Understanding some algorithms and strategies involved for automated deduction.
* Using automated reasoning tools and understanding their outcomes.

Theoretical and Practical Contents

1. Mathematical representation of knowledge.
2. Deductive methods and tools for propositional logic.
3. Deductive methods and tools for first-order logic.
4. Applications of automated reasoning in Artificial Intelligence: Prolog.

TEACHING METHODS

In the master classes, we describe the theoretical subjects of the course and resolve some practical exercises.

Likewise, in the practical group classes, we resolve some additional exercises by means of using state-of-the-art automated tools.

In both cases, we use active methodologies that encourage students to acquire skills by working, both autonomously and in teams, in order to solve the different proposed objectives. In addition, we encourage the formulation of questions and their discussion, so that students acquire skills related to oral communication, synthesis capacity and teamwork.

In order to facilitate and ensure learning, we monitor and provide feedback on the basis of previously established evaluation criteria, providing students with the opportunity to become aware of their progress.

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	40			20					
Horas de Actividad No Presencial del Alumno/a	60			30					

Legend:
M: Lecture-based
S: Seminar
GA: Applied classroom-based groups
GL: Applied laboratory-based groups
GO: Applied computer-based groups
GCL: Applied clinical-based groups
TA: Workshop
TI: Industrial workshop
GCA: Applied fieldwork groups

Evaluation methods

- Continuous evaluation
- End-of-course evaluation

Evaluation tools and percentages of final mark

- Written test, open questions 70%
- Exercises, cases or problem sets 30%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The criteria established in the current regulations are applied for the choice of assessment system (continuous or final), and also for changes to the assessment system (from continuous to final). The default assessment mode is continuous. Actually, the subject is oriented to the continuous assessment modality.

=== Continuous evaluation ===

The assessment of the acquired knowledge and skills consists in mid-course exams (70%) and practical exercises (30%).

More concretely, there are 3 mid-course exams. Next, we state the subjects and percentages of the final grade that respectively correspond to each exam:
* First mid-course exam: Propositional logic, 20%.
* Second mid-course exam: First-order logic, 25%.
* Third mid-course exam: Practical applications - Prolog, 25%.

All the tests are marked out of 10 points.

The final grade is obtained by calculating the weighted average of the marks in the mid-course exams and practical exercises.

In any case, in order to pass the course it is compulsory to satisfy the following conditions:
a) Exceed the minimum mark (3 of 10 points) in all the mid-course exams
b) Exceed the minimum mark (5 of 10 points) in the final grade.

=== End-of-course evaluation ===

Changes from continuous assessment to final assessment can be requested as long as a percentage equal to or higher than 80% of the final grade has not been assessed.

Final assessment is made through a written exam, which is marked out of 10 points and gives the final grade of the course.

It is compulsory to exceed the minimum mark (5 of 10 points) in the final grade in order to pass the course.

In order to resign from the evaluation, it is necessary not to take the final written exam.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

We apply the criteria stablished for the end-of-course evaluation method of the ordinary examination period.

That is, the assessment is made through a final written exam, which is marked out of 10 points and gives the final grade of the course.

It is compulsory to exceed the minimum mark (5 of 10 points) in the final grade in order to pass the course.

In order to resign from the evaluation, it is necessary not to take the final written exam.

MANDATORY MATERIALS

All the resources that are available at the virtual classroom in eGela.

BIBLIOGRAPHY

Basic bibliography

"Logic for Computer Scientists". Uwe Schöning. Volume 8 in the series "Progress in Computer Science and Applied Logic". 166 pages. Birkhäuser, 1989. ISBN: 9780817647629. e-ISBN: 13:978-0-8176-4763-6. DOI: 10.1007/978-0-8176-4763-6. Springer, 2008 (reprint).

"Introduction to Logic, Third Edition". Michael Genesereth and Eric J. Kao. Volume 5(1) in the series "Synthesis Lectures on Computer Science". 177 pages. Morgan & Claypool, 2016.ISSN: 1932-1228 (print) 1932-1686 (electronic). DOI:10.2200/S00734ED2V01Y201609CSL008. Online resources available at: http://intrologic.stanford.edu/

Detailed bibliography

"Handbook of Automated Reasoning". Alan Robinson and Andrei Voronkov (editors). 981 pages (Volume I), 1185 (Volume II). The MIT Press (North-Holland), 2001. ISBN: 9780262182218 (Volume I), ISBN: 9780262182225 (Volume II), ISBN: 9780262182232 (Volumes I and II).

Journals

* Journal of Automated Reasoning (https://www.springer.com/journal/10817/)
* Journal of Logic and Computation (https://academic.oup.com/logcom)
* ACM Transactions on Computational Logic (https://dl.acm.org/journal/tocl)
* The Journal of Logic and Algebraic Programming (https://www.sciencedirect.com/journal/the-journal-of-logic-and-algebraic-programming)

Web sites of interest

The TPTP Problem Library for Automated Theorem Proving: https://tptp.org/
System on TPTP: https://www.tptp.org/cgi-bin/SystemOnTPTP
The CADE ATP System Competition: https://tptp.org/CASC/
Logic Tools: https://logictools.org/

OBSERVATIONS

Universidad del País Vasco Euskal Herriko Unibertsitatea

COURSE GUIDE 2024/25

Faculty 226 - Faculty of Informatics **Cycle** .

Degree GIARTI20 - Bacherlor's Degree in Artificial Intelligence **Year** Second year

COURSE

26630 - Signals & Systems **Credits, ECTS:** 6

COURSE DESCRIPTION

PLEASE NOTE THAT THIS SUBJECT IS TAUGHT ONLY IN SPANISH/BASQUE, ALTHOUGHT IT IS ENGLISH FRIENDLY.

This course is a compulsory course in the 2nd year of the Engineering Degree in Artificial Intelligence (taught during the first term).

The subject is designed to introduce students to both the theoretical and practical aspects of Digital Signal Processing. For this reason, the subject uses concepts previously learned in first-year subjects of the degree in the area of mathematics (Mathematical Analysis, Algebra), statistics (Statistical Methods in Engineering) and programming (Basic Programming, Programming Methodology, Modular Programming and Object Oriented).

Within the context of the degree in Artificial Intelligence, the course provides students with the necessary tools to process signals of various kinds and transform them so that they can be used as input to intelligent information processing systems that are presented in multiple subjects of the degree (Data Mining, Artificial Intelligence, Machine Learning and Neural Networks, Biomedical and Physiological Data Analysis, Speech Processing, among others).

In the professional field, the subject enables students to digitally process any type of signal (sound, image, information from sensors, time series, etc.) in multiple fields (audiovisual, industry, medicine, meteorology, etc.). In this way, it serves as a link to other areas such as Data Science, Big Data, Industry 4.0, Robotics, Physiological Computing, etc.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

PLEASE NOTE THAT THIS SUBJECT IS TAUGHT ONLY IN SPANISH/BASQUE, ALTHOUGHT IT IS ENGLISH FRIENDLY.

According to the verified report of the degree in Artificial Intelligence, the competences (specific, transversal) and learning outcomes are presented.

The specific competences acquired by taking the subject are:
M07CE1 - Knowledge of the representation of signals and systems in the time and frequency domains, both in continuous and discrete time.
M07CE2 - Ability to understand, analyse, evaluate and apply the most appropriate digital signal processing strategies to deal with a given physical process.

The transversal competences acquired by taking this subject are:
CT1 - Autonomy and Self-regulation
Ability to use self-management and self-regulation techniques.
CT3 - Communication and Multilingualism
Ability to communicate ideas and arguments in a comprehensible way and according to established formal criteria.
CT8 - Teamwork
Value teamwork, accepting the potential of diversity as a learning opportunity. Carry out with responsibility the tasks that correspond to them in order to achieve the objectives and the collective result.

The specific learning outcomes provided by the subject are the following:
RA1 - Know how to use digital signal processing software and critically interpret the results obtained.
RA2 - Master and be able to apply the mechanisms of transformation of continuous signals to digital: sampling and quantification.
RA3 - Know the main methods of calculating the Fourier transform and know how to apply them to digital signals.
RA4 - Know the main parameters of FIR and IIR digital filters, and know how to design and apply them to digital signals.

Based on these competences and learning outcomes, the following objectives are contemplated in the subject:
O1 - To introduce students to the basic concepts related to Digital Processing: signals, systems, time and frequency analysis, filters.
O2 - To deepen in these concepts for signals of different nature, and to show the methods used in digital systems to capture, process and produce this type of signals.
O3 - To show different practical applications of these techniques and alternatives for their implementation.
O4 - To put into practice the concepts studied, applying them in the laboratory to real cases of signal processing using the

MATLAB platform (other alternatives such as SCILAB, Octave, Python, etc. may also be used).

Theoretical and Practical Contents

PLEASE NOTE THAT THIS SUBJECT IS TAUGHT ONLY IN SPANISH/BASQUE, ALTHOUGHT IT IS ENGLISH FRIENDLY.

Theme 1
1.1 Introduction to digital signal processing
1.2 Signals and systems Why digital processing?
Introduction to the subject in which the basic definitions of the PDS are shown.

Theme 2
2.1 Digital signals
2.2 Definitions and properties. Digitization. Basic signals and operations
2.3 Analysis of different types of signals (sound, image, physiological, etc.)
Practical part: Specific Project 1 (PE1) - Introduction to Matlab
After introducing the main types of signals, a specific project will be carried out in order to learn the functionalities of the Matlab platform.

Theme 3
3.1 Time domain analysis
3.2 Usual operations. Windowing and short-term operations. Correlation
Practical part: Specific Project 2 (SP2) - Time Domain Analysis
This chapter presents the treatment of signals in the time domain. It introduces short-time analysis of signals and the possible features to be extracted, e.g. correlation. It ends with a project in which a sound signal is analysed to automatically extract the frequencies present by means of correlation.

Theme 4
4.1 Frequency domain analysis
4.2 Starting idea. Fourier series and transform. Application to two-dimensional systems
4.3 Projects: Analysis of digital signals in the frequency domain
Practical part: Specific Project 3 (SP3) - Frequency domain analysis
This chapter presents the treatment of signals in the frequency domain after applying the Fourier transform. Window analysis is again used in order to extract features in the frequency domain. It ends with a project in which several sound signals (DTFM, melodies) are analysed in order to extract the frequencies present in them by analysing the spectra.

Theme 5
5.1 Filters
5.2 LTI systems. FIR filters. Z transform. IIR filters. Non-linear filters
Practical Part: Specific Project 4 (SP4) - LTI Filters: FIR
Practical Part: Specific Project 5 (SP5) - LTI Filters: IIR
This topic introduces the two types of LTI filters, FIR and IIR, together with the Z-transform. In this topic, two specific projects with FIR and IIR filters respectively are developed in practical applications, e.g. removal of unwanted noise in signals.

Theme 6
6.1 Applications of digital signal processing.
6.2 Areas of application and examples.
The last topic of the course explores the concept of sampling, quantification and aliasing. In addition, applications of PDS are considered that point towards possible final projects.
Practical part: Final Project (FP) - Application of PDS in a given context.
This is a project of medium/high complexity in which what has been learnt in the course is applied.

TEACHING METHODS

PLEASE NOTE THAT THIS SUBJECT IS TAUGHT ONLY IN SPANISH/BASQUE, ALTHOUGHT IT IS ENGLISH FRIENDLY.

There are four types of activities:

- Autonomous study by the students of the material available in the virtual classroom for each subject in which the theoretical/practical concepts to be used are presented, as well as a proposal of exercises associated with them. In addition to directly accessible information, students can use bibliographic references as support material.

- Presentation and exercise classes in which, in a participative way, the theoretical/practical concepts of each topic are shared and the doubts associated with them are clarified, always emphasizing their usefulness and practical aspects. In these sessions, the initially proposed exercises ("on paper") will be shared in order to deepen the theoretical foundations. Exercises will also be proposed on each topic that the students will have to solve and that will be evaluated with the corresponding feedback.

- Development of specific projects in which students in groups (preferably in groups of 2 or 3) apply the theoretical/practical concepts learnt to real problems, using specific signal processing software. For each of these sessions, a technical report of the results must be submitted that will be evaluated with the corresponding feedback.

- Development of a final project (medium/high complexity level) in which the students (preferably in groups of 2 or 3) will apply the theoretical/practical knowledge previously learned in the course.

In order to facilitate student learning, specific projects will be monitored by providing feedback based on previously established and shared evaluation criteria. In this way, students are aware of their level of learning and take steps to improve it if necessary.

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	40			20					
Horas de Actividad No Presencial del Alumno/a	60			30					

Legend:
M: Lecture-based
S: Seminar
GA: Applied classroom-based groups
GL: Applied laboratory-based groups
GO: Applied computer-based groups
GCL: Applied clinical-based groups
TA: Workshop
TI: Industrial workshop
GCA: Applied fieldwork groups

Evaluation methods

- Continuous evaluation
- End-of-course evaluation

Evaluation tools and percentages of final mark

- The percentages and types of assessment are specified in the following sections 100%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

PLEASE NOTE THAT THIS SUBJECT IS TAUGHT ONLY IN SPANISH/BASQUE, ALTHOUGHT IT IS ENGLISH FRIENDLY.

The assessment systems considered are the continuous assessment system and the final assessment system. In the ordinary call, the continuous assessment system is the one that will be used in preference, as indicated in the current regulations of the UPV/EHU. The mark is calculated as follows:

- Theory: classroom exercises and written tests 50% (5 points: 2 points for topics 1-2-3, 2.5 points for topics 4-5, and 0.5 points for topic 5).
- Practical: specific projects 35% and final project 15%. This part of the course uses a PBL type methodology and involves the autonomous completion of the proposed projects, with the delivery of the corresponding technical reports (transversal communication skills) by each group of two or three people (collaborative learning). In addition, there will be individual written evaluations that will weigh the marks of the practical part in the following way:

Minimun mark	Weigthing to be applied
0	0.3
3	0.5
5	0.7
8	1.0

For the final assessment mode, the students will have to submit the reports corresponding to the specific projects and the final project at least two weeks before the date of the ordinary call (date of the final theory test). In this case, the examination will weigh 60% and the practical part 40% (based on previously submitted projects). There will be an individual written evaluation that will weigh the overall mark of the practical part (see the weighting in the continuous assessment).

In order to pass the subject, in any modality, it is necessary to pass both the practical and theoretical parts of the subject separately.

Students who, fulfilling the conditions to continue in the continuous assessment system, decide to opt for the final or global assessment, must inform the teacher responsible for the subject by email before the beginning of the second week of the grouped timetable of the four-month period established in the centre's calendar.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

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In the case of the extraordinary call, the final mark is calculated based on two parts:

- Theory (60%): It is assessed by means of a knowledge test on the date of the extraordinary call.

- Practical (40%): This is assessed on the basis of the technical reports corresponding to the specific and final projects, which must be submitted before the date of the theory test. There will be an individual written evaluation that will weigh the overall mark of the practical part.

In order to pass the course it is necessary to pass both parts (theoretical and practical).

MANDATORY MATERIALS

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For the correct development of the subject it is required:
- a PC type personal computer.
- and specific software for signal processing (MATLAB, etc.), for the laboratory practices.

The centre provides both resources. In addition, students have the possibility of carrying out the practical projects on their own computers using the UPV/EHU's MATLAB corporate licence and free software (SCILAB, Octave, Python, etc.).

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Basic bibliography

PLEASE NOTE THAT THIS SUBJECT IS TAUGHT ONLY IN SPANISH/BASQUE, ALTHOUGHT IT IS ENGLISH FRIENDLY.

J. G. Proakis, D.G. Manolakis: "Tratamiento digital de señales". Prentice-Hall, 1997.
R.G. Lyons: "Understanding Digital Signal Processing". Prentice Hall, 2010.
A. Lárez: "Procesamiento Digital de Señales: parte 1". Eleunion, 2022.
J. G. Proakis, D.G. Manolakis: Digital Signal Processing: Principles, Algorithms, and Applications. 4th Edition, Pearson Education, Inc., New Delhi, 2007.
A. V. Oppenheim, R. W. Schafer: "Digital Signal Processing". Prentice-Hall, 1988.
A.V. Oppenheim, R. W. Schafer: "Discrete-Time Signal Processing". Prentice Hall, 2009.
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Detailed bibliography

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B. Gold, N. Morgan: "Speech and audio Signal Processing: Processing and perception of speech and music", Wiley 2000.
J. R. Deller, J. G. Proakis: "Discrete-Time Processing of Speech Signals". MacMillan, 1993.

Journals

PLEASE NOTE THAT THIS SUBJECT IS TAUGHT ONLY IN SPANISH/BASQUE, ALTHOUGHT IT IS ENGLISH FRIENDLY.

Digital Signal Processing (Elsevier)
Signal Processing (Elsevier)
IEEE Signal Processing Letters

Universidad del País Vasco — Euskal Herriko Unibertsitatea

COURSE GUIDE 2024/25

Faculty 226 - Faculty of Informatics **Cycle** .

Degree GIARTI20 - Bacherlor's Degree in Artificial Intelligence **Year** Third year

COURSE

28271 - Advanced Machine Learning **Credits, ECTS:** 6

COURSE DESCRIPTION

The subject is taught in the second semester of the 3rd year of the Artificial Intelligence degree. It is a natural continuation of the Data Mining subject (2nd year). It is also tightly linked to other subjects of the first semester, such as Machine Learning and Neural Networks, and Natural Language Processing.
The subject has a dual perspective. First, the theoretical roots of the machine learning paradigm are studied, and introduced a classifiers which naturally raises from these roots. Second, non-standard classification problems are studied and solved: that's, going beyond the "confort area" of supervised and unsupervised classification.
All these problems are crucial for the subjects in the 4th year of the degree.

In order to study this subject, the student needs to use the knowledge previously learned in the Data Mining subject, and other basic subjects such as Advanced Statistical Methods and Operation Research.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

Output of the learning process:
- Knowledge on the theoretical-practical roots of the machine learning paradigm

Theoretical and Practical Contents

1. Machine Learning fundamentals
 - PAC learning, VC
 - Loss functions
 - Empirical Risk Minimization

2. Methods based on kernels
 - Linear methods for classification - Support Vector Machines (SVMs)

3. Weakly supervised classification
 - Semi-supervised classification
 - Positive unlabeled learning
 - Learning with label proportions
 - Crowd learning
 - Miscelanea: other types of weakly supervised problems

4. Non-standard supervised classification
 - Multi-label learning
 - Multi-dimensional classification
 - Hierarchical classification
 - Structured output prediction

TEACHING METHODS

Different teaching methodologies are used. Some of them, teaching classes with slides, presenting the theoretical parts and case studies of the subject. Some of these problems will be solved by the students.

On the other class, computer laboratories are used. Coding practices will be used to solve the exposed problems.

The student will receive feedback from the teacher, based on the output of these theoretical and laboratory classes. These works will be graded.

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
Hours of face-to-face teaching	40			20					
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Legend:
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GL: Applied laboratory-based groups — GO: Applied computer-based groups — GCL: Applied clinical-based groups
TA: Workshop — TI: Industrial workshop — GCA: Applied fieldwork groups

Evaluation methods

- Continuous evaluation
- End-of-course evaluation

Evaluation tools and percentages of final mark

- Written test, open questions 40%
- Exercises, cases or problem sets 60%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

While continual and global evaluation systems are allowed, the first one, continual evaluation, is hardly recommended and will be the default system, as exposed in the UPV/EHU rules.

The student who, fulfilling the requirements to complete the continual evaluation, decides the global evaluation, needs to inform the teachers during the first 9 months of the course (in writing form).

The evaluation of the subject is continual, and composed of the following tests-exams:
1- Tests during the course: 60% of the final mark. This will be done by:
- Individual works to evaluate the concepts exposed during the classes.
- Group and individual works to evaluate how the students solve the problems exposed during the classes and practical sessions.

2- Writing exam in the official date fixed by the Faculty in the official exam-period: 40% of the final mark. It is a writing-exam, where the theoretical-practical concepts exposed in the subject will be evaluated.

The final mark is a sum of both, previous (sub)marks: but it is needed to obtain a minimum of 4 points (over 10) in each of the both tests-exams.

The student has the right to be evaluated by the "global evaluation system". To proceed with this, the student needs to present, in writing form, his/her election of the global system: during the first 9 weeks of the course. If the student does not present any work during the first 9 weeks of the course, it is understood that he/she opt for the global evaluation type.

In both types of evaluation, if the student is not present in the final writing exam, it is understood that he/she gives up, and will be qualified as "non-present".

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The rules of the ordinary call will be applied.

The students who opted for the continual evaluation form can "save" for this extraordinary call the partial marks obtained in the tests and works done during the course. When these are completed, he/she only needs to perform the extraordinary exam of the subject, which covers the 40% of the final mark. It is also needed to obtain, at least, a 4 over 10, in each of the tests-exam, to be considered to pass the subject.

MANDATORY MATERIALS

None.

BIBLIOGRAPHY

Basic bibliography

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Hernández-González, J., Inza, I., & Lozano, J. A. (2016). Weak supervision and other non-standard classification problems: a taxonomy. Pattern Recognition Letters, 69, 49-55.

Jaskie, K., & Spanias, A. (2019, July). Positive and unlabeled learning algorithms and applications: A survey. In 2019 10th International Conference on Information, Intelligence, Systems and Applications (pp. 1-8). IEEE.

Soleimani, H., & Miller, D. J. (2017). Semisupervised, multilabel, multi-instance learning for structured data. Neural computation, 29(4), 1053-1102

Van Engelen, J. E., & Hoos, H. H. (2020). A survey on semi-supervised learning. Machine Learning, 109(2), 373-440.

Varma, P., Sala, F., He, A., Ratner, A., & Ré, C. (2019, May). Learning dependency structures for weak supervision models. In International Conference on Machine Learning (pp. 6418-6427). PMLR.

Zhou, Z. H. (2018). A brief introduction to weakly supervised learning. National science review, 5(1), 44-53.

Detailed bibliography

None

Journals

Web sites of interest

- U. von Luxburg (2020). Statistical Machine Learning. YouTube videos serie. https://www.youtube.com/playlist?list=PL05umP7R6ij2XCvrRzLokX6EoHWaGA2cC

OBSERVATIONS

Web sites of interest

PLEASE NOTE THAT THIS SUBJECT IS TAUGHT ONLY IN SPANISH/BASQUE, ALTHOUGHT IT IS ENGLISH FRIENDLY.

www.mathworks.com
www.scilab.org
www.dsprelated.com
www.gnu.org/software/octave
www.scipy.org

OBSERVATIONS

Universidad del País Vasco — Euskal Herriko Unibertsitatea

COURSE GUIDE 2024/25

Faculty 226 - Faculty of Informatics **Cycle** .

Degree GIARTI20 - Bacherlor's Degree in Artificial Intelligence **Year** Third year

COURSE

26222 - Search Heuristics **Credits, ECTS:** 6

COURSE DESCRIPTION

The study of this subject is the solution of optimization problems. Finding the best solution to a problem is one of the most important elements of decision making. Optimal planning of processes, optimization of finding the shortest route in a transport company or allocation of resources are examples of optimization problems that appear so often in real life.

In the Operative Research subject, classic techniques for solving optimization problems are explained, such as Simplex, Branch & Bound or the Hungarian method. To apply these algorithms, the problems must have specific characteristics (usually they are simple problems). However, many of the problems presented in reality are very complex (NP-hard) and therefore it is impossible to use the algorithms we have mentioned. The algorithms that we will learn in the Heuristic Searches subject will, in a short time, try to obtain the best possible solutions. Of course, no guarantee of optimal results. They are known as heuristic algorithms, and they are based on intuition. During the subject, we will study combinatorial optimization problems, and learn how to formalize them, and design and implement algorithms to solve them. Not only that, we will learn how to choose the most effective among the proposed algorithms.

"Please note that this subject is taught only in Spanish/Basque"

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

- Acquiring the ability to formalize combinatorial optimization problems, represent their solutions appropriately, and define the search space.

- Knowing how to design and apply constructive algorithms, algorithms based on a single solution, and population algorithms.

- To acquire the ability to grasp multiple objectives or problems in dynamic contexts, and to have the ability to apply appropriate algorithms by analyzing the scientific bibliography.

- Knowing how to define and apply an experimental design to compare stochastic algorithms. Mastering techniques for visualizing results, and having the ability to apply statistical analysis methods to draw strong conclusions.

Theoretical and Practical Contents

* Unit 1 - Introduction to heuristic searches.
    1.1. Combinatorial optimization problems.
    1.2. Coding and search space for solutions.
    1.2. The complexity
    1.3. A review of classical methods.
    1.4. Constructive algorithms.

* Unit 2 - Local search heuristic algorithms.
    2.1. Environmental function
    2.2. Local search algorithms
    2.3. Selection criteria.
    2.4. Local maxima and minima and their estimation
    2.5. Bases of attraction

* Unit 3 - Advanced local searches.
    3.1. Multi-start methods (MLS, GRASP, ILS,...)
    3.2. Environment function modification methods (VNS, VND...)
    3.3. Methods for accepting bad solutions (SA, TS,...)

* Unit 4 - Algorithms based on populations
    4.1. Introduction
    4.2. Genetic algorithms
    4.3. Estimation of Distribution Algorithms
    4.4. Swarm Intelligence algorithms (ACO, PSO)

* Unit 5. Variations of optimization problems
    5.1. Multi-objective optimization
    5.2. Dynamic optimization

5.3. Optimization of problems with constraints

* Unit 6. Experimental design and algorithm comparison.
6.1. Experimental design.
6.2. Execution of algorithms.
6.3. Visualization of results.
6.4. Statistical analysis of the results (Uncertainty analysis)

TEACHING METHODS

In this lesson we will have four types of activities:

Lectures - Theoretical content will be presented and illustrated with simple examples. Student participation will be encouraged, with small exercise challenges focused on reflection.

Individual laboratory practice - Students will individually program heuristic algorithms for optimization problems in the Python language. The aim will be to illustrate the theoretical content.

Group project - In groups, they will have to develop a project. The teachers will ask them an optimization problem, and formalize the problem, and they will have to propose two algorithms to optimize it. Finally, they will have to develop an experimental design to compare the performance of the two. They will have to write all the work in a 4-page scientific article at the end of the semester.

Seminars - In these special sessions we will work on some concrete content that is additional to the workshop. Using a relaxed format, students will initially work on the content, followed by discussion.

TYPES OF TEACHING

Types of teaching	M	S	GA	GL	GO	GCL	TA	TI	GCA
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GCL: Applied clinical-based groups
TA: Workshop
TI: Industrial workshop
GCA: Applied fieldwork groups

Evaluation methods

- Continuous evaluation
- End-of-course evaluation

Evaluation tools and percentages of final mark

- Jarraian azaltzen dira portzentaiak. 100%

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

Two types of assessment will be available: CONTINUOUS and FINAL.

During the CONTINUOUS evaluation you will have to complete six tasks: 2 tests (one practical and one theoretical), 2 project submissions and 2 laboratory submissions. By default, all students will go through this type of assessment. In this type of evaluation, the grade will be calculated through the evaluation of the following tasks:
- Project - 20% (divided into 2 phases, 10% each)
- Laboratory test - 20% (two tests, 10% each)
- 1. Theoretical test - 30%
- 2. Practical test - 30%

In order to be able to keep the CONTINUOUS evaluation, a minimum grade of 3.5 out of 10 must be obtained in each test. A minimum grade must also be passed in the laboratory assignments. Those who do not pass the minimum will automatically go to the FINAL evaluation.

In the assessment, the FINAL will be evaluated through a theoretical-practical exam and the delivery of the project:
- Project - 20%
- Theoretical-practical test - 80%

If the student did not pass, he would have another opportunity to do the theoretical-practical test in the non-regular call.

If desired, the student can proceed to the final assessment, always before the second exam.

Given the content of the course and its practical nature, it is recommended to carry out the assessment on a continuous

basis.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

In the non-ordinary exam, there will be only one theoretical-practical test worth 80% of the grade, which will cover the theoretical and practical concepts of the subject. The other 20% can be obtained with the delivery of the project.

MANDATORY MATERIALS

Course notes that will be provided in eGela, as well as numerous scientific articles that the professor will recommend to the students. Finally, the practical exercises will be programmed in Python and using Jupyter Notebooks or Google Colab.

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Basic bibliography

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3 (Sep. 2003), 268-308
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Journals

IEEE Trans. On Evolutionary Computation
Evolutionary Computation Journal
European Journal of Operational Research
Computers and Operations Research
Journal of Heuristics
Journal of Machine Learning Research
Information Sciences

Web sites of interest

OR-Library http://people.brunel.ac.uk/~mastjjb/jeb/info.html . Repositorio de problemas de optimización.
Red Española de Metaheurísticos. http://heur.uv.es/
Dirección de LIO una librería de algoritmos heurísticos http://www.dsi.uclm.es/investigacion/simd/SOFTWARE/LIO/

OBSERVATIONS