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 (EFC) 2024-2025**
**CAMPUS OF BIZKAIA**

**MASTER COURSES FACULTY OF SCIENCE AND TECHNOLOGY (310)**

Contact: ciencia.internacional@ehu.eus

**English Friendly Courses taught in SPANISH:**

<table>
<thead>
<tr>
<th>COURSE</th>
<th>SEMESTER</th>
<th>CREDITS</th>
<th>SCHEDULE</th>
<th>LINK TO SYLLABUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master’s Degree in Chemical Engineering</td>
<td></td>
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<tr>
<td>504253 Ampliación de Reactores Químicos</td>
<td>1st</td>
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<tr>
<td>504254 Optimización Avanzada de Procesos Químicos</td>
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<td>504255 Modelado y Simulación de Procesos Químicos</td>
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<tr>
<td>504263 Combustibles desde fuentes alternativas al petróleo</td>
<td>2nd</td>
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<tr>
<td>504265 Tecnologías de Refinería y Petroquímica</td>
<td>2nd</td>
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<tr>
<td>504267 Tecnologías catalíticas para el control de la contaminación del aire</td>
<td>2nd</td>
<td>3</td>
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<tr>
<td>504270 Valorización de residuos</td>
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<table>
<thead>
<tr>
<th>Master’s Degree in Synthetic and Industrial Chemistry</th>
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<tbody>
<tr>
<td>504304 Síntesis Química Avanzada</td>
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<tr>
<td>504306 Síntesis Estereocontrolada</td>
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<tr>
<td>504309 Química Orgánica Avanzada</td>
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<tr>
<td>504312 Productos Naturales, Síntesis, biosíntesis y aplicaciones</td>
<td>2nd</td>
<td>3</td>
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</tbody>
</table>

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1 SEMESTER: Annual: September 2024 to May 2025
1\textsuperscript{st}: September 2024 to January 2025
2\textsuperscript{nd} : January 2025 to May 2025

2 SCHEDULE: Morning (M)/ Afternoon (A): begins at 13.30
# ENGLISH FRIENDLY COURSES (EFC) 2024-2025
## CAMPUS OF BIZKAIA

### MASTER COURSES FACULTY OF ECONOMICS AND BUSINESS (321)


**Contact:** [economicas.internacional@ehu.es](mailto:economicas.internacional@ehu.es)

<table>
<thead>
<tr>
<th>COURSE</th>
<th>SEMESTER³</th>
<th>CREDITS</th>
<th>SCHEDULE⁴</th>
<th>LINK TO SYLLABUS</th>
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</thead>
<tbody>
<tr>
<td>Master in Business Management from an Innovation and Internationalization Perspective</td>
<td>1st</td>
<td>3</td>
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<tr>
<td>502122 Globalización y Gestión Financiera</td>
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<tr>
<td>502109 Marketing Ecológico: Estrategias y Técnicas de Investigación para un desarrollo sostenible</td>
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<td>3</td>
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<tr>
<td>502110 Comportamiento del consumidor y dirección de marca</td>
<td>2nd</td>
<td>3</td>
<td>A</td>
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<tr>
<td>502120 Gobierno y control de la empresa familiar</td>
<td>2nd</td>
<td>3</td>
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<tr>
<td>Master's degree in Economics: Economic Analysis Tools</td>
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<tr>
<td>503485 Econometría</td>
<td>1st</td>
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<tr>
<td>503486 Técnicas de inferencia estadística</td>
<td>1st</td>
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<tr>
<td>503487 Análisis básico de series temporales</td>
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<tr>
<td>503501 Economía ambiental</td>
<td>1st</td>
<td>3</td>
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<tr>
<td>503506 Teoría de Juegos</td>
<td>1st</td>
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<tr>
<td>503488 Temas de Estadística y Series Temporales</td>
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<tr>
<td>503504 Economía Recursos Naturales y Política Ambiental</td>
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³ SEMESTER: Annual: September 2024 to May 2025
1st: September 2024 to January 2025
2nd: January 2025 to May 2025

⁴ SCHEDULE: Morning (M)/ Afternoon (A): begins at 13.30
### ENGLISH FRIENDLY COURSES (EFC) 2024-2025
#### CAMPUS OF BIZKAIA

**MASTER COURSES FACULTY OF ENGINEERING – BILBAO (345)**


**Contact:** ingenieria.internacional@ehu.eus

<table>
<thead>
<tr>
<th>COURSE</th>
<th>SEMESTER</th>
<th>CREDITS</th>
<th>SCHEDULE</th>
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<tbody>
<tr>
<td>Master’s Degree in Telecommunications Engineering</td>
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<td>504005 Sistemas electrónicos de comunicaciones</td>
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<td>504007 Microelectrónica</td>
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<td>504010 Convergencia e Integración de Redes de Acceso y Troncales</td>
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<td>504022 Gestión y Metodología en Investigación</td>
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<td>504027 Procesado de señales biomédicas</td>
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<td>504018 Diseño avanzado de comunicaciones vía radio</td>
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| Master’s Degree in Industrial Engineering | | | | |
| 503302 Diseño y Desarrollo de Producto | 1st | 4,5 | A | |
| 503905 Sistemas Integrados de Fabricación | 1st | 3 | M | |
| 503915 Dirección de Proyectos | 1st | 6 | A | |
| 503924 Laboratorio de Diseño de Producto | 1st | 4,5 | A | |
| 503955 Integración de Sistemas Industriales | 1st | 4,5 | A | |
| 503956 Automatización y Robótica | 1st | 6 | A | |

5 **SEMESTER:** Annual: September 2024 to May 2025
1st: September 2024 to January 2025
2nd: January 2025 to May 2025

6 **SCHEDULE:** Morning (M)/ Afternoon (A): begins at 13.30
<table>
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<tr>
<th>COURSE</th>
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<th>SCHEDULE⁶</th>
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<tr>
<td>503922 Diseño y Modelado Paramétrico</td>
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<td>503923 Ciclo de Vida del Producto</td>
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<tr>
<td>503959 Gestión de Recursos Hidráulicos y centrales Hidroeléctricas</td>
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<td>503960 Oleohidráulica</td>
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<td><strong>Master in Advanced Materials Engineering</strong></td>
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<td>503320 Comportamiento mecánico de materiales</td>
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<td><strong>Master in Space Science and Technology</strong></td>
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<td>501990 Fisica Espacial</td>
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<td>501991 Fundamentos de Instrumentación Óptica</td>
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<td>501994 Materiales para el Espacio I: Fundamentos</td>
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<td>502005 Interferometría Espacial</td>
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<td>502007 Física del Sistema Solar</td>
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<td>502001 Ensayos No Destructivos: Materiales Espaciales</td>
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<td><strong>Master in Control Engineering, Automation and Robotics</strong></td>
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<td>504137 Robótica Industrial</td>
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<td>204140 Integración de Sistemas Industriales</td>
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<td><strong>Master in Mechanical Engineering</strong></td>
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<tr>
<td>504244 Metrología Dimensional</td>
<td>1st</td>
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</table>
### MASTER COURSES FACULTY OF MEDICINE AND NURSING – BILBAO (327)


**Contact:** [medicina.internacional@ehu.eus](mailto:medicina.internacional@ehu.eus)

<table>
<thead>
<tr>
<th>COURSE</th>
<th>SEMESTER</th>
<th>CREDITS</th>
<th>SCHEDULE</th>
<th>LINK TO SYLLABUS</th>
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<tbody>
<tr>
<td>Master's Degree in Public Health</td>
<td>2nd</td>
<td>9</td>
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<tr>
<td>502862</td>
<td>Creación de un protocolo y desarrollo de un proyecto de investigación</td>
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**SEMMESTER:**

- **Annual:** September 2024 to May 2025
- **1st:** September 2024 to January 2025
- **2nd:** January 2025 to May 2025

**SCHEDULE:** Morning (M)/ Afternoon (A): begins at 13.30
COURSE GUIDE 2024/25

Faculty  310 - Faculty of Science and Technology
Degree  INQUI15b - Master in Chemical Engineering

COURSE

504253 - Advanced chemical reactors

COURSE DESCRIPTION

This course is a continuation of the course Reactor Design of the Bachelor Degree in Chemical Engineering. The knowledge acquired in the design of conventional reactors, as well as new reactors for new processes for Chemical Reaction Engineering, Biochemistry and Electrochemistry is expanded. The following aspects are addressed: i) fundamentals, analysis and design of reactors for heterogeneous (gas-solid, gas-liquid, liquid-liquid, gas-liquid-solid, solid-solid), electrochemical and biological (with microorganisms and enzymes) processes; ii) reactor selection and optimization of process conditions for catalytic, non-catalytic and multiphase processes; iii) analysis of the current state of technological development and prospects for innovation in the fields of knowledge and industrial implementation; v) analysis of the role of chemical reactors in sustainability and new processes of energy and environmental interest.

The course is closely related to others in the Master's program, such as Modelling and Simulation of Chemical Processes (calculation tools to simulate and design certain configurations of chemical reactors are discussed), as well as with several elective courses describing processes of energy and environmental interest with chemical reactors (such as Refinery and Petrochemical Technologies, Fuels from alternative sources to petroleum, Hydrogen: raw material and energy vector).

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA

Application of the knowledge from Mathematics, Physics, Chemistry, Biology, and other natural sciences obtained from their studies, experience, and practice, using critical thinking to establish technical solutions that are viable from the economic point of view.

Design of products, processes, systems, and services of the chemical industry, as well as the optimization of others that have already been developed, based on the diverse areas of Chemical Engineering: process understanding, transport phenomena, separation processes, and chemical, nuclear, electrochemical, and biochemical reactions.

Conceptualize engineering models, apply innovative methods in the resolution of problems and the application of proper computer applications for the design, simulation, optimization and control of the processes and the systems.

Have the ability to solve non-familiar problems, not-completely defined, and have competing specifications, considering the multiple ways of solution, including the most innovative ones, choosing the best and evaluating the different design solutions.

Manage and supervise all types of facilities, processes, systems, and services of the different industrial areas related to chemical engineering.

Design, build and implement methods, processes and facilities for the integrated management of solid, liquid and gaseous supplies and wastes in industries, with the ability to assess their impacts and risks.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

After completing the course, students will be able to:
- Describe the characteristics of heterogeneous conventional reactors and newly designed reactors.
- Select the most suitable reactor for each process, depending on production, economic, safety, energetic and/or environmental criteria.
- Formulate and handle material and energy conservation equations of reactors.
- Design reactors under real flow conditions by means of flow models.
- Design and optimize the operating conditions of the reactors.

Theoretical and Practical Contents


**METODOLOGIA (ACTIVIDADES FORMATIVAS)**

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groupwork</td>
<td>9,5</td>
<td>0 %</td>
</tr>
<tr>
<td>Case analysis</td>
<td>15</td>
<td>40 %</td>
</tr>
<tr>
<td>Expositive classes</td>
<td>23</td>
<td>100 %</td>
</tr>
<tr>
<td>Handling sources and resources</td>
<td>25</td>
<td>0 %</td>
</tr>
<tr>
<td>Exercises</td>
<td>40</td>
<td>40 %</td>
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**TYPES OF TEACHING**

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
<th>GL</th>
<th>GO</th>
<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
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<tr>
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<td>6</td>
<td>17</td>
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<td>25,5</td>
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</table>

**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 tools and percentages of final mark**

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written examination</td>
<td>75 %</td>
<td>85 %</td>
</tr>
<tr>
<td>Practical tasks</td>
<td>15 %</td>
<td>25 %</td>
</tr>
</tbody>
</table>

**ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

3 tasks (non-presential):
1. Written exam (75 %): 2 midterm exams composed of 5/6 theoretical/practical questions. These questions are answered individually, after a period of preparation using available material on e-gela and bibliographic media. If students pass these midterm exams, do not have to do the corresponding parts in the final one.
2. Individual written work (15 %): A written work on advanced reactor design for a process selected by each student will be carried out. This work will include fundamental aspects of reactor design, of any of the types and for any of the heterogeneous reactions studied in the course or others. The recommended length is around 12 pages (20 pages maximum) including title, nomenclature and bibliography (10 citations maximum).
3. Exercises (10 %): Design exercises of fixed bed and fluidized bed catalytic reactors will be carried out, using in the first case Scilab calculation software. The calculation program will be delivered, as well as the result obtained in the design of each reactor.
Evaluation criteria: Clarity of the calculation program and correctness of the values obtained; adequate description of the resolution procedure(s) used.
Deadline: Before the twelfth week of the course.
Withdrawal: The student will have to give advance notice regarding his/her withdrawal from the ordinary call in writing, at least one week before the exam. To do so, he/she will have to send an email to all of the lecturers of the subject in addition to the coordinator of the Master’s Degree.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

2 tasks (non-presential):
1. Written exam (80 %): 10 theoretical/practical questions.
2. Individual written work (10 %): same one as the one described for the ordinary call.
The assessment criteria are the same as the ones for the ordinary call.
Withdrawal: the same ones as for the ordinary call.

MANDATORY MATERIALS

- E-gela virtual classroom.
- Scilab Software.

BIBLIOGRAPHY

Basic bibliography

Detailed bibliography
Ranade, V.V., Chaudhari, R.V., Gunjal, P.R., Trickle Bed Reactors, Elsevier B.V., 2011.

Journals

Web sites of interest
COURSE GUIDE  2024/25

Faculty  310 - Faculty of Science and Technology
Degree  INQUI901 - Chemical Engineering

COURSE

504254 - Advanced optimization of chemical processes
Credits, ECTS: 4,5

COURSE DESCRIPTION
The chemical industry is undergoing huge changes worldwide, to the increased cost of energy, increasingly stringent environmental regulations, and global competition in product pricing and quality. One of the most important engineering tools for addressing these issues is optimization. Modifications in plant design and operating procedures have been implemented to reduce costs and meet constraints, with an emphasis on improving efficiency and increasing profitability.

The course focuses on three key aspects: Firstly on how to formulate optimization problems appropriately because many engineers and scientists find this phase of their decision-making process the most exasperating and difficult; secondly on modeling the optimization problem and thirdly on the analysis of optimization results.

To apply optimization effectively in the chemical industries, both the theory and practice of optimization must be understood, both of which are explained in this course. It is organized into four parts: linear programming, integer programming, nonlinear programming and design of experiments focused on plant optimization.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

Apply knowledge of mathematics, physics, chemistry, biology, and other natural sciences, obtained through study, experience, and practice, with critical reasoning to establish economically viable solutions to technical problems
To design products, processes, systems and services for the chemical industry, as well as the optimization of others already developed, taking as a technological base the different areas of chemical engineering, including processes and transport phenomena, separation operations and chemical, nuclear, electrochemical and biochemical reaction engineering.
Conceptualize engineering models, apply innovative problem-solving methods and appropriate computer applications for the design, simulation, optimization and control of processes and systems.
Manage and supervise all types of installations, processes, systems and services in the different industrial areas related to chemical engineering.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA
Tras cursar la asignatura, el alumnado será capaz de:
- Identificar un problema de optimización en el ámbito de la ingeniería química.
- Definir un problema de optimización (lineal, entera o no-lineal).
- Seleccionar el método de optimización apropiado para la resolución de cada problema.
- Implementar el método de optimización y resolver el problema utilizando un software de cálculo apropiado.
- Analizar el resultado de un problema de optimización

Theoretical and Practical Contents

INTRODUCTION: Formulation of an optimization problem; types of problems; Review of basic techniques.
LINEAR PROGRAMMING: Problem definition. Simplex Algorithm. Examples and applications in Chemical Engineering.

METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentation and defence of projects</td>
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<tr>
<td>Exercises</td>
<td>10</td>
<td>20 %</td>
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<tr>
<td>Expositive classes</td>
<td>15</td>
<td>100 %</td>
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<tr>
<td>Handling sources and resources</td>
<td>17,5</td>
<td>0 %</td>
</tr>
<tr>
<td>Groupwork</td>
<td>30</td>
<td>30 %</td>
</tr>
<tr>
<td>Case analysis</td>
<td>35</td>
<td>40 %</td>
</tr>
</tbody>
</table>
**TYPES OF TEACHING**

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
<th>GL</th>
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<tr>
<td>Hours of face-to-face teaching</td>
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**Legend:**
- M: Lecture-based
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- TA: Workshop
- TI: Industrial workshop
- GCA: Applied fieldwork groups

**Evaluation tools and percentages of final mark**

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written examination</td>
<td>0 %</td>
<td>50 %</td>
</tr>
<tr>
<td>Presentations</td>
<td>30 %</td>
<td>60 %</td>
</tr>
<tr>
<td>Practical tasks</td>
<td>40 %</td>
<td>70 %</td>
</tr>
</tbody>
</table>

**ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

The assessment is continuous based on works made throughout the term. These works will be graded attending to criteria of originality, degree of difficulty, appropriateness, coherence, resolution, and presentation. At the end, students will take an individual test.

Students can resign the ordinary call until one month before classes are over. In this case, the student must send a written resignation to any of the teachers in charge for the subject.

**EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

In the extraordinary assessment call, students will have take an exam and submit and present a individual work on optimization.

**MANDATORY MATERIALS**

Matlab.

**BIBLIOGRAPHY**

**Basic bibliography**


**Detailed bibliography**

**Journals**
- Industrial & Engineering Chemistry Research
- Chemical Engineering Science
- Chemical Engineering Processing

**Web sites of interest**
<table>
<thead>
<tr>
<th>COURSE GUIDE</th>
<th>2024/25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty</td>
<td>310 - Faculty of Science and Technology</td>
</tr>
<tr>
<td>Degree</td>
<td>INQUI901 - Chemical Engineering</td>
</tr>
<tr>
<td>Credits, ECTS</td>
<td>6</td>
</tr>
</tbody>
</table>

## COURSE DESCRIPTION

This subject is a core subject from the Chemical Engineering field and therefore it is mandatory, like in any other Chemical Engineering Master’s Degree in Spain or around the world. In order to take advantage of the course, it is necessary to have studied the basic subjects of Chemical Engineering. This includes subjects that deal with transport phenomena (Fluid Mechanics, Heat Transfer, and Mass Transfer), as well as those that deal with the design of chemical reactors (Kinetics of Chemical Processes and Reactor Design) and separation processes (Separation Processes). Moreover, it is recommended to have knowledge of the following subjects: Numerical Methods, Thermodynamics, Instrumentation and Control of Chemical Processes, and Programming. All of these subjects are included in the Chemical Engineering Bachelor Degree in addition to many other technical Bachelor Degrees. The knowledge and use of scientific programming languages such as Scilab and Matlab or that of process simulation in steady state (Pro II, ASPEN, HYSIS, or DWSIM) is desirable, but not imperative. The subject is closely related to all the contents from the Master’s that broaden the knowledge of the foundations of Chemical Engineering: Advanced Chemical Reactors, Advanced Process Control, Advanced Separation Processes, and Advanced Optimization of Chemical Processes.

Studying and passing this subject provides the student with the ability to approach the modelling and simulation of non-steady physic-chemical processes of industrial interest, using the calculus capacity of microprocessors to build tools that give way to address the effect of the design variables and those of operation conditions on the results of the process. The possibilities to actually apply the knowledge acquired in this subject in real professional practice are then unlimited.

### COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

**COMPETENCIAS DE LA ASIGNATURA**

- Aplicar conocimientos de matemáticas, física, química, biología y otras ciencias naturales, obtenidos mediante estudio, experiencia, y práctica, con razonamiento crítico para establecer soluciones viables económicamente a problemas técnicos
- Diseñar productos, procesos, sistemas y servicios de la industria química, así como la optimización de otros ya desarrollados, tomando como base tecnológica las diversas áreas de la ingeniería química, comprensivas de procesos y fenómenos de transporte, operaciones de separación e ingeniería de las reacciones químicas, nucleares, electroquímicas y bioquímicas
- Conceptualizar modelos de ingeniería, aplicar métodos innovadores en la resolución de problemas y aplicaciones informáticas adecuadas, para el diseño, simulación, optimización y control de procesos y sistemas
- Tener habilidad para solucionar problemas que son poco familiares, incompletamente definidos, y tienen especificaciones en competencia, considerando los posibles métodos de solución, incluidos los más innovadores, seleccionando el más apropiado, y poder corregir la puesta en práctica, evaluando las diferentes soluciones de diseño

**RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA**

Tras cursar la asignatura, el alumnado será capaz de:
- Identificar los fenómenos fundamentales que controlan un proceso
- Desarrollar el modelado matemático
- Resolver las ecuaciones mediante herramientas de cálculo avanzadas
- Evaluar la adecuación del modelo desarrollado en base al análisis de los resultados
- Proporcionar y ejecutar la simulación de situaciones diversas y estudiar la respuesta del modelo

### Theoretical and Practical Contents

- Macroscopic and Microscopic Mass Balances in multicomponent systems. Concentration profiles with one or more independent variables. Transfer in the interface.
- Preparation of the developed model by computer software for evaluation and external use.

### METODOLOGIA (ACTIVIDADES FORMATIVAS)
Actividad Formativa | Hours | Porcentaje presencialidad
---|---|---
Presentation and defence of projects | 6 | 100 %
Expositive classes | 12 | 100 %
Handling sources and resources | 17 | 0 %
Groupwork | 30 | 40 %
Case analysis | 40 | 30 %
Exercises | 45 | 40 %

**TYPES OF TEACHING**

<table>
<thead>
<tr>
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<th>M</th>
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**Evaluation tools and percentages of final mark**

<table>
<thead>
<tr>
<th>Denominación</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Written examination</td>
<td>0 %</td>
<td>40 %</td>
</tr>
<tr>
<td>Presentations</td>
<td>20 %</td>
<td>40 %</td>
</tr>
<tr>
<td>Practical tasks</td>
<td>40 %</td>
<td>80 %</td>
</tr>
</tbody>
</table>

**ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

EVALUATION CRITERIA:

1. Voluntary exercises: 30%
   - Theoretical exercises: In order to obtain the maximum grade a well-written and reasoned report, with a well-explained approach to the balances corresponding to the proposed system is required.
   - Practical exercises: In order to obtain the maximum grade the following are required: a checked algorithm that has been validated functionally. Moreover, a report must contain: 1) the approach to the balances corresponding to the proposed system, 2) the required mathematical development to obtain the system model, 3) a flow-chart of the algorithm that explains the resolution strategy, and 4) an analysis of the results obtained by simulation.
   - The maximum grade of this section is reached by properly carrying out 5 of the 8 proposed exercises.
2. GUI Exercise: 20%
   - The evaluation of the GUI will be carried out by the following criteria:
     - Operability (0-10, weight: 5)
     - Number of elements (1 point/element, weight: 1)
     - Number of different elements (1 point/type of element, weight: 3)
     - Aesthetics (0-10, weight: 2)
     - Originality (0-10, weight: 2)
3. Continuous assessment of the subject: 10%
   - Glossary: each original contribution will be valued at 1 point
   - Forum:
     - Question: 1 point
     - First answer: 2 points
     - Excellent answer: 3 points
   - All the points obtained in the glossary and the forum will be summed.
   - The student will have to obtain 40 points in order to reach the maximum grade of this section.
4. Final Exam: 40%
   - The student will have to carry out a complete modelling and simulation of the process in question. All the material available in egela is allowed for its use in the exam.

**FINAL MARK:**

A minimum mark of 4/10 is required in each section that is evaluated.

**WITHDRAWAL:**

The student will have to give advance notice regarding his/her withdrawal from the ordinary call in writing, at least 24
hours before the exam. To do so, he/she will have to send an email to all of the lecturers of the subject in addition to the coordinator of the Master’s Degree.

**EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

**EVALUATION CRITERIA:**

The same ones as for the ordinary call.

**WITHDRAWAL:**

The student will have to give advance notice regarding his/her withdrawal from the ordinary call in writing, at least 24 hours before the exam. To do so, he/she will have to send an email to all of the lecturers of the subject in addition to the coordinator of the Master’s Degree.

**MANDATORY MATERIALS**

Egela virtual classroom
Software: Scilab and Matlab

**BIBLIOGRAPHY**

**Basic bibliography**


**Detailed bibliography**


**Journals**

www.sciencedirect.com/science/bookseries/15707946

**Web sites of interest**

http://www.berkeleymadonna.com
www.mathworks.es/
"Fuels from Alternative Sources to Petroleum" is an elective subject of 3 ECTS credits, which is taught in the second semester of the Master's Degree in Chemical Engineering. The objective of the course is to advance in the knowledge of chemical technologies for obtaining products of interest and automotive fuels from alternative raw materials to petroleum (coal, natural gas and vegetable biomass). The current status and prospects for the development of technologies to obtain and valorize the different alternative raw materials are studied.

First, the raw materials related to C1 chemistry (coal and natural gas via synthesis gas, and methanol/dimethylether) are analyzed and then the so-called biofuels (bioethanol, biodiesel and biooil or pyrolysis liquid) are studied.

At the end of the subject, the student will be able to make a critical analysis of the technological status and viability of the different processes for obtaining fuels by alternative means to oil.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

To know the current status of the technologies for the valorization of alternative raw materials to oil (coal, natural gas, biomass), both those related to C1 chemistry (via synthesis gas) and biofuels (bioethanol, biodiesel and biooil).

Handle bibliographic sources that allow access to the scientific and technological advances, to international trends in the use of alternative technologies and raw materials to oil, and to studies and data offered by specialized agencies and business groups.

Identify the best options among the technological proposals studied according to the context and possibilities of each region.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

After taking the course, students will be able to:
- Know the processes of obtaining fuels from alternative sources to oil.
- Analyze the feasibility of using raw materials: oil, coal, natural gas and biomass.
- Know how to discriminate between the different catalytic processes for the sustainable production of fuels.
- To be able to design technologies related to C1 chemistry and to the production of biofuels.
- To estimate the CO2 valorization capacity in biorefinery processes.

LESSON 1: THE BIOREFINERY. Socioeconomic perspectives of petroleum supply and petrochemical industry.
Alternative sources for energy production and automotive fuels. Industrial exploitation and sustainability. Intermediate compounds and key steps in alternative technology to petrochemicals. C1 chemistry. Biofuels.

LESSON 2: SYNTHESIS GAS AS A FEEDSTOCK.


METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentation and defence of projects</td>
<td>3</td>
<td>100 %</td>
</tr>
<tr>
<td>Handling experimental equipment and facilities</td>
<td>4</td>
<td>100 %</td>
</tr>
<tr>
<td>Groupwork</td>
<td>6</td>
<td>0 %</td>
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</tbody>
</table>
**Types of Teaching**

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
<th>GL</th>
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<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
<td>18</td>
<td>5</td>
<td>3</td>
<td>4</td>
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<tr>
<td>Horas de Actividad No Presencial del Alumno/a</td>
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<td>11</td>
<td>7</td>
<td>5</td>
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</tbody>
</table>

Legend:
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- GA: Applied classroom-based groups
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**Evaluation tools and percentages of final mark**

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
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<tbody>
<tr>
<td>Written examination</td>
<td>50 %</td>
<td>70 %</td>
</tr>
<tr>
<td>Presentations</td>
<td>15 %</td>
<td>30 %</td>
</tr>
<tr>
<td>Practical tasks</td>
<td>15 %</td>
<td>30 %</td>
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</table>

**Ordinary Examination Period: Guidelines and Opting Out**

The evaluation of the subject in the ordinary call will consist of:
1. The completion of theoretical-practical tasks (papers, exhibitions, laboratory practices), with a weighting of 50%, being necessary a minimum score of 3.
2. Final written exam on, with a weighting of 50%, being necessary a minimum score of 3.
In order to pass the course, a minimum grade of 5 will be required, as an average of the two previous sections.
In order to waive the ordinary exam, a signed letter must be submitted to the professor (at least 10 days before the exam) indicating such intention.

**Extraordinary Examination Period: Guidelines and Opting Out**

The evaluation of the subject in the extraordinary call will consist of a final exam, with a weighting of 100%. In no case will be considered the negative results obtained during the ordinary call.
In order to waive the extraordinary exam, a signed letter must be submitted to the professor (at least 10 days before the exam is held) indicating such intention.

**Mandatory Materials**

eGela teaching material: theoretical presentations, notes, bibliography, etc.

**Bibliography**

**Basic bibliography**

**Detailed bibliography**

**Journals**

**Web sites of interest**
In this course we study the refinery processes that allow obtaining fuels and chemicals (raw materials of the petrochemical industry and lubricants) from crude oil. Special emphasis is placed on the state of the art of current technology and the challenges in the medium and long term, based on two fundamental aspects: the quality of the products obtained and the environmental challenges of each stage. The course includes the visit to a industrial site and laboratory experiments.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA

Understand the current state of the standard technologies in industrial facilities of petroleum refining and petrochemical industries, pointing out the tendencies of processing of raw materials.

Manage bibliographic sources that allow access to scientific and technological advances, to international technology trends in the use raw materials. Studying data offered by specialized enterprises in the sector.

Knowing how to identify the best options among the technological proposals studied according to the context and the possibilities of each region.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

Tras cursar la asignatura, el alumnado será capaz de:

- Identificar y describir las diferentes unidades existentes en la refinería y en la industria petroquímica, en base a las materias primas, productos, tecnologías, condiciones de operación y catalizadores.
- Caracterizar las principales propiedades del crudo y/o productos derivados (especialmente los combustibles y lubricantes).
- Investigar, a través de búsquedas en bases de datos, y comunicar de forma oral y/o escrita los avances tecnológicos de las diferentes unidades de la refinería y la industria petroquímica.
- Redactar informes técnicos sobre un proceso catalítico desarrollado en los laboratorios de investigación.

Theoretical and Practical Contents

1. Introduction: Socio-economic perspective of the oil supply and the petrochemical industry. Properties of crude oil. General scheme of a refinery


7. Petrochemical: Light olefins. Aromatics

8. Lubricants: Lubricants. Tribology

METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visit to industrial sites</td>
<td>4</td>
<td>100 %</td>
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<tr>
<td>Groupwork</td>
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<tr>
<td>Expositive classes</td>
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<td>100 %</td>
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<td>Handling experimental equipment and facilities</td>
<td>20</td>
<td>20 %</td>
</tr>
<tr>
<td>Handling sources and resources</td>
<td>25</td>
<td>0 %</td>
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</table>
### TYPES OF TEACHING

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<tbody>
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<td>30 %</td>
<td>70 %</td>
</tr>
<tr>
<td>Practical tasks</td>
<td>30 %</td>
<td>70 %</td>
</tr>
</tbody>
</table>

### ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The ordinary call consists of the evaluation of two parts, weighted in the following way:
- Written exam, 60% of the note
- Individual practical work, 40% of the mark

In case of renouncing the ordinary call, the assessment will be carried out in the following way:
Written exam, 100% of the grade, containing additional questions to assess the knowledge evaluated in the "Individual practical work."

### EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The extraordinary exam consist of a written exam that accounts for 100% of the grade, containing additional questions to assess the knowledge evaluated in the "Individual practical work."

### MANDATORY MATERIALS

### BIBLIOGRAPHY

**Basic bibliography**
- Ramos Carpio, M. A., Refino del petróleo, gas natural y petroquímica; Ed. Fundación Fomento Innovación industrial, Madrid (1997).

**Detailed bibliography**
- Speight, J.G., Petroleum Refining Processes (Chemical Industries), Ed. Marcel Dekker, 2002

**Journals**

**Web sites of interest**
COURSE GUIDE 2024/25

Faculty 310 - Faculty of Science and Technology
Degree INQUI15b - Master in Chemical Engineering

COURSE
504270 - Waste valorisation

Credits, ECTS: 3

COURSE DESCRIPTION
The Waste Valorization course deals with the analysis of the problems of industrial waste, as well as its characterization, and decision-making about its management. It deals with the evaluation of the state of the art and the development of the available technologies for waste valorization. It considers the use of alternatives to waste minimization and valorization to solve practical problems and the application of waste valorization processes to practical cases of waste generation. In order to expand training in energy and waste, it is recommended to study the optional subject of the university Master's Degree in Chemical Engineering “Remediation of Contaminated soils”.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA
- Understand the problem of industrial waste, as well as, characterize it, and make decisions about its management.
- Evaluate the state of the art and the development of available technologies for waste valorization.
- Analyze alternatives to waste minimization and valorization to solve practical problems.
- Apply waste valorization processes to practical cases of waste generation.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA
After studying the subject, students will be able to:
- Analyze and interpret the application of current legislation on waste and characterization of industrial waste
- Identify and describe the main industrial waste valorization processes
- Select the most appropriate management among the alternatives for the minimization and valorization of specific waste in accordance with current legislation

Theoretical and Practical Contents

METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
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</thead>
<tbody>
<tr>
<td>Expositive classes</td>
<td>13</td>
<td>100 %</td>
</tr>
<tr>
<td>Case analysis</td>
<td>15</td>
<td>40 %</td>
</tr>
<tr>
<td>Handling sources and resources</td>
<td>22</td>
<td>0 %</td>
</tr>
<tr>
<td>Exercises</td>
<td>25</td>
<td>44 %</td>
</tr>
</tbody>
</table>

TYPES OF TEACHING

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Evaluation tools and percentages of final mark

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</tr>
</thead>
<tbody>
<tr>
<td>Presentations</td>
<td>30 %</td>
<td>70 %</td>
</tr>
<tr>
<td>Practical tasks</td>
<td>30 %</td>
<td>70 %</td>
</tr>
</tbody>
</table>

 ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT
Abstracts, reports, and presentations tasks: 70-80%
Tasks of questions in a fixed time: 20-30%

The assessment guidelines in this subject are based on the documents: "Regulatory Regulations for Student Assessment in Official Undergraduate Degrees" and "Protocol on Academic Ethics and Prevention of Dishonest or Fraudulent Practices in Assessment Tests and Academic Papers at the UPV/EHU" (https://www.ehu.eus/es/web/estudiosdegrado-gradukoikasketak/akademia-araudiak)

REQUESTING FOR FINAL ASSESSMENT SYSTEM
Students who want to be assessed by the final assessment system, regardless of their participation in the continuous assessment, will have to submit a written resignation to continuous evaluation, filling in the form available in egela of the VR subject and uploading the completed form through the VR subject in egela, for which they will have a period of 9 weeks (weeks 1 to 9 of the semester), according to the academic calendar of the center. (Art. 8.3 Text approved in the Degree Committee of May 16, 2019).
Resignations will NOT be accepted by other means, nor after the deadline.

RESIGNATION TO THE CALL
Both in the case of continuous and final assessment, since the weight of the final exam of the subject "Waste valorization" is greater than 40% of the subject's grade, it will be sufficient not to go to the final exam so that the final grade of the subject is << not presented >>. (Art. 12.2 Text approved in the Degree Committee of May 16, 2019 and applicable in 2019/20)

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

ASSESSMENT:
Assessment proof/final exam 100% of the total
The assessment guidelines in this subject are based on the documents: "Regulatory Regulations for Student Assessment in Official Undergraduate Degrees" and "Protocol on Academic Ethics and Prevention of Dishonest or Fraudulent Practices in Assessment Tests and academic papers at the UPV/EHU" (https://www.ehu.eus/es/web/estudiosdegrado-gradukoikasketak/akademia-araudiak)

RESIGNATION TO THE CALL
It is sufficient not to go to the extraordinary exam, so that the final grade of the subject is << not presented >>.

MANDATORY MATERIALS
Course notes and basic bibliography

BIBLIOGRAPHY

Basic bibliography
- Marañon, E. Residuos industriales y suelos contaminados. 2000, Servicio de publicaciones, U Oviedo, Oviedo.

Detailed bibliography

Journals

Web sites of interest
www.epa.gov/osw/
http://www.ibet.pt/Industry/
Water_energy_and_the_environment/Waste_valorization.htm
COURSE GUIDE 2024/25

Faculty 310 - Faculty of Science and Technology
Degree QAPLI902 - Synthetic and Industrial Chemistry

COURSE

504304 - Advanced Chemical Synthesis

Credits, ECTS: 3

COURSE DESCRIPTION

The course belongs to the common module of 12 ECTS of the Master involving compulsory courses and is taught during the first semester of the year. The four constituent courses of this module will provide students with essential advanced knowledge complementing that received in the Degree. This first semester is therefore basically theoretical and allows the students to complete their basic training and provides them with the basis for their Master’s thesis.

The Advanced Chemical Synthesis is a course that is directly related to the compulsory subjects of the common module "Metals in Synthesis" and "Stereocontrolled Synthesis" of the first semester and to the optional subjects of the speciality modules "Advanced Organic Chemistry" of the first semester and "Design and Synthesis of Drugs" Synthesis in Solid Phase and Combinatorial Chemistry" taught in the second semester.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA

Planificar la síntesis de una molécula objetivo mediante el análisis retrosintético
Seleccionar y aplicar metodologías sintéticas eficientes a la síntesis de compuestos de interés
Identificar y discutir las etapas clave de una secuencia de síntesis,

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

Theoretical and Practical Contents


Unit 2. Electrophilic synthons. Nucleophilic synthons: stabilized and unstabilized carbanions. Disconnection of monofunctional systems. Disconnection of difunctional systems. Synthetic examples

Unit 3. Protective groups and auxiliary groups in organic synthesis. Practical examples.

Unit 4. Formation of C-C and C-heteroatom bonds.

Unit 5. Synthesis by pericyclic reactions: Synthetic examples of cycloaddition reactions, electrocyclic reactions and sigmatropic transpositions.

METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
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<tr>
<td>Groupwork</td>
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<td>5</td>
<td>0 %</td>
</tr>
<tr>
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<tr>
<td>Text analysis</td>
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<tr>
<td>Exercises</td>
<td>25</td>
<td>40 %</td>
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TYPES OF TEACHING

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
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<th>GA</th>
<th>GL</th>
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<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
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</tbody>
</table>

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 tools and percentages of final mark

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written examination</td>
<td>40 %</td>
<td>70 %</td>
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</table>
Due to the Coronavirus pandemic, this evaluation method could suffer changes if the guidelines of the sanitary authorities require it so. The necessary modifications would be announced timely.

**ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

Due to the Coronavirus pandemic, this evaluation method could suffer changes if the guidelines of the sanitary authorities require it so. The necessary modifications would be announced timely.

**EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

Due to the Coronavirus pandemic, this evaluation method could suffer changes if the guidelines of the sanitary authorities require it so. The necessary modifications would be announced timely.

**MANDATORY MATERIALS**

**BIBLIOGRAPHY**

**Basic bibliography**

**Detailed bibliography**
- "Organic Synthesis Highlights" Series, Varios, Wiley-VCH.

**Journals**

**Web sites of interest**
COURSE GUIDE 2024/25

Faculty 310 - Faculty of Science and Technology
Degree QAPLI902 - Synthetic and Industrial Chemistry

COURSE
504312 - Natural Products: Synthesis, Biosynthesis and Applications

Credits, ECTS: 3

COMPETENCIES/LEARNING RESULTS
Understanding of the structures of the Secondary Metabolism Natural Products, and how they are produced and interconverted in nature (35%)
Ability to propose reasonable biosynthetic pathways for given natural products (25%)
Ability to apply the principles of synthetic design to the synthesis of relevant natural products (40%)

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT
Conocer y entender las estructuras de los Productos Naturales del metabolismo secundario y cómo se sintetizan y se interconvierten en los seres vivos
Proponer rutas biosintéticas razonables para productos naturales
Aplicar los principios del diseño de síntesis a la síntesis de Productos Naturales de interés

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

Theoretical and Practical Contents
- Secondary metabolism. Elucidating biosynthetic pathways.
- Chapter 8. Recent advances in natural product synthesis. Selected examples

METODOLOGÍA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
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<tbody>
<tr>
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<td>Groupwork</td>
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<tr>
<td>Exercises</td>
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<td>40 %</td>
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TYPES OF TEACHING

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<td>Legend: M: Lecture-based</td>
<td>S: Seminar</td>
<td>GA: Applied classroom-based groups</td>
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<td>TA: Workshop</td>
<td>TI: Industrial workshop</td>
<td>GCA: Applied fieldwork groups</td>
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Evaluation tools and percentages of final mark

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<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
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<tr>
<td>Written examination</td>
<td>30 %</td>
<td>70 %</td>
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<tr>
<td>Practical tasks</td>
<td>30 %</td>
<td>70 %</td>
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</table>
The final grade will be the result of the following parts:

1. Written theory and practice exam: The exam will consist of theory and practice written exercises on the topics worked during the course. The appropriate approach to the exercises will be assessed, as well as the coherence and accuracy of the answers. The pass mark is 5/10.

2. Individual work. Set of exercises. Each student will be given a set of exercises that she/he will have to deliver at the end of the course. Bibliographic resources are allowed to solve these exercises. The appropriate approach to the exercises will be assessed, as well as the coherence and accuracy of the answers. The pass mark is 5/10.

Declining to sit implies not taking part in any of the above assessment parts.

This assessment system could be modified if required by the Sanitary authorities.

1. Written theory and practice exam: The exam will consist of theory and practice written exercises on the topics worked during the course. The appropriate approach to the exercises will be assessed, as well as the coherence and accuracy of the answers. The pass mark is 5/10.

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This assessment systems could be modified if required by the Sanitary authorities.

BIBLIOGRAPHY

Basic bibliography

Detailed bibliography

Journals

Web sites of interest
DESCRIPTION AND CONTEXTUALIZATION OF THE COURSE

Family firms account for two thirds of all businesses around the world, generate around 70-90 percent of annual global GDP, and create 50-80 percent of jobs in the majority of countries worldwide, playing a significant role in economic growth and territorial development. Common denominators of such firms include family involvement in the enterprise and a desire to maintain family control over the business in future generations.

The particular nature of such enterprises and the interaction between family and firm significantly influences ownership, governance and management, clearly marking them out from non-family businesses. These distinctive features add greater complexity to firms management and it is important to understand the relationships arising out of the relationship between family and firm and the particular elements they bring to governance and management.

Aims of the course

This course is oriented towards management of family businesses. Its main purpose is therefore to provide students with tools for understanding family firms' behaviour. The course will examine specific features of family firms including setting objectives (economic and noneconomic), generational succession, governing bodies, relationships between firm and family and internal behavior. In addition, their relationships and their influence on entrepreneurship, innovation and the internationalization strategy, among other aspects, are also analyzed.

COMPETENCIES AND LEARNING OUTCOMES

The expected learning outcomes can be summarised as follows:

- Knowing and understanding the specific nature of the family business and the implications of such circumstances for governance and management.

- Understanding the challenges and dynamics of family firms throughout their lifecycles and their continuity over time.

- Identifying the strengths and weaknesses of family businesses, enabling the acquisition of skills for managing business and family systems.

- Understanding the concept of corporate governance in a broad sense, and its application in the context of the family firm.

- Identifying the governance structures of the family business and the business family, as well as the mechanisms for channelling the relationships between these structures.

- Being able to understand the influence of economic and non-economic aspects derived from the family nature in the strategic decision-making of the business, especially in relation to the entrepreneurship, the innovation and the internationalization of the family business.

- Developing management skills that promote growth and internationalisation of the family firm.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA

- Conocer el peso de la empresa familiar en la economía
- Conocer las características que diferencian a la empresa familiar de la no familiar
- Ser capaz de identificar el control familiar en distintas estructuras empresariales: de propiedad concentrada y de propiedad dispersa
- Comprender las relaciones de agencia en el seno de la empresa familiar
- Identificar los conflictos de interés entre los distintos agentes vinculados a la empresa familiar
- Ser capaz de comprender la influencia del altruismo en los costes de agencia
Comprender el concepto de gobierno corporativo en un sentido amplio, y la razón de la existencia de Códigos de Buen Gobierno
Ser capaz de trasladar el concepto de gobierno corporativo a la peculiaridad de la empresa familiar
Identificar las estructuras de gobierno de la empresa familiar y de la familia empresaria, así como los mecanismos para encauzar las relaciones entre dichas estructuras

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

- Distinguir los elementos que permiten identificar una empresa de carácter familiar.
- Determinar características singulares de la empresa familiar que pueden ser fuente de ventaja competitiva.
- Determinar características singulares de la empresa familiar que pueden ser fuente de conflictos.
- Explicar las relaciones entre propiedad, dirección y familia desde una perspectiva generacional.
- Aplicar los conceptos de gobierno corporativo a la empresa familiar y a la familia empresaria.
- Sintetizar y determinar los mecanismos que canalizan las relaciones entre la familia y la empresa.
- Comprender las paradojas que pueden plantearse en el gobierno y dirección de la empresa familiar: tradición, innovación e internacionalización.

Theoretical and Practical Contents

1. FAMILY FIRM: CULTURE AND VALUES.
2. DESIGN OF GOVERNMENT STRUCTURES OF THE FAMILY FIRM.
3. TRANSGENERATIONAL CONTINUITY OF THE FAMILY FIRM.
4. INNOVATION, ENTREPRENEURSHIP, AND INTERNATIONALIZATION OF THE FAMILY FIRM.
5. UNIQUENESS IN THE FINANCIAL ASPECTS OF THE FAMILY FIRM.

The course contents is complemented with a series of seminars and conferences given by staff and executives from family businesses. This activity is organised by the Family Business Chair at the University of the Basque Country, in collaboration with the Provincial Government of Bizkaia, Bilbao Chamber of Commerce, CEBEK (the Businesses Confederation of Bizkaia) and AEFAME (Association of Family Firms of the Basque Country).

METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
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<td>Tutorials</td>
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<td>Presentation and defence of projects</td>
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<td>Student's personal work</td>
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<td>Case studies</td>
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### TYPES OF TEACHING

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<th>Types of teaching</th>
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<th>TA</th>
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<th>GCA</th>
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<tbody>
<tr>
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<tr>
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</table>

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### Evaluation tools and percentages of final mark

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
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</tr>
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<td>Critical debate in the classroom</td>
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<tr>
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<tr>
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</tr>
<tr>
<td>Written preparation of the final master's dissertation</td>
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<td>40 %</td>
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### ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

**Organization of the Subject, Assessment Procedures and the Student's Learning Tasks**

Overall assessment will take into account the achievement of objectives, acquisition of skills and assimilation of the course contents. This will include attendance at classes and active participation in the classroom, as well as attendance at proposed activities and the submission of assignments.

Assignments may be submitted in either of the two official languages of the Basque Autonomous Country (Spanish and Basque) or in English. Likewise, if pupils are interested in carrying out their final assignment in English, lecturers will ensure proper monitoring and tutoring.

The weight of each of the activities in the final grade is as follows: 20% attendance at classes with active participation in them, 10% attendance at conferences, colloquia or other activity offered by teachers and 70% with tests and proposed tasks.

To pass the subject, it is compulsory to attend at least 80% of the face-to-face classes and take the tests and proposed tasks. In addition, the score achieved, after applying the planned weightings, must reach, at least, the threshold of 5. The tasks will be carried out as the course is developed, and will be presented on the dates determined and communicated by the teaching staff.

### EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

**Extraordinary Call: Guidelines and Waiver**

In the extraordinary call, the evaluation of the subject will be carried out through a final test with all the theoretical-practical contents that have been addressed during the course.

The final test will comprise 100% of the grade for the course.

### MANDATORY MATERIALS
## Bibliography

### Basic bibliography

### Detailed bibliography

### Journals

- [Family Business Review](https://journals.sagepub.com/home/fbr)

### Web sites of interest

- International Family Enterprise Research Academy (IFERA): [https://ifera.org/](https://ifera.org/)
- Family Firm Institute: [https://www.ffi.org/](https://www.ffi.org/)
- Institute for Family Business: [https://www.ifb.org.uk/](https://www.ifb.org.uk/)
The course is optional and is taught in the first semester of the first year of the University Master in Business Management from Innovation and Internationalization. This subject is generally taken by students who come from different grades, such as: business administration and management, economics, engineering, law, advertising and communication, etc. The students in this master must acquire the ability to have a critical and rational vision and, also a synthetic ability about readings, academicals articles and data around Business Management. It will explain and practice communicate skills, both with their peers / and with the academic community and with society in the fields of financial economics, market research and marketing, and Business Management. Thus, the main objective is that students become familiar with financial management from a perspective of financial globalization. Financial decisions in the company must be made efficiently and for them new technologies are an important instrument, but it is also important to make them understand the integration of ethical and sustainable commitment as essential components in their decisions. Students generally come with financial knowledge, as they have taken subjects such as Financial Management: Financing (2nd year of ADE and 4th GADEDE) or Management of Financial Markets (4th year). In the case of students who have not completed finance subjects in their grades, they are provided with supplementary materials so that they can monitor the classes efficiently. In particular, this subject includes a large part of the topics that are considered basic for the initial training of financial and management chief positions that require financial advisory skills. In this subject, in addition to the concepts of economic-financial globalization, financial management, treasury management, topics related to ethical behavior are included, or the inclusion of sustainable and / or ethical finance to instill students towards the fulfillment of the SDGs, specifically, the Sustainable Economy (SDG 8). The starting point is the definition of the different financial entities and the framework in which they are developed. Subsequently, their management tasks are analyzed, focusing on those related to the sources of financing, investment and operations in the financial markets, as well as the adequate management of the risks assumed. It ends with a global vision, studying the different strategic lines followed by credit institutions.

The teachers who explain this subject promote academic ethics by encouraging sensitivity and perception of the ethical aspects of students, both in their attitude within the classroom and in the performance of individual or team work and various tasks and practices throughout the course.

### COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

**COMPETENCIAS DE LA ASIGNATURA**

- Potenciar la capacidad investigadora en finanzas: desarrollar las habilidades para identificar, analizar, estudiar y dar solución a los problemas científicos en finanzas
- Comprender el nuevo entorno financiero que rodea a las empresas
- Aprender a identificar los posibles efectos derivados de fenómenos aún emergentes
- Desarrollar la capacidad de adaptación al nuevo entorno empresarial
- Comprender los fundamentos de la gestión de tesorería
- Aprender a identificar los efectos de una modificación de la política de dividendos sobre el valor de la empresa
- Aprender a identificar la metodología de investigación empírica que se ajusta al objetivo de un trabajo.
- Aprender a identificar y valorar los problemas éticos en las finanzas

**RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA**

1. - Comprensión de los aspectos que le permite interrelacionar los diferentes conceptos en un entorno globalizado y considerando la sostenibilidad como criterio inclusivo.
2. - Analizar los factores de la globalización económica y financiera que afectan a la gestión financiera, y a la gestión de tesorería en particular.
3. - Identificar, comprender y analizar los conceptos éticos y los factores que propician y condicionan las finanzas.
4. - Identificar y comprender las funciones, responsabilidades y decisiones del gestor financiero en una economía sostenible.
5. - Comunicar de forma comprensiva los resultados de un caso de estudio relacionado con la materia con fluidez oral y escrita.

### Theoretical and Practical Contents

- **Contents:**
  - Part I: Research in Finance
  - The purpose of the research in finance: problem and research questions
  - The publication in international high quality journals
  - Empirical studies in Corporate Finance
Part II: Cash Management
- Treasury Management vs. Cash Management
- Treasury Management: a financial culture
- Information and Communication Technologies in cash management
- New technologies

Part III: Ethics in Finance
- New perspectives of finance: from benefit to values
- Sustainability Finance
- The case of ethics in trade credit and cash holding
- Ethical banks and Social efficiency of banking

Part IV: Economical and Financial Globalisation
- Concept and origin of economic and financial globalization
- The development context of the economic and financial globalization process
- Level achieved in economic and financial globalization
- Positive effects and negative effects of globalization

Part V: Adaptation of business financial management to financial globalization
- Adaptation of the financial function
- Adaptation of the tasks to be performed by the financial function
- Country risk

Note: At the beginning of the semester the students will receive (through the web) a detailed schedule of the different topics. Exercises and notes will be uploaded to the web system for the students to work on them. The basic bibliography will be provided using university platform.

METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
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<tr>
<td>Student's personal work</td>
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<tr>
<td>Group discussion</td>
<td>20</td>
<td>40 %</td>
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<tr>
<td>Expositive classes</td>
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Evaluation tools and percentages of final mark

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</thead>
<tbody>
<tr>
<td>Attendance and participation</td>
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<td>35 %</td>
</tr>
<tr>
<td>Evaluation by means of the presentation of projects</td>
<td>10 %</td>
<td>25 %</td>
</tr>
<tr>
<td>Presentations</td>
<td>15 %</td>
<td>35 %</td>
</tr>
<tr>
<td>Questions to discuss</td>
<td>10 %</td>
<td>30 %</td>
</tr>
<tr>
<td>Writing up the teamwork</td>
<td>15 %</td>
<td>35 %</td>
</tr>
</tbody>
</table>

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

1. A compulsory written test (10% of the final grade), which will consist of various questions of theoretical and practical content.
2. Carrying out activities - classroom practices and group work - (40% of the final grade):
   i. Task 1: use of ICTs to detect ethical problems in the area of finance and their defense in written and oral form (with recording) (15% of the final grade).
   ii. Task 2: critical reflection of current articles on financial globalization (25% of the final grade).
   b. The development of activities (individual or in group) of a participatory and compulsory nature in the classroom will allow obtaining the remaining 5 points (50% of the final grade). In total, various practices will be carried out (depending on the academic year-see on eGela):
   i. Practice 1: search, read and comment on articles and information related to financial globalization.
   ii. Practice 2: search for information and presentation on ethical concepts
   iii. Practice 3: analysis using Excel of financial decisions
   iv. Practice 4: feedback between the students and the exhibitions. Opinions.
Teaching will be done in person (or bimodally, if the size of the group does not make it possible for all the students to attend the classroom in person). If for health reasons classroom attendance is not allowed in the classroom, it will go to online teaching and assessment. All information will be upload in eGela.

**EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

Same that ordinary.

Teaching will be done in person (or bimodally, if the size of the group does not make it possible for all the students to attend the classroom in person). If for health reasons classroom attendance is not allowed in the classroom, it will go to online teaching and assessment. All information will be upload in eGela.

**MANDATORY MATERIALS**

There is no mandatory manual, but the students will gest resources upload and share by the professor (slides and articles). It will reduce the taking of notes during classrooms. This material will be available in the eGela. If someone needs for any reason the materials can be provided via mail / wetransfer or give more materials about it.

**BIBLIOGRAPHY**

**Basic bibliography**


Detailed bibliography

Bibliografía complementaria


Journals

- Estrategia financiera: http://www.estategafiacinancerias.es/
- Inversión y finanzas.
- Finanzas.com: http://www.finanazas.com/
- Diario expansion: http://www.expansion.com/
- El economista: http://www.eldiario.es/
- El confidencial: http://www.elconfidencial.com
- Corresponsables: https://www.corresponsables.com

Monográficos

Web sites of interest
Direcciones web de utilidad
ASSET. TESOREROS DE ESPAÑA: https://asset.es/
BANCA ÉTICA: http://bancaetica.cat/es/
BANCO DE ESPAÑA: http://www.bde.es
COMISIÓN NACIONAL DEL MERCADO DE VALORES: http://www.cnmv.es
ECONOMYWEB: http://www.economyweb.com
EUROPEAN BUSSINESS ETHICS NETWORK: https://www.eben-spain.org/
EUROPEAN FINANCE ASSOCIATION: http://european-finance.org/r/home
FINANZAS PARA TODOS: http://www.finanzasparatodos.es/
INSTITUTO SUPERIOR TECNICAS/PRACTICAS BANCA: http://www.iberfinanzas.com
POLITICAS DE LA UNION EUROPEA: http://europa.eu.int/scadplus/leg/es/l00000.htm
UNIÓN EUROPEA: http://www.europa.eu.int/index-es.htm
BLOGS...#
http://www.loyolaandnews.es/seccion/blogs-tematicos/etica-y-finanzas/
https://blog.iese.edu/antonioargandona/
http://blog.cristianismejusticia.net/2012/03/16/hacia-unas-finanzas-eticas-al-servicio-de-los-pueblos-por-jordi-mari

Econometrics is a compulsory subject in the Interuniversity Master's Degree in Economics: Tools of Economic Analysis. It is taught simultaneously and in a coordinated way in the three universities that offer this program.

The work developed in this course allows students to use the linear regression model to analyze the behavior of economic variables using the data available (cross-sectional, time series and panel). The regression model will be studied in depth, with special emphasis on the alternative estimators used in the case of non-compliance with the assumptions.

Knowledge of descriptive statistics and probability theory as well as statistical inference is necessary to follow this Econometrics course properly. In addition, it is necessary to know how to use linear and matrix algebra at a basic level.

The linear regression model is a useful model to apply in those subjects that require the analysis of economic models for decision making.

Specific Competences

To acquire a solid knowledge of modern statistical-econometric methods for the quantification of economic relations, the comparison of theories and the evaluation of public policies.

To know and use the different sources of microeconomic and macroeconomic data relevant for the evaluation of the labour market situation: labour force survey, salary structure survey.

To understand the logic of modelling and econometric methods for the analysis of time series and cross-section data, as well as their usefulness in economic forecasting.

Carry out empirical work, selecting the appropriate statistical-econometric methods according to the nature of the data and the problem to be analyzed and using specialized computer programs. To interpret and transmit the results of a quantitative analysis and to prepare reports.

In addition to the basic competencies of this course, the following Transversal Competencies are worked on throughout the course:

CT1692 - Managing information and communication technologies in your professional and research performance in the field of economic analysis.
CT1702 - Planning tasks, organizing resources and managing time efficiently.
CT1709 - To identify and solve specific problems by developing the capacity for analysis and synthesis.
CT1711 - Communicate fluently, both orally and in writing in Spanish, and read, understand and write texts in English.

The learning outcomes of this course, related to the specific competences are:

- To apply economic theory to represent real-life situations.
- To interpret in economic terms the mathematical results of formal models.
- To know how to look for information relevant to evaluate the economic situation both at a territorial level and in the different markets of interest: labour, financial, ..., using different sources of microeconomic and macroeconomic data.
- To understand the logic of econometric modelling for the analysis of time series, cross-section and panel data.
- To acquire solid knowledge of modern statistical-econometric methods for the quantification of economic relations, the contrast of theories and prediction.
- To apply the econometric-statistical methods for the analysis and evaluation of economic policies, whether at the public or private, local, national or international level.
- To carry out empirical work, selecting the appropriate statistical-econometric methods according to the nature of the
data and the problem to be analysed and using specialised computer programmes.

- To interpret and transmit the results of a quantitative analysis and prepare reports.

**COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT**

**COMPETENCIAS DE LA ASIGNATURA**

Manejar los métodos estadístico-econométricos diseñados para el análisis y evaluación de políticas públicas.

Conocer y utilizar las distintas fuentes de datos microeconómicos y macroeconómicos relevantes para evaluar la situación del mercado de trabajo: encuesta de población activa, encuesta de estructura salarial.

Conocer los procedimientos para estimar y contrastar las consecuencias de la unión económica, con especial atención a la evaluación de las políticas económicas europeas actuales destinadas al logro de la convergencia.

Conocer y utilizar las fuentes de datos estadísticos y las herramientas econométricas que permiten contrastar las teorías económicas relativas a la Economía industrial.

Comprender la lógica de la modelización y los métodos econométricos para el análisis de datos de series temporales y de sección cruzada, así como su utilidad en la predicción económica.

Adquirir conocimientos sólidos de los métodos estadístico-econométricos modernos para la cuantificación de las relaciones económicas, el contraste de teorías y la evaluación de políticas públicas.

Realizar trabajos empíricos, seleccionando los métodos estadístico-econométricos apropiados según la naturaleza de los datos y el problema a analizar y utilizando los programas informáticos especializados.

Interpretar y transmitir los resultados de un análisis cuantitativo y elaborar informes.

**RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA**

demás de las competencias básicas de la asignatura recogidas en la memoria de la titulación, a lo largo del curso se trabajan las siguientes Competencias Transversales:

CT1692 - Manejar las tecnologías de la información y comunicación en su desempeño profesional e investigador en el campo del análisis económico.

CT1702 - Planificar tareas, organizar recursos y gestionar de forma eficiente el tiempo.

CT1709 - Identificar y resolver problemas concretos desarrollando la capacidad de análisis y de síntesis.

CT1711 - Comunicarse de forma fluida, tanto de forma oral como escrita en castellano, así como leer, comprender y redactar textos en inglés.

CT - Compromiso social (comprensión crítica de la problemática socio-ambiental global)

Los resultados de Aprendizaje de esta asignatura, relacionados con las competencias específicas de la asignatura son:

- Aplicar la teoría económica para representar situaciones reales.
- Interpretar en términos económicos los resultados matemáticos de modelos formales.
- Saber buscar información en las distintas fuentes de datos microeconómicos y macroeconómicos relevantes para evaluar la situación económico tanto a nivel territorial como de los distintos mercados de interés: laboral, financiero, ...
- Comprender la lógica de la modelización econométrica para el análisis de datos de series temporales y de sección cruzada.
- Adquirir conocimientos sólidos de los métodos estadístico-econométricos modernos para la cuantificación de las relaciones económicas, el contraste de teorías y la predicción.
- Aplicar los métodos estadístico-econométricos para el análisis y evaluación de políticas económicas, tanto a nivel público como privado, local, nacional o internacional.
- Realizar trabajos empíricos, seleccionando los métodos estadístico-econométricos apropiados según la naturaleza de los datos y el problema a analizar y utilizando los programas informáticos especializados.
- Interpretar y transmitir los resultados de un análisis cuantitativo y elaborar informes.
- Emitir juicios fundamentados sobre temas relevantes de índole socio-económico y ambiental a partir de la interpretación de datos y utilizando los modelos econométricos apropiados.

**Theoretical and Practical Contents**

1. Review of the basic concepts of probability, distribution functions and mathematical statistics necessary for this course.
2. Specification, estimation and inference of the general linear regression model under the linear regression assumptions.
3. Generalization of the linear regression model and presentation of a general estimation method that allows working under different sets of assumptions.
4. Study of the specific problems raised by time series data: violation of the assumptions of stationarity and absence of autocorrelation.
5. An introduction to panel data models, both fixed and random effects.

### METODOLOGÍA (ACTIVIDADES Formativas)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
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</thead>
<tbody>
<tr>
<td>Theory</td>
<td>2.5</td>
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</tr>
<tr>
<td>Seminars</td>
<td>8.5</td>
<td>50 %</td>
</tr>
<tr>
<td>Classroom practicals</td>
<td>12</td>
<td>50 %</td>
</tr>
<tr>
<td>Computer practicals</td>
<td>21.4</td>
<td>33 %</td>
</tr>
<tr>
<td>Lectures</td>
<td>55.6</td>
<td>36 %</td>
</tr>
</tbody>
</table>

### TYPES OF TEACHING

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
<th>GL</th>
<th>GO</th>
<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
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<td>4.5</td>
<td>6</td>
<td>7</td>
<td>2.5</td>
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<td></td>
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<tr>
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<td>35.6</td>
<td>4</td>
<td>6</td>
<td>14.4</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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 tools and percentages of final mark

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written examination</td>
<td>40 %</td>
<td>60 %</td>
</tr>
<tr>
<td>Presentations</td>
<td>20 %</td>
<td>40 %</td>
</tr>
<tr>
<td>Questions to discuss</td>
<td>10 %</td>
<td>30 %</td>
</tr>
</tbody>
</table>

### ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The ordinary assessment session is structured as follows:

50% of the grade for the subject is obtained by answering exercises, case studies and problems individually and in groups.

50% of the grade for the subject is obtained by means of an individual written exam in which students must answer theoretical questions and solve problems related to the theoretical and practical contents taught on the subject. This exam is the same in the three universities that offer this programme.

Students may decline to take part in the ordinary assessment session by merely notifying the faculty in writing up to one week before the official exam date.

The faculty who teach this subject reserve the right to modify the evaluation system because of causes of major force. Any change will be announced on the e-gela platform in good time and in an appropriate manner.

### EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

In the extraordinary assessment session assessment consists of an individual exam (which accounts for the entire grade awarded) covering all the learning outcomes for the subject. It will take place on the date set on the official course calendar.

Students may decline to take part in the extraordinary assessment session by merely notifying the faculty in writing up to one week before the official exam date.

The faculty who teach this subject reserve the right to modify the evaluation system because of causes of major force. Any change will be announced on the e-gela platform in good time and in an appropriate manner.

### MANDATORY MATERIALS

- Egela platform
- Econometric software Gretl
BIBLIOGRAPHY

Basic bibliography


Detailed bibliography


Journals

Journals (Spanish)
http://www.revecap.com  Revista de Economía Aplicada
http://www.revistaestudiosregionales.com  Revista de Estudios Regionales
http://www.funep.es/invecon/sp/sie.asp  Investigaciones Económicas
http://www1.euskadi.net/ekonomiaz

Journals (English)
Computational Economics
Econometrica
Econometric Reviews
Econometric Theory
Empirical Economics Journal
International Journal of Forecasting
Journal of Applied Econometrics
Journal of Business and Economic Statistics
Journal of Econometrics
Journal of Economic Dynamics and Control
Journal of Forecasting
Oxford Bulletin of Economics and Statistics
Review of Economics and Statistics
Review of Economic Studies
Studies in Nonlinear Dynamics and Econometrics

Web sites of interest

Software


Institutions
http://www.eustat.es  EUSTAT
http://www.ogasun.ejgv.euskadi.net. Departamento de Economía y Hacienda. Gobierno Vasco. Bases de datos: Ikerbide, Udalmap, ...
http://www.ine.es  INE
http://www.meh.es  Ministerio de Economía y Hacienda
http://ec.europa.eu/eurostat  EUROSTAT
http://www.ecb.int/  Banco Central Europeo
http://www.oecd.org  OECD

Datos
http://www.nber.org/data_index.html
http://www.estadief.minhac.es/
http://fisher.osu.edu/fin/osudown.htm
http://econ.queensu.ca/jae/
http://www.psidonline.isr.umich.edu/data/
COURSE GUIDE 2024/25

Faculty 321 - Faculty of Economics and Business
Degree ECONO802 - Master in Economics: Economic Analysis Tools
COURSE 503486 - Methods of Statistical Inference
COURSE DESCRIPTION

This is a course on Statistical Inference based on a Decision Theory perspective. In this course the student will be introduced to the required statistical tools that will allow him/her to be able to state and make formal statements about statistical inference processes within an economical framework. The course includes an initial introduction to Statistics viewed from the Theory of Decision perspective, so that specific criteria for selecting optimal statistical procedures can be stated. These criteria will allow the student to be able to study topics on parameter estimation methods and their specific properties, as well as on convergence and hypothesis testing.

The main objective of this course is that the students become familiar and are able to efficiently use all of the provided elements from basic and advanced statistical inference from a Bayesian perspective: point and interval estimation, properties of estimators, and hypothesis testing, which will require a previous study of some of the most commonly used and necessary probability distributions in Statistics. The material included in this course will allow the student to be able to state and solve specific problems in statistical inference, required for any data analysis process, as well as to carry out any quantitative analysis or study related to the student's specific field.

SPECIFIC SKILLS:
- Identify and be able to select the most appropriate characteristics of the different theoretical probability models (discrete and continuous) for each case and, thus, be able to assess their utility and applicability in the specific professional field under study.
- Assess the different problems in statistical inference to be able to appropriately select the best alternative of analysis.
- Be able to apply the available statistical methods to take the most adequate decision on the basis of professional and methodological criteria.
- Select the most appropriate source of information to be able to study the specific problem of interest and, in addition, be able to analyze data sets using the most adequate statistical technique under each setting.
- Be able to interpret and communicate the results of the different analyses, using clear and concise statements, as well as tools from the up-to-date technologies of information (TICs).

CROSS SECTIONAL SKILLS:
- Be able to state motivated judgements based on the results obtained from the different data analyses.
- Be able to fluently communicate in an oral and written form.
- Be able to participate in team-work, with responsibility and showing respect for others, as well as displaying initiative and leadership within the group.
- Be able to carry out analytical judgements and critical statements on given settings within the specific fields of study.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA

Aplicar los criterios y la metodología del análisis económico para obtener procedimientos generales de diseño y análisis de políticas públicas: estructuración de problemas, pronóstico, recomendación y evaluación.
Manejar los métodos estadístico-econométricos diseñados para el análisis y evaluación de políticas públicas.
Conocer los principios del análisis económico más relevantes en la gestión óptima de los recursos naturales, teniendo en cuenta que la incertidumbre y la irreversibilidad juegan un papel muy importante.
Manejar los modelos y las técnicas microeconométricas, así como los programas informáticos habituales en el análisis empírico del mercado de trabajo.
Realizar tareas de consultoría y asesoramiento en el diseño de estrategias empresariales y de políticas económicas locales adaptadas a las condiciones de integración económica.
Realizar trabajos empíricos, seleccionando los métodos estadístico-econométricos apropiados según la naturaleza de los datos y el problema a analizar y utilizando los programas informáticos especializados.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

Theoretical and Practical Contents

Chapter 1. STATISTICS AND DECISION THEORY.

Chapter 2. SELECTION CRITERIA FOR STATISTICAL PROCEDURES (I).

Chapter 3. SELECTION CRITERIA FOR STATISTICAL PROCEDURES (II).
What to do if we do not have a specific loss function? Unbiased estimation. Maximum likelihood estimation method.

Chapter 4. SUFFICIENCY.

Chapter 5. POINT ESTIMATION. SOME BASIC RESULTS.
Equi-invariance (or "invariance"). Hunt-Stein's Theorem.

Chapter 6. STOCHASTIC CONVERGENCE AND ASYMPTOTIC PROPERTIES.

Chapter 7. POINT ESTIMATION. THE MAXIMUM LIKELIHOOD METHOD.
Maximum likelihood estimation and sufficient statistics. Asymptotic properties: consistency (Wald's Theorem), asymptotic normality, asymptotic efficiency. B.A.N. estimators ("normally asymptotically optimal").

Chapter 8. HYPOTHESIS TESTING.

<table>
<thead>
<tr>
<th>METODOLOGIA (ACTIVIDADES FORMATIVAS)</th>
</tr>
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<tbody>
<tr>
<td><strong>Actividad Formativa</strong></td>
</tr>
<tr>
<td>Theory</td>
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<tr>
<td>Seminars</td>
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<tr>
<td>Computer practicals</td>
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<td>Classroom practicals</td>
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<td>Lectures</td>
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</tbody>
</table>
**TYPES OF TEACHING**

<table>
<thead>
<tr>
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<th>M</th>
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<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
<td>15</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>0</td>
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</tr>
<tr>
<td>Horas de Actividad No Presencial del Alumno/a</td>
<td>25</td>
<td>7</td>
<td>5</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

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**Evaluation tools and percentages of final mark**

<table>
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<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous assessment through class attendance</td>
<td>20 %</td>
<td>20 %</td>
</tr>
<tr>
<td>Evaluation of assignments by topic (educational and summative evaluation)</td>
<td>80 %</td>
<td>80 %</td>
</tr>
</tbody>
</table>

**ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

Grading in this course is based on take-home homework assigned to students along the course, as well as on the active participation of students, both individually and as a team, and on the discussion resulting from the real problems' solutions related to the material included in the practical sessions about the specific contents in the course program. The solution to exercises and problems in the practical sessions, in the seminars, and in the lecture sessions will be part of the students' ongoing evaluation grades.

Class participation in class: 20% of the final grade
Regular take-home homework: 80% of the final grade

Students not handling all of the assigned homework will have a "Failing" grade. Students handling no homework at all will have an "Absent" grade. Homework: The work submitted by the students must be their own work and must have been written completely by themselves. The students must identify and include the source of all facts, ideas, opinions and viewpoints of others through in-text referencing and the relevant sources should all be included in the list of references at the end of their work. Direct quotations from books, journal articles, internet sources or any other source must be acknowledged and the sources cited must be included in the list of references.

**EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

The second call grade will be solely based on a final exam. The final exam will include all of the material included in the course program. The use of mobile or electronic devices, notes, books is not allowed in this exam.

**MANDATORY MATERIALS**

**COMPULSORY REFERENCES:**

**BIBLIOGRAPHY**

**Basic bibliography**

RECOMMENDED ADDITIONAL REFERENCES:


**Detailed bibliography**

ADDITIONAL REFERENCES:


**Journals**

**JOURNALS:**

- Applied Statistics
- Applied Stochastic Models in Business and Industry
- Biometrics
- Biometrika
- Biostatistics
- Communications in Statistics - Theory and Methods
- Journal of Applied Statistics
- Journal of the American Statistical Association
- Journal of the Royal Statistical Society - Series B
- Journal of Statistical Computation and Simulation
- Journal of Statistical Planning and Inference
- Methodology - European Journal of Research Methods for the Behavioral and Social Sciences
- Statistics in Medicine
- Statistical Methods in Medical Research
- Statistical Modelling
- The American Statistician

**Web sites of interest**

**WEBSITES:**

- American Statistical Association (http://www.amstat.org/)
- Biostatnet (http://eio.usc.es/pub/biostatnet/)
- International Statistical Institute (http://www.isi-web.org/)
- International Biometric Society (http://www.biometricsociety.org/)
- Royal Statistical Society (http://www.rss.org.uk/)
- Sociedad Española de Estadística e Investigación Operativa (http://www.seio.es/)
- Sociedad Española de Biometría (http://biometricsociety.net/)
**COURSE GUIDE** 2024/25

<table>
<thead>
<tr>
<th>Faculty</th>
<th>321 - Faculty of Economics and Business</th>
<th>Cycle</th>
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</thead>
<tbody>
<tr>
<td>Degree</td>
<td>ECONO802 - Master in Economics: Economic Analysis Tools</td>
<td>Year</td>
</tr>
</tbody>
</table>

**COURSE**

503488 - Statistics and Time Series Topics | Credits, ECTS: 6

**COURSE DESCRIPTION**

This course allows the student to deepen in the different techniques used in the analysis of economic time series and its statistical treatment, putting special emphasis in the analysis in the frequency domain and dynamic volatility models. The aim is to enable students to carry out quality research in the field of economic analysis by applying advanced statistical and econometric instruments and knowledge. At the end of the course the student should know how to extract information from an economic series, use different statistical and econometric packages, and master both semi-parametric and non-parametric statistical models. Likewise, the student must know the characteristics and utilities of the integrated and fractional processes and of the changing volatility models, especially important in financial series.

**COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT**

**COMPETENCIAS DE LA ASIGNATURA**

- Comprender la lógica de la modelización y los métodos econométricos para el análisis de datos de series temporales y de sección cruzada, así como su utilidad en la predicción económica.
- Adquirir conocimientos sólidos de los métodos estadístico-económicos modernos para la cuantificación de las relaciones económicas, el contraste de teorías y la evaluación de políticas públicas.
- Identificar, buscar, organizar y sistematizar la información estadística relevante para ayudar a explicar las cuestiones económicas de interés, tanto a nivel microeconómico como macroeconómico.
- Realizar trabajos empíricos, seleccionando los métodos estadístico-económicos apropiados según la naturaleza de los datos y el problema a analizar y utilizando los programas informáticos especializados.
- Interpretar y transmitir los resultados de un análisis cuantitativo y elaborar informes.

**RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA**

**Theoretical and Practical Contents**

First part of the course is devoted to the Time series volatility analysis. The tools needed to perform a detailed time series analysis in the frequency domain, alternative to the traditional time domain, are presented and described. The concepts of cycle, distribution, spectral density, linear filters, the periodogram and estimators of spectral density functions are introduced.

The second part of the course is devoted to the Time series analysis in the frequency domain. It is focused on basic concepts of frequency domain, Fourier analysis, estimation in the frequency domain and fractional integration. Several financial models for dynamic heterocedasticity, both within the ARCH and Stochastic Volatility approaches are described.

The third part of the course is focused on non-linearity in Econometrics. It aims at maximum likelihood estimation, numerical optimization methods, non-linear regression, identifiability and specification tests.

The last fourth part is devoted to the software package R for statistical and graphical analysis that has a dual nature of program and programming language. R has many functions for statistical and graphical analysis.

A. Time series volatility analysis

1. Introduction: Statistical characteristics of the financial series
2. ARCH models and extensions
3. Stochastic volatility models

B. Time series analysis in the frequency domain

1. Basic concepts of frequency domain
   2. Fourier analysis
3. Estimation in the frequency domain
4. Long memory in time series: Fractional integration

C. Non-linearity in Econometrics

1. Maximum likelihood
2. Numerical optimization methods
3. Non-linear regression: Numerical calculation algorithms
4. Maximum likelihood estimation: Numerical calculation algorithms
5. Identifiability
6. Specification tests
D. Programming in R

1. Introduction
2. Basic commands
3. Linear regression
4. Time Series Analysis: Box-Jenkins Methodology
5. Non-linearity in the estimation by Maximum Likelihood

### METODOLOGÍA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
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</thead>
<tbody>
<tr>
<td>Exams, evaluation tests</td>
<td>5</td>
<td>100 %</td>
</tr>
<tr>
<td>Presentation and defence of exercises</td>
<td>10</td>
<td>100 %</td>
</tr>
<tr>
<td>Computer practically</td>
<td>10</td>
<td>33 %</td>
</tr>
<tr>
<td>Theory</td>
<td>20</td>
<td>100 %</td>
</tr>
<tr>
<td>Preparation and presentation of work</td>
<td>20</td>
<td>10 %</td>
</tr>
<tr>
<td>Classroom practicals</td>
<td>20</td>
<td>50 %</td>
</tr>
<tr>
<td>Lectures</td>
<td>65</td>
<td>37 %</td>
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### TYPES OF TEACHING

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
<th>GL</th>
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<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
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<tr>
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<td>10</td>
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</table>

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 tools and percentages of final mark

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
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</thead>
<tbody>
<tr>
<td>Written examination</td>
<td>10 %</td>
<td>60 %</td>
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<tr>
<td>Exhibition of work, readings...</td>
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<td>50 %</td>
</tr>
<tr>
<td>Questions to discuss</td>
<td>40 %</td>
<td>60 %</td>
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</table>

### ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The final grade is composed of the qualification obtained from subjects A and B (50%) and topics C and D (50%).

Grading of topics A and B will be based on individual problems and a final exam. Grading of topics C and D will be based on the assignments students will have to do throughout the school term. There are a total of 6 assignments in topics C and D. Each assignment will have the following weight in the grading of topics C and D:

- Task 1: 10%
- Task 2: 10%
- Task 3: 10%
- Task 4: 10%.
- Task 5: 10%
- Task 6: 50%

The evaluation will preferably be in-classroom. If this is not possible, the final exam will be taken using the services available at Egela. The student will have a limited time to download the final exam form from Egela and upload the solution to that platform (preferably in pdf and in any case in a perfectly legible format to enable evaluation). This exam is individual, so in order to guarantee it the teaching team of the course might request an oral interview of verification of the answers after the correction of the exam with an individualized conversation with the student.

### EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

Evaluation by means of a final written test.

### MANDATORY MATERIALS


**BIBLIOGRAPHY**

**Basic bibliography**


**Detailed bibliography**


**Journals**

R Journal

**Web sites of interest**

http://www.r-project.org/

www.tutorialr.es/
COURSE GUIDE 2024/25

Faculty 321 - Faculty of Economics and Business
Degree ECONO802 - Master in Economics: Economic Analysis Tools

COURSE
503501 - Environmental Economics

COURSE DESCRIPTION

The Environmental Economics course is an optional subject offered by the University of the Basque Country (Master in Economics: Economics Analysis Tools). This course explores the relationship between the economy and the environment. We show the tools that economic analysis provides for the study of the main environmental problems like local pollution, climate change, biodiversity loss or depletion of natural resources. Basic economic concepts to follow this course are offered by the compulsory subjects taken by the master’s students during the first part of the semester. At the same time, this course offers useful concepts and tools that will be used in different optional subjects that the students can take during the second and third semester (Natural Resource Economics and Environmental Policy, Regulation and Competition Policy, Analysis of Public Choice or Evaluation of Transport and Network Policies).

In case legal imperatives or safety reasons ban face to face interaction then teaching will be online.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA

Conocer los principios del análisis económico más relevante en la gestión óptima de los recursos naturales, teniendo en cuenta que la incertidumbre y la irreversibilidad juegan un papel muy importante.

Analizar el comportamiento de los mercados y de los agentes económicos para la correcta modelización de los problemas ambientales.

Identificar los objetivos y los requisitos que deben satisfacer las políticas medioambientales cuya finalidad sea la utilización eficiente de los activos ambientales y el desarrollo sostenible.

Conocer de forma precisa la legislación vigente, los acuerdos internacionales y la actuación de los organismos públicos en materia medioambiental.

Realizar labores de estudio, asesoramiento y diseño de políticas medioambientales que garanticen el desarrollo sostenible.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

Theoretical and Practical Contents

Environmental Economics explore the relationship between economics and the environment. Microeconomic analysis is used to analyze and explain environmental problems as market failures due to external effects, public goods or the absence of property rights. We present different economic instruments and environmental policies that are used to solve environmental problems with special emphasis in the case of Climate Change. Finally, we present the main methods and concepts used to value environmental assets and services.

Table of contents

Tema 1. Economics and the environment: Introduction
Tema 2. Economic instruments and environmental policy
Tema 3. Economic growth, the environment and Sustainable Development Goals
Tema 4. The Economics of Climate Change
Tema 5. Environmental Valuation: concepts and methods

METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
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<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
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<td>Theory</td>
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<td>Lectures</td>
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TYPES OF TEACHING

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Evaluation tools and percentages of final mark

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
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</thead>
<tbody>
<tr>
<td>Written examination</td>
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<tr>
<td>Presentations</td>
<td>10 %</td>
<td>30 %</td>
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<tr>
<td>Questions to discuss</td>
<td>10 %</td>
<td>30 %</td>
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</table>

**ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

Class attendance is mandatory to follow continuous evaluation based on
(i) individual tasks;
(ii) active participation in roleplaying games on Climate Change;
(iii) oral presentation of individual work;
(iv) group assignments and class participation;

A final written exam will be mandatory for those students who fail the continuous evaluation. Any student who does not show up for the final exam will have "Not Submitted" as final grade.

**EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

Evaluation system on second round: there will be a single final written exam that counts 100% of the final grade. It will comprise problems and long essays regarding the main issues discussed along the course.

**MANDATORY MATERIALS**

Relevant documentation and study material (lecture slides and readings) will be posted on the course website. EGELA is the virtual classroom to support face-to-face teaching.

**BIBLIOGRAPHY**

**Basic bibliography**

**Detailed bibliography**

**Journals**
Ecological Economics
Review of Environmental Economics and Policy
Journal of Environmental Economics and Management
Environmental and Resource Economics
Resource and Energy Economics
Energy Economics
Land Economics
American Economic Review
Journal of Political Economy

**Web sites of interest**
NEP (New Economic Papers) (http://nep.repec.org/)
The Economics of Ecosystem and Biodiversity (http://www.teebweb.org/)
Pew Center on Global Climate Change (USA) (http://www.c2es.org/)
BC3 (Basque Center for Climate Change) (http://www.bc3research.org/)
"Economics of Natural Resources and Environmental Policy" is an elective subject (6 ECTS) of the Master in Economics: Economic Analysis Tools. This one-year Master program (60 ECTS) extends over three trimesters and is jointly offered by the Universities of Cantabria, Oviedo and the UPV/EHU. This subject, being elective, is taught only at the UPV/EHU, being the students who move to take it. For this reason, teaching is concentrated in one day, on Wednesdays during the 9 weeks of the second trimester.

The main objective of this course is to explain how natural resources such as fishery resources, forest resources or non-renewable resources are managed/should be managed. Regardless of the initial training of the master's students, the basic concepts for this subject are covered in the compulsory subjects of the Master. Additionally, the introductory topic will deepen into certain mathematical and computational tools that will be used extensively in this subject: the analysis of the qualitative behavior of discrete dynamic systems and dynamic optimization in discrete time.

In turn, this subject provides basic concepts for other elective subjects of the Master that are offered in the second and third trimesters such as: “Regulation and Competition Policy”, “Analysis of Public Decisions” and “Evaluation of Transport and Network Policies”.

The development of the subject is proposed according to the double track of the Master: professional and research oriented. Thus, the course presents the student with a range of tools of economic analysis for the solution of natural resource management problems that will be of interest to both collaborating companies and institutions, where they can carry out placements, and to carry out a research project (Master Thesis) that may lead to the future completion of a Doctoral Thesis.

In addition to the specific competences of the subject collected in the memory of the degree, throughout the course the following transversal competences are worked:

CT1692 - Managing information and communication technologies in professional and research activities in the field of economic analysis.

CT1702 - Planning tasks, organizing resources and efficiently managing time.

CT1709 - Identifying and solving specific problems developing the capacity for analysis and synthesis.

CT1711 - Communicating fluently, both orally and in writing in Spanish, as well as reading, understanding and writing texts in English.

The learning results of the subject are the following:

R1 - To have a basic knowledge of natural resource economics.
R2 - To know and understand the economic models used to study natural resource management problems.
R3 - To apply the economic models studied to specific natural resource management problems (local, regional or international).
R4 - To plan tasks properly and efficiently manage time.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA

Conocer los principios del análisis económico más relevante en la gestión óptima de los recursos naturales, teniendo en cuenta que la incertidumbre y la irreversibilidad juegan un papel muy importante.

Analizar el comportamiento de los mercados y de los agentes económicos para la correcta modelización de los problemas ambientales.

Identificar los objetivos y los requisitos que deben satisfacer las políticas medioambientales cuya finalidad sea la utilización eficiente de los activos ambientales y el desarrollo sostenible.

Conocer de forma precisa la legislación vigente, los acuerdos internacionales y la actuación de los organismos públicos en materia medioambiental.

Realizar labores de estudio, asesoramiento y diseño de políticas medioambientales que garanticen el desarrollo sostenible.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA
The introductory topic covers (1) the main methods of qualitative analysis of the behavior of discrete dynamic systems, (2) some methods for dynamic discrete time optimization and (3) the use of Excel, and specifically some routines such as “Solver”, to carry out optimization and simulation exercises. The aim of the introductory topic is to get acquainted with the most basic mathematical and computational instruments that allow operating, through very simple numerical problems, the most common theoretical concepts in Natural Resource Economics and build bridges towards the empirical analysis of this type of problems.

The second topic focuses in the economic theory that underlies the optimal exploitation of fishery resources. It starts analyzing separately the biological aspects (dynamics of fishing stocks) and the economic aspects (fishery production functions) of a fishery. Next, the overexploitation that occurs in fisheries exploited under an open-access regime is analyzed, both through a static and a dynamic model. Subsequently, open-access exploitation levels are compared with those that are produce in a context where property regimes are well defined and this is also analysed in both an static and a dynamic context. Finally, different fisheries management policies proposed in the literature are analyzed, with special emphasis on total allowable catches, individual transferable quotas and marine reserves.

The third topic analyzes another renewable resource, forests, whose management has some interesting peculiarities. As with other renewable resources, optimal forest management will result from the combination of information from biological origin and certain economic variables. Therefore, the topic begins by analyzing the functions of forest resource growth (volume of marketable wood), to later incorporate economic variables (prices, costs and discount rates) in order to define optimal forest rotation in two contexts: a single rotation or an indefinite succession of rotations. Finally, a link is established with the following topic, that of the non-renewable resources, analyzing the determination of the optimal stock of natural forests (old growth forests).

The fourth and final topic analyzes how to exploit resources that are not renewed on a time scale of economic relevance. It aims at answering the following questions: What is the proper rate of extraction of a non-renewable resource? Is it always optimal to exhaust a non-renewable resource? Can it ever be optimal to leave a field of non-renewable resources with positive reserves? Is the rate of exploitation of a renewable resource different when exploiting it under a regime of perfect competition instead of doing it under a monopoly? If you can increase the resource base to exploit through the search for new reserves, what is the right investment in searching for these new reserves? Finally, the appropriate measure of scarcity of non-renewable resources is discussed.

### METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
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<tr>
<td>Theory</td>
<td>5</td>
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<tr>
<td>Seminars</td>
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<tr>
<td>Classroom practicals</td>
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</tr>
<tr>
<td>Lectures</td>
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### TYPES OF TEACHING

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<th>GCL</th>
<th>TA</th>
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<th>GCA</th>
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<tbody>
<tr>
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<td>10</td>
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</table>

Legend:
- M: Lecture-based
- S: Seminar
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### Evaluation tools and percentages of final mark

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
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</thead>
<tbody>
<tr>
<td>Written examination</td>
<td>50 %</td>
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<tr>
<td>Presentations</td>
<td>10 %</td>
<td>30 %</td>
</tr>
<tr>
<td>Questions to discuss</td>
<td>10 %</td>
<td>30 %</td>
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</table>

### ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

Class attendance guarantees that the evaluation of the subject can be a continuous evaluation based on:

(i) individual tasks, and
(ii) oral presentation of an individual work.

If a student does not pass the subject through this continuous assessment system, they may choose a final exam, which will consist of a written test with exercises to solve and questions to be developed related to the topics of the program and the required readings.

To renounce the ordinary call, it will be enough not to sit the final exam and it will be reflected in the Transcript of Records.
EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The extraordinary call will consist of a written test with exercises to solve and questions to be developed related to the topics of the program and the compulsory readings. This test will be 100% of the grade and will take place on the date set in the official exam calendar.

To renounce the extraordinary call, it will be enough not to sit the exam. It will be reflected in the Transcript of Records as NOT PRESENTED.

MANDATORY MATERIALS


BIBLIOGRAPHY

Basic bibliography


Journals

Web sites of interest
COURSE GUIDE 2024/25

Faculty 321 - Faculty of Economics and Business
Degree ECONO802 - Master in Economics: Economic Analysis Tools

COURSE DESCRIPTION
The course of Game Theory consists of an introduction to both Game Theory as well as an introduction to Experimental Economics and Behavioral Economics.

The first part of the course focuses on the core concepts of Game Theory (both cooperative and non-cooperative): definition of a game in normal and extensive-form, coalitions and different solution concepts.

The second part of the course focuses on revising the core assumptions made in Microeconomic Theory and Game Theory in light of empirical evidence gathered using experimental methods.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

Theoretical and Practical Contents
Core concepts in the definition of strategic environments: games, players, actions and strategies, information sets and order in decision making, and finally, payoffs.
Core concepts in the definition of a cooperative game: players, coalitions, characteristic function, axioms.
Core concepts and their assumptions in different solution concepts: Nash equilibrium, rationalizability, subgame perfect Nash equilibrium, Bayesian Nash equilibrium, core, Shapley value, stability.
Core concepts in the use of experimental methods: randomized experiments, subjects, recruitment, treatments, incentives, instructions.
Main findings of behavioral and experimental economics regarding social preferences and non-equilibrium play.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

The course of Game Theory consists of an introduction to both Game Theory as well as an introduction to Experimental Economics and Behavioral Economics.

The first part of the course focuses on the core concepts of Game Theory (both cooperative and non-cooperative): definition of a game in normal and extensive-form, coalitions and different solution concepts.

The second part of the course focuses on revising the core assumptions made in Microeconomic Theory and Game Theory in light of empirical evidence gathered using experimental methods.

COMPETENCIAS DE LA ASIGNATURA
Conocer los principios del análisis económico más relevante en la gestión óptima de los recursos naturales, teniendo en cuenta que la incertidumbre y la irreversibilidad juegan un papel muy importante.

Analizar el comportamiento de los mercados y de los agentes económicos para la correcta modelización de los problemas ambientales.

Identificar los objetivos y los requisitos que deben satisfacer las políticas medioambientales cuya finalidad sea la utilización eficiente de los activos ambientales y el desarrollo sostenible.

Analizar el comportamiento de los agentes económicos en la toma de decisiones con el fin de entender cómo funcionan los mercados, especialmente en condiciones de competencia e información imperfecta.

Comprender el papel de las instituciones públicas en la economía industrial, tanto desde la perspectiva de la regulación de mercados como de la implementación de políticas microeconómicas.

METODOLOGIA (ACTIVIDADES FORMATIVAS)

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<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
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TYPES OF TEACHING

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Evaluation tools and percentages of final mark

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<th>Ponderación máxima</th>
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</thead>
</table>


La evaluación consistirá en un examen final que contará el 100% de la nota final.

<table>
<thead>
<tr>
<th>ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentations</td>
</tr>
<tr>
<td>Questions to discuss</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentations</td>
</tr>
<tr>
<td>Questions to discuss</td>
</tr>
</tbody>
</table>

MANDATORY MATERIALS
Todo el material necesario será impartido en las notas de clase así como en las transparencias utilizadas durante las clases magistrales.

BIBLIOGRAPHY

Basic bibliography


Detailed bibliography

Journals

Web sites of interest
https://www.coursera.org/course/gametheory
http://www.springerlink.com/content/101791/
COURSE GUIDE 2024/25

Faculty  345 - Faculty of Engineering - Bilbao
Degree  INTEL902 - Master in Telecommunication Engineering
Cycle  
Year  First year

COURSE
504005 - Electronic Communications Systems
Credits, ECTS: 9

COURSE DESCRIPTION
The subject belongs to the first year of the Master's degree in telecommunication engineering. It studies and expands knowledge about design of electronic instrumentation and electronic communications systems with emphasis on RF systems. Electronic circuits and systems for signal conditioning, acquisition, processing and transmission of signals generated by sensors, transducers and telecommunication systems are studied. It requires knowledge and skills with design, verification and circuit manufacturing tools.

In the event that the sanitary conditions prevent the realization of a teaching activity and / or face-to-face evaluation, a non-face-to-face modality will be activated of which the students will be informed promptly.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT
COMPETENCIAS DE LA ASIGNATURA
Ability to use programmable logic devices, as well as to design advanced electronic systems, both analog and digital.
Ability to design communications components such as routers, switches, hubs, transmitters and receivers in different bands.
Ability to develop electronic instrumentation, as well as transducers, actuators and sensors.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

Theoretical and Practical Contents
Theory
- Components and devices in electronic instrumentation.
- Electronic instrumentation systems for signal acquisition, control and processing.
- Components and devices in telecommunications systems.
- Electronic systems and signal conditioning in telecommunications.
- Treatment and acquisition of signals. Modulation-demodulation and A/D-D/A converters.
- Interference signals, treatment and electromagnetic compatibility.

- Design and specifications of RF systems. Link Budget.
- Discrete passive and active RF components. Transmission lines and adaptation networks.
- Active and Passive Filters
- RF Small Signal Amplifiers.
- Oscillators and frequency synthesizers.
- Mixers and phase circuits.
- RF power amplifiers.

Lab practices:
The laboratory sessions develop the concepts acquire in theory through practical circuits that the student must design and assemble.

METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom practicals</td>
<td>15</td>
<td>40 %</td>
</tr>
<tr>
<td>Laboratory practicals</td>
<td>75</td>
<td>40 %</td>
</tr>
<tr>
<td>Lectures</td>
<td>135</td>
<td>40 %</td>
</tr>
</tbody>
</table>

TYPES OF TEACHING

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
<th>GL</th>
<th>GO</th>
<th>GCL</th>
<th>TA</th>
<th>Ti</th>
<th>GCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
<td>54</td>
<td>6</td>
<td>30</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horas de Actividad No Presencial del Alumno/a</td>
<td>81</td>
<td>9</td>
<td>45</td>
<td></td>
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</tr>
</tbody>
</table>

Legend:
M: Lecture-based  S: Seminar  GA: Applied classroom-based groups
TA: Workshop  TI: Industrial workshop  GCA: Applied fieldwork groups

Evaluation tools and percentages of final mark
To pass the subject is mandatory to pass each and every one of the parts individually.
- Theoretical part: It is necessary to individually pass all the examinations of the ordinary call.
- Practical part: Attendance to laboratory sessions is mandatory to pass the practical part.
It is necessary to individually pass each of the parts of the laboratory.
The resignation procedure will be the one included in the corresponding regulations. The student who resigns continuous evaluation will be assessed for the 100% of the subject by means of a test that includes both the theoretical and the practice part.

### ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written examination</td>
<td>60 %</td>
<td>60 %</td>
</tr>
<tr>
<td>Practical tasks</td>
<td>40 %</td>
<td>40 %</td>
</tr>
</tbody>
</table>

**Extraordinary Examination Period: Guidelines and Opting Out**

Same criteria as in the ordinary call.
Scores in either of the two parts (theory and practices) will only be kept until the extraordinary examination sitting of the same academic year.

### Mandatory Materials

- KiCAD, OrCAD, PSpice, LTspice, Keysight ADS or equivalent CAD/CAE software.

### Bibliography

#### Basic bibliography

#### Detailed bibliography
- Modern Electronic Communication (9th Edition) by Jeff Beasley and Gary M. Miller (May 6, 2007)

#### Journals
- Microwaves & RF [news@news.mwrf.com]
- Microwaves Journal
- Microwave Engineering Europe [microwave@electronics-eetimes.com]
- analog@electronics-eetimes.com

#### Web sites of interest
- http://web.awrcorp.com/Usa/Products/Microwave-Office/
- Microwaves & RF [news@news.mwrf.com]
- Microwaves Journal
- Microwave Engineering Europe [microwave@electronics-eetimes.com]
- analog@electronics-eetimes.com
COURSE GUIDE

Faculty: 345 - Faculty of Engineering - Bilbao
Degree: INTEL902 - Master in Telecommunication Engineering

COURSE

504007 - Microelectronics
Credits, ECTS: 4.5

COURSE DESCRIPTION

Basic knowledge about active electronic components, manufacturing processes and technologies in integrated circuits, as well as the use of design tools, mathematical models, analysis and simulation of electronic circuits.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA

Ability to design and manufacture integrated circuits.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

Theoretical and Practical Contents

1. INTRODUCTION TO THE INTEGRATED CIRCUITS.
   1.1 Historical evolution of integrated circuits.
   1.2 Classification of integrated circuits.

2. MANUFACTURING PROCESSES OF INTEGRATED CIRCUITS.
   2.1 Manufacture of integrated circuits.
   2.2 Semiconductor substrates. Obtaining monocrystalline silicon.
   2.3 Growth of monocrystals. Preparation of the substrate.
   2.4 Epitaxial growth. Diffusion of impurities. Ionic implantation.
   2.5 Oxidation, deposition of insulators and polysilicon.
   2.6 Lithography techniques. Metallization. Encapsulated

3. MOS TECHNOLOGY
   3.1 NMOS logic.
   3.2 CMOS logic.
   3.3 Input and output circuits. Verification.
   3.4 Advanced circuits in MOS technology.
   3.5 Fundamentals of circuits with switched capacities.
   3.6 CMOS logic gate circuits.

4. BIPOLAR TECHNOLOGY.
   4.1 Manufacturing process of bipolar integrated circuits.
   4.2 Diodes and transistors in bipolar integrated circuits.
   4.3 Passive components in integrated circuits.
   4.4 Bipolar Logics: TTL, ECL and I2L.

METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom practicals</td>
<td>7,5</td>
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<tr>
<td>Computer practicals</td>
<td>37,5</td>
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</tr>
<tr>
<td>Lectures</td>
<td>67,5</td>
<td>40 %</td>
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TYPES OF TEACHING

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
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<th>GA</th>
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<th>GO</th>
<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
<td>27</td>
<td>3</td>
<td>15</td>
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<tr>
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<td>4,5</td>
<td>22,5</td>
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</tbody>
</table>

Legend:

M: Lecture-based
S: Seminar
GA: Applied classroom-based groups
GL: Applied laboratory-based groups
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GCL: Applied clinical-based groups
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Evaluation tools and percentages of final mark

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written examination</td>
<td>70 %</td>
<td>70 %</td>
</tr>
</tbody>
</table>
The evaluation is composed of two parts:
A theory exam for the 70% of the final grade.
A practical laboratory exercise for the 30% of the final grade.
The subject is passed only provided that both parts have been passed separately (Theory >35%, Laboratory > 15%).

**ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

The same that in the ordinary call.

**MANDATORY MATERIALS**

Software installed in the computer rooms (both, for classes and open access) DSCH v2.7f and Microwind v2.6k

**BIBLIOGRAPHY**

**Basic bibliography**

**Detailed bibliography**

**Journals**

**Web sites of interest**
http://bwrc.eecs.berkeley.edu/classes/icbook/spice www.microwind.org
www.cadence.com
This course examines the provision models and procedures for the management and operation of access and backbone networks.

After this course students should have general knowledge on how to solve the convergence, interoperability and design of heterogeneous networks.

In the event that sanitary conditions prevent the face-to-face teaching activity and/or assessment, online modalities will be made active and the students will be promptly informed.

### COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

**COMPETENCIAS DE LA ASIGNATURA**

Capacidad para resolver la convergencia, interoperabilidad y diseño de redes heterogéneas con redes locales, de acceso y troncales, así como la integración de servicios de telefonía, datos, televisión e interactivos.

### RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

**Theoretical and Practical Contents**

1. **INTRODUCTION**
2. **ACCESS NETWORKS**
   - Provision models, procedures for the management and operation of heterogeneous access networks.
3. **BACKBONE NETWORKS**
   - Transport models based on packages.
   - Models for optical transport.
4. **CONTROL PLANE**
   - Control architectures in Next Generation Networks.
5. **INTEGRATION OF ACCESS, BACKBONE AND CONTROL PLANE IN NGN**
   - Models and integrative architectures in Next Generation Networks

### METODOLOGÍA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
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<tbody>
<tr>
<td>Seminars</td>
<td>10</td>
<td>40 %</td>
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<tr>
<td>Seminars</td>
<td>10</td>
<td>40 %</td>
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<tr>
<td>Laboratory practicals</td>
<td>37,5</td>
<td>40 %</td>
</tr>
<tr>
<td>Lectures</td>
<td>65</td>
<td>40 %</td>
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</tbody>
</table>

### TYPES OF TEACHING

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
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<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
<td>26</td>
<td>4</td>
<td>15</td>
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<td></td>
<td></td>
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<tr>
<td>Horas de Actividad No Presencial del Alumno/a</td>
<td>39</td>
<td>6</td>
<td>22,5</td>
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**Legend:**
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<th>Denominación</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Written examination</td>
<td>25 %</td>
<td>60 %</td>
</tr>
<tr>
<td>Presentations</td>
<td>10 %</td>
<td>40 %</td>
</tr>
<tr>
<td>Practical tasks</td>
<td>20 %</td>
<td>50 %</td>
</tr>
</tbody>
</table>

**ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

The evaluation of the course is designed to be done through continuous evaluation.

The final grade of the subject (with the continuous assessment) will be developed with the next grading formula:
*Lectures: 50% of the grade  
Based on written exams

*Presentations: 10% of the grade  
10% assignments developed in seminars

*Practical Tasks: 40% of the grade
*30% group reports  
*10% continuous assessment in practical tasks

To pass the course, it is COMPULSORY to attend ALL continuous assessment classes (laboratory classes and seminars).

The student wishing to renounce the continuous evaluation will have to do so by submitting an email to the professor responsible for the assignature: eva.ibarrola@ehu.eus in 8 weeks from the beginning of the semester.

A minimum grade of 4 both is needed both in the theoretical part and in the practical part to pass the course.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The practical and theoretical contents will be evaluated through a final exam that will be 100% of the grade of the subject.

MANDATORY MATERIALS

Official web site of the subject: https://egela.ehu.es/

BIBLIOGRAPHY

Basic bibliography
- PETER TOMSU, CHRISTIAN SCHMUTZER, "NEXT GENERATION OPTICAL NETWORKS", ED. PRENTICE HALL, 2002
- JORDI PALET, IPv6 PARA ESPAÑA, CONSULINTEL 2011.
- KARTALOPOULOS, STAMATIOS, NEXT GENERATION INTELLIGENT OPTICAL NETWORKS: FROM ACCESS TO BACKBONE, SPRINGER, 2008.

Detailed bibliography
- Broadband Network Architectures: Designing and Deploying Triple-Play Services; Naoaki Yamanaka, Kohei Shiomoto, Eiji Oki; Prentice Hall
- GMPLS Technologies: Broadband Backbone Networks and Systems (Optical Science and Engineering); Chris Hellberg, Dylan Greene, Truman Boyes ;CRC Press.
- Broadband Cable Access Networks: The HFC Plant (The Morgan Kaufmann Series in Networking), David Large and James Farmer, Morgan Kaufmann.

Journals
IEEE Network: The Magazine of Global Internetworking, IEEE PRESS.

Web sites of interest
Broad Band Forum: http://www.broadband-forum.org/
TeleManagementForum: http://www.tmforum.org/
Laboratory of digital circuits is a subject of the course 1 semester 2 within the "Master's Degree in Telecommunication Engineering". The teaching is done in the School of Engineering. In this subject the field programmable circuits (FPGA) are worked on and in particular the devices that combine a programmable part and microprocessor (SoPC). It provides the knowledge and tools to analyze, design and use programmable circuits: characteristics, technological evolution, programmable logic devices, circuit description in VHDL and programming in C. The postgraduate course is supported (mainly) in the following subjects of the degree in telecommunication engineering:

- Course 2: Digital Electronics
- Course 3: Digital Systems
- Course 4: Digital circuits laboratory (optional)

The concepts, technologies and processes studied in this subject serve as support for subjects such as:

- Electronic communications systems
- Advanced signal processing
- Design and management of telecommunication networks and services
- Processing of biomedical signals

In the event that health conditions prevent the completion of a teaching activity and / or evaluation in person, it will activate a mode of non-presence of which students will be informed promptly.

## COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

### COMPETENCIAS DE LA ASIGNATURA

Knowledge of hardware description languages for highly complex circuits.

Ability to use programmable logic devices, as well as to design advanced electronic systems, both analog and digital.

Ability to design communications components such as routers, switches, hubs, transmitters and receivers in different bands.

### RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

## Theoretical and Practical Contents

### Classroom:

During the classes in the classroom, we will see different coding techniques as well as the problems that may arise in the advanced design of FPGAs. The content of the theory must be applied in the IP cores that will be designed in the laboratory:

- Class Intro and 7 Series Architecture Overview
- FPGA Design Methodology and HDL Coding Techniques
- Synchronous Design Techniques and Reset Methodology
- Synchronization Circuits
- FPGA Design Techniques and Timing Exceptions
- Zynq Architecture
- Introduction to AXI and Zynq PS-PL AXI Ports

### Laboratory

- FPGA Design Flow using Vivado
  
  These practices will provide students with an introduction to the design flow using the Vivado® Design software suite for the Xilinx All Programmable devices. The documentation for this course can be found on the Xilinx University Program website as well as on the subject page.

- Embedded System Design Flow on Zynq using Vivado
  
  This course provides students with an introduction to the design of Zynq embedded systems using a Zedboard and Vivado board. The documentation for this course can be found on the Xilinx University Program website as well as on the subject page.

- IP core design

  Realization of free final practice. Creation of an IP core with interconnection using standard buses for real-time audio processing configurable using software.
**METODOLOGIA (ACTIVIDADES FORMATIVAS)**

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures</td>
<td>30</td>
<td>50 %</td>
</tr>
<tr>
<td>Laboratory practicals</td>
<td>82.5</td>
<td>36 %</td>
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</table>

**TYPES OF TEACHING**

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
<th>GL</th>
<th>GO</th>
<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horas de Actividad No Presencialidad</td>
<td>15</td>
<td>30</td>
<td>52.5</td>
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</table>

**Evaluation tools and percentages of final mark**

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written examination</td>
<td>25 %</td>
<td>50 %</td>
</tr>
<tr>
<td>Presentations</td>
<td>25 %</td>
<td>25 %</td>
</tr>
<tr>
<td>Otros</td>
<td>25 %</td>
<td>25 %</td>
</tr>
<tr>
<td>Practical tasks</td>
<td>50 %</td>
<td>75 %</td>
</tr>
</tbody>
</table>

**ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

One or more exams whose weighted average corresponds to 100% of the written test grade.
Final project for 100% of the part corresponding to the project.
The resignation must be done following the current regulations.

**EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

Project for 100% of the grade.

**MANDATORY MATERIALS**

* Xilinx University Program: [http://www.xilinx.com/support/university/students.html](http://www.xilinx.com/support/university/students.html)

**BIBLIOGRAPHY**

**Basic bibliography**


**Detailed bibliography**


**Journals**

**Web sites of interest**

http://www.xilinx.com
http://www.digilentinc.com
http://www.ehu.es/Electronica_EUITI/vhdl/pagina/inicio.htm
http://www.vhdl-online.de/tutorial/
http://esd.cs.ucr.edu/labs/tutorial/
COURSE GUIDE 2024/25

Faculty 345 - Faculty of Engineering - Bilbao
Degree INTEL902 - Master in Telecommunication Engineering

COURSE
504018 - Advanced Radio Communications Design
Credits, ECTS: 7.5

COURSE DESCRIPTION
This course focuses on the design and planning of several radio communication systems such as: backbone and access networks, mobile communications networks, satellite communications, radar systems and radionavigation systems.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA
- Capacidad para desarrollar sistemas de radiocomunicaciones: diseño de antenas, equipos y subsistemas, modelado de canales, cálculo de enlaces y planificación.
- Capacidad para implementar sistemas por cable, línea, satélite en entornos de comunicaciones fijas y móviles.
- Capacidad para diseñar y dimensionar redes de transporte, difusión y distribución de señales multimedia.
- Capacidad para diseñar sistemas de radionavegación y de posicionamiento, así como los sistemas radar.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

Theoretical and Practical Contents

COMPETENCES:
- Ability to develop radio communication systems: antenna design, equipment and subsystems, channel modeling, link calculation, and planning.
- Ability to implement systems via cable, line, and satellite in fixed and mobile communication environments.
- Ability to design and dimension networks for the transport, broadcasting, and distribution of multimedia signals.
- Ability to design navigation and positioning systems, as well as radar systems.

SYLLABUS
Lectures and seminars.


Laboratory projects.

- Project 1. Introduction to simulation SW. Antenna design Case study: design and simulation of microstrip antennas. Result presentation.
- Project 2. Measurements automation. Introduction to the SW for equipment remote control. Development of a control software to carry out a measurement campaign and subsequent analysis. Result presentation.
- Project 3. Measurement of RF signals and characterization of circuits using the S parameters. Propagation models and introduction to basic channel modeling. Measurement of channel impulse and frequency response; propagation speed. Planning and execution of indoor measurement campaign; Data processing and conclusions about the radio channel. Result presentation.
presentation.

**METODOLOGIA (ACTIVIDADES FORMATIVAS)**

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures</td>
<td>37,5</td>
<td>40 %</td>
</tr>
<tr>
<td>Analytical problems - working groups (report)</td>
<td>37,5</td>
<td>40 %</td>
</tr>
<tr>
<td>Seminars</td>
<td>37,5</td>
<td>40 %</td>
</tr>
<tr>
<td>Laboratory practicals</td>
<td>112,5</td>
<td>40 %</td>
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</table>

**TYPES OF TEACHING**

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
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<th>TI</th>
<th>GCA</th>
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</thead>
<tbody>
<tr>
<td>Hours de Actividad No Presencial del Alumno/a</td>
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<td>22,5</td>
<td>67,5</td>
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</tr>
</tbody>
</table>

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 tools and percentages of final mark**

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written examination</td>
<td>40 %</td>
<td>40 %</td>
</tr>
<tr>
<td>Presentations</td>
<td>30 %</td>
<td>30 %</td>
</tr>
<tr>
<td>Multiple-choice examination</td>
<td>30 %</td>
<td>30 %</td>
</tr>
</tbody>
</table>

**ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

Mid-course exam: NO.

Clarification of the assessment system:

1) On-going assessment. The 40% of the final grade of the course, which corresponds to the contents of lectures and seminars is distributed into two parts:
   i) Tests carried out along the teaching period (up to a 20% of the final grade of the course). The amount and contents covered by these tests will be decided by the teaching staff according to the observed learning progression of the students. It may be possible to discard some of the worst grades obtained in these tests to obtain the corresponding score for this subsection.
   ii) Written exam the day of the first official call regarding the contents of the lectures and the seminars, worth between 20% and 40% of the total grade of the subject. In every case the overall grade of parts i) and ii) will add up to a 40% of the total, and a minimum grade of 3.5 points over 10 will be required to pass the course. Should this requirement not be fulfilled, the final grade will be the grade obtained in this part i) + ii). Electronic devices such as calculators, smartphones, smartwatches, etc cannot be used in order to answer quizzes. For the rest of the exam only calculators are allowed.

The remaining 60% is assigned to the laboratory projects. The skills to be acquired in these projects are assessed following two procedures:

a) There will be oral presentations by the working groups of the laboratory about the work carried out in the projects with a weight of 30% of the final grade of the course. Each project will be given a 0-to-10 grade, and each grade will determine a 7.5% of the final grade of the course, so that, being 4 projects, the overall grade provided by this assessment procedure will be the mentioned 30%.

More specifically, half of the groups will present projects 1 and 3, while the other half will present projects 2 and 4. After each presentation, there will be a question time in which all the other groups than the one that has made the presentation will have to pose at least one question per group. Otherwise, all the members of the defaulting group will be penalized with a negative point over 10 in the grade of that particular project. One negative point per each due question. The question time will conclude with the questions and comments of the professor regarding both the technical contents and the formal aspects of the presentation. The conclusions from these questions and comments will be the basis of the grade of this project. A previously published rubric, made available to the students, might be used for this evaluation.

The working groups that are not to do the oral presentation in a certain project will have to develop a presentation-format report from the scratch for that project. However, they will be allowed to take information from the document already provided by the professo.
presented by other group and amend it or improve it, taking into consideration the questions and comments arisen in the question time. This document will be used for the evaluation of this project for each non-presenting group. For this procedure to work properly, the composition of the working groups should be kept constant along the course.

b) Test exam regarding the laboratory projects with 3 to 5 questions corresponding to each project for an overall number of 20 questions. The weight of this exam will be 30% of the final grade of the course.

2) Not on-going assessment.
In order to relinquish the on-going assessment, a letter must be sent to the subject coordinator following the procedure and within the time limits defined by the University regulations. As a consequence, it will be possible to obtain the maximum grade by means of the written exam of the contents of the lectures, the seminars and the laboratory projects, with the following distribution: lectures and seminars will have a weight of 40% of the final grade of the course, while laboratory projects will be assigned the remaining 60%. In the first part, the one corresponding to lectures and seminars, a minimum grade of 3.5 points over 10 will be required to pass the course. Should this requirement not be fulfilled, the final grade will be the grade obtained in this part. The laboratory part will be a 30-question test with there being no minimum.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

There are two modifications with respect to the evaluation format of the first call. In the second call:
- In the 40% of the grade corresponding to master classes and seminars, the tests throughout the training period will not be taken into account and, therefore, 40% of master classes and seminars will be evaluated through the written test to be taken on the day of the official call. The rest is maintained, including the minimum grade requirement of 3.5 out of 10 in that part of master classes and seminars. If this requirement is not verified, the grade obtained in this part will be taken as the final grade.
- The laboratory test will consist of 20 questions in any case.

MANDATORY MATERIALS
- Course slides and exercises based on practical scenarios to be solved, available on the online platform (eGela)
- Guides of the Laboratory Projects (also available on eGela) and reference material.

BIBLIOGRAPHY

Basic bibliography

Detailed bibliography
Bahl I. "Microwave Solid State Circuit Design"- John Wiley & Sons
Radar System Analysis and Modeling, D. K. Barton, Artech House , 2005

Journals
IEEE Transactions on Communications
IEEE Transactions on Vehicular Technology
IEEE Transactions on Broadcasting
IEEE Antennas and Wireless Propagation Letters

Web sites of interest

http://www.itu.int
http://www.ebu.ch
http://www.etsi.org
http://www.dvb.org
http://www.umts-forum.org
http://www.3gpp.org
http://ieeexplore.ieee.org
http://www.esa.int/esaNA/galileo.html
http://www.gps.gov
This subject seeks to introduce the student to the research methodology, providing the conceptual and practical tools necessary to achieve effective development of their research tasks. This subject covers the basis of the scientific method and the main activities to carry out by a person who intends to develop scientific and / or technological research and work in the field of R + D + i in any of its aspects. With this aim, the following topics are studied: scientific publications, doctoral theses, congresses and technical conferences, patents, spinoffs and incubators, the transfer of scientific and technological knowledge to the production environment, the information search, the preparation of proposals for research projects, certification of R + D + i projects and oral communications. Other issues such as fraud, error, bias, philosophy of science, and research ethics are also addressed. This subject allows the student to acquire not only technical knowledge about the described specific topics, but by carrying out practical work that reproduces real activities, the student acquires the skills and knowledge required to carry out R & D & i activities in a company, university or research center. This subject is part of the educational innovation project named HBP/PIE i3lab24-17 (UZTATU) "Integración de las tecnologías de Telecomunicación en la Educación: aprendizaje con enfoque investigador e interdisciplinar entre la ingeniería y la educación para la adquisición de las competencias transversales del Máster Universitario en Ingeniería de Telecomunicación (INTELEDU)" of the HPB/PIE i3lab (2024-2025) call.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

- Capacity for the elaboration, direction, coordination, and technical and economic management of projects on: systems, networks, infrastructures and telecommunication services, including the supervision and coordination of the partial projects of its attached work; common telecommunication infrastructures in buildings or residential centers, including digital home projects; telecommunication infrastructures in transport and environment; with its corresponding power supply facilities and evaluation of electromagnetic emissions and electromagnetic compatibility.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

At the end of the subject, students must have acquired the skills described, as well as the expected learning outcomes. These learning outcomes are as follows:
- Develop a project working as a team.
- Ability to carry out tasks of preparing requests for research projects developing the fundamental knowledge of the research methodology.
- Understand the procedures and basic techniques to carry out research work.

Theoretical and Practical Contents

1. Fundamental concepts about scientific research: The researcher and the research process. The scientific method.
2. Scientific publications and documentation.
3. The doctoral thesis.
5. Information search. Scientific databases.
6. Patents. Incubators for technology-based companies and spinoffs.
7. Transfer of knowledge to the productive environment. Policies and indicators.
10. Certification of research projects in companies. Scholarships and grants. Research career.
12. Uncertainty, measurements and metrology.
13. Oral communication, congresses and conferences. Practical cases.
14. Presentation of research project proposals. Evaluation of research projects. Practical cases.

METODOLOGIA (ACTIVIDADES FORMATIVAS)
<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer practicals</td>
<td>37.5</td>
<td>40%</td>
</tr>
<tr>
<td>Lectures</td>
<td>37.5</td>
<td>40%</td>
</tr>
</tbody>
</table>

**Evaluation tools and percentages of final mark**

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous evaluation</td>
<td>20 %</td>
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<tr>
<td>Written examination</td>
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<tr>
<td>Practical tasks</td>
<td>60 %</td>
<td>80 %</td>
</tr>
</tbody>
</table>

**ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

In the regular exam schedule, the evaluation system consists of two parts: written exam of the contents or the whole subject (35% of the grade) and 2 practical works (65% of the grade).

The distribution of 65% of the grade related to practical works in the different activities carried out in the subject is detailed below:

- Writing and presenting a research project proposal: 35%
- Creating and presenting an informative video about general telecommunication concepts: 30%

The evaluation process includes both individual and group work evaluation.

To pass the subject in the regular exam schedule following the described evaluation method, it is necessary that the weighted average of the grades of the sections described above is greater than 5 points and that in any case, the mark of the written exam is greater than or equal to 4 points out of 10.

Attending seminars is obligatory.

Students who do not wish to take continuous assessment must present their withdrawal from continuous assessment according to the procedure and deadlines established in Article 8.3 of the UPV/EHU Student Assessment Regulations.

NOTE: if health reasons do not allow a teaching activity or evaluation task to take place face-to-face, a not face-to-face modality will be used and students will be informed punctually.

**EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

In the special exam schedule, the assessment will consist of a final exam, the score obtained in this exam being 100% of the subject’s grade.

Withdrawals will be carried out according to applicable regulations.

**MANDATORY MATERIALS**

- S. Ramón y Cajal: Reglas y consejos sobre la investigación científica. 1935.
- C. Ascheron and Angela Kitkuth, "Make your mark in Science", Wiley, 2005
- Alan Chalmers, “La ciencia y cómo se elabora”, Siglo XXI, 1992
- Horace Freeland, Anatomía del fraude científico, Drakontos, 2006
BIBLIOGRAPHY

Basic bibliography

- Alan Chalmers, "Qué es esa cosa llamada ciencia", Siglo XXI, 2006
- Michael Shermer, "¿Por qué creemos en cosas raras?", Alba, 2002.
- Francis Bacon, Novum Organum.
- Pérez Monfort, R., "Reflexiones matutinas sobre la investigación científica; Viernes 10 7:00am", Fondo de Cultura económica, México, 1994.
- B. Russell, Historia de la filosofía occidental. Austral, 2007, Tomos I y II

Detailed bibliography

- Richard Dawkins, "Evolución", Espasa Calpe, 2009

Journals

- JOURNAL OF MANAGEMENT INFORMATION SYSTEMS, M E SHARPE INC
- INTERNATIONAL JOURNAL OF SOCIAL RESEARCH METHODOLOGY BY ROUTLEDGE
- ACADEMY OF MANAGEMENT JOURNAL
- INTERNATIONAL JOURNAL OF RESEARCH & METHOD IN EDUCATION BY ROUTLEDGE
- COMPUTERS & OPERATIONS RESEARCH BY ELSEVIER
- NATURE
- SCIENCE

Web sites of interest

- Magazine "El Escéptico", edita ARP- Sociedad para el avance del pensamiento crítico: http://www.arp-sapc.org
- Página del Centro Español de Metrología: www.cem.es.
- FECYT http://www.accesowok.fecyt.es/cursos/online.html
- On being a scientist: a guide to responsible conduct in research. The national Academic of Science, The national Academic of Engineering and the Institute of Medicine (USA); http://www.nap.edu/catalog.php?record_id=12192
- Science magazine, http://www.scientemag.org/
COURSE GUIDE

2024/25

Faculty 345 - Faculty of Engineering - Bilbao
Degree INTEL902 - Master in Telecommunication Engineering

COURSE

504023 - Security and Distributed Systems

Credits, ECTS: 4,5

COURSE DESCRIPTION

Students will acquire a complete and practical vision of the concepts and technologies used for the design of telematic applications, services and infrastructures with specific security and audit requirements and the related regulations. This subject addresses the protocols, methodologies and tools for the specification, design, implementation and validation of secure networks, systems, services and applications. The applicable legislation in this field is also analyzed. In the event that health conditions prevent carrying the teaching activity and/or face-to-face evaluation, a non-face-to-face modality will be activated, of which the students will be promptly informed.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA

Conocimiento de conceptos de seguridad, criptografía y diseño de protocolos de seguridad, que permitirán diseñar y validar soluciones telemáticas que tengan las necesidades de seguridad adaptadas a cada escenario.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

In general, the learning outcome pursued in the course is as follows:
Broad and consistent knowledge in the area of security in distributed systems covering the entire service chain: from the authentication of terminals or users to the verification of systems.

In detail:

RA1: Ability to define, implement and validate security protocols at different levels using the usual tools used by engineering professionals in their professional performance.

RA2: Knowledge of the securization of telematic systems, services and applications, such as telematic voting, electronic commerce and the securization of transactions and data exchange in general.

RA3: Ability to define, implement and verify access control systems to information systems, password management and digital identities in distributed systems, including problems associated with mobile environments and user mobility in general.

RA4: Ability to define, implement and validate security policies in distributed systems, carry out risk analysis using specific tools and methods, as well as perform security audits on systems in operation.

RA5: Knowledge of the applicable legal framework and current legislation regarding security in information systems, as well as its implications in the design, implementation and operation of distributed systems.

Theoretical and Practical Contents

C11 Block

Topic 1. Basic security concepts:
   1.1 Introduction and review of security concepts.

Topic 2. Concepts of cryptography and protocol design:
   2.1 Encryption Algorithms.
   2.2 Blind signature. Application in payment and voting services.
   2.3 Protection of digital content.
   2.4 Formal verification of security protocols.

C12 Block

Topic 3. Authentication and authorization architectures and protocols:
   3.1 Authentication systems.
   3.2 Access control systems.
   3.3 Identity Management.

Topic 4. Design and security auditing of distributed systems:
   4.2 Methodologies for the design of secure systems, security assessment and risk analysis
   4.3 Audit and security analysis.
Topic 5. Related legislation:
  5.1 Applicable Law.

**METODOLOGIA (ACTIVIDADES FORMATIVAS)**

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer, laboratory, hands-on field practice</td>
<td>0</td>
<td>0 %</td>
</tr>
<tr>
<td>Computer work practice, laboratory, site visits, field trips, external visits</td>
<td>0</td>
<td>0 %</td>
</tr>
<tr>
<td>Individual work and/or group work</td>
<td>0</td>
<td>0 %</td>
</tr>
<tr>
<td>Seminars</td>
<td>10</td>
<td>40 %</td>
</tr>
<tr>
<td>Seminars</td>
<td>10</td>
<td>40 %</td>
</tr>
<tr>
<td>Laboratory practicals</td>
<td>37.5</td>
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</tr>
<tr>
<td>Lectures</td>
<td>65</td>
<td>40 %</td>
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</tbody>
</table>

**TYPES OF TEACHING**

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
<th>GL</th>
<th>GO</th>
<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
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<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
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<td>4</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>22.5</td>
<td></td>
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<tr>
<td>Horas de Actividad No Presencial del Alumno/a</td>
<td>39</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22.5</td>
</tr>
</tbody>
</table>

Legend:
- M: Lecture-based
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**Evaluation tools and percentages of final mark**

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawing up reports and presentations</td>
<td>5 %</td>
<td>25 %</td>
</tr>
<tr>
<td>Realización de prácticas (ejercicios, casos o problemas)</td>
<td>40 %</td>
<td>70 %</td>
</tr>
<tr>
<td>Team work (problem solving, project design)</td>
<td>25 %</td>
<td>35 %</td>
</tr>
</tbody>
</table>

**ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

The evaluation of the subject in the ordinary call is based on continuous evaluation and will be carried out according to the following criteria:

- 60% - Completion of laboratory practices and preparation of reports (covering the contents of units 1, 2 and 3)
- 30% - Solving a complex problem (covering the contents of unit 4) using the PBL methodology (problem-based learning). Evaluation of the deliverables defined in the PBL proposal.
- 10% - Completion and delivery of a short research paper (related to the contents of unit 5)

To pass the subject in the ordinary call following the continuous assessment method, it is necessary that the weighted average of the qualifications of the sections described above is greater than 5 points.

In this case of not following the continuous evaluation method, on the official date assigned to the ordinary call, a test will be carried out for 100% of the grade that should cover the evaluation of the theoretical, practical and complex problem-solving knowledge.

Students who wish to waive continuous assessment must do so in accordance with the procedure and deadlines established in Article 8.3 of the UPV/EHU Student Assessment Regulations.

**EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

A test will be carried out for 100% of the grade that should cover the evaluation of the theoretical, practical and complex problem-solving knowledge.

**MANDATORY MATERIALS**

BIBLIOGRAPHY

Basic bibliography

Detailed bibliography

Journals
Revista de Seguridad en Informática y Comunicaciones: http://www.revistasic.com/

Web sites of interest
Red temática Iberoamericana de Criptografía y Seguridad de la Información: http://www.criptored.upm.es
Herramienta Cryptool: http://www.cryptool.com
Herramienta Span: http://www.irisa.fr/celtique/genet/span/
Agencia Vasca de Protección de datos: http://www.avpd.es
Agencia Española de Protección de Datos: http://www.agpd.es
COURSE GUIDE

Faculty: 345 - Faculty of Engineering - Bilbao
Degree: INTEL902 - Master in Telecommunication Engineering
Cycle: 
Year: Second year

COURSE

504026 - Speech Technologies
Credits, ECTS: 4.5

COURSE DESCRIPTION

The subject is a general introduction to speech technologies and its goal is to qualify the student to work in this area. This includes both the research profiles and the professional profiles devoted to the design, development and commercialization of dialogue, speech synthesis and recognition systems, biometric security systems, etc. In this subject, basic concepts of signal processing taught in the Telecommunication Technology Engineering degree, mainly in the subject of Signal Treatment and also in Multimedia Signal Processing, where basic techniques to process audio and speech signals are studied. Besides, knowledge in advanced signal statistical processing is required. This topic is studied in Advanced Signal Processing, in the first course of the master.

In the event that the sanitary conditions prevent the realization of teaching activities and/or face-to-face evaluations, an online modality will be activated and the students will be informed promptly.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

Describe the processes of generation and perception of the voice signal.
Demonstrate knowledge about the time and frequency representation of the voice signal and the techniques used for its analysis.
Demonstrate understanding of problems related to speech acoustic modeling, language modeling, automatic speech and speaker recognition, and voice synthesis systems, as well as about the techniques used to evaluate them.
Measure and interpret the main parameters that characterize the speech signal.
Implement a perceptual voice encoder.
Develop a basic speech recognition system.

Theoretical and Practical Contents

Lesson 1 Introduction to speech technologies
Lesson 2 Speech generation and perception
Lesson 3 Speech signal digital processing techniques
Lesson 4 Speech coding
Lesson 5 Introduction to speech and speaker recognition
Lesson 6 Text to speech conversion

METODOLOGIA (ACTIVIDADES FORMATIVAS)

Types of teaching

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
<th>GL</th>
<th>GO</th>
<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
</tr>
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<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
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<td>22.5</td>
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Legend:
M: Lecture-based
S: Seminar
GA: Applied classroom-based groups
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TI: Industrial workshop
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Evaluation tools and percentages of final mark

<table>
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<tr>
<th>Denominación</th>
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</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The evaluation is divided in three independent parts: master lessons, lab practices and a group work.
- The knowledge about the master lessons will be proven with a multiple choice 20 question test (40%).
- The lab practices will be evaluated by the reports and the work developed at the lab (45%).
- The group work will be evaluated by means of a group grade that will take into account the development and presentation of the work (15%).
In the regular evaluation, the exam must be passed with at least a 4 over 10 and to succeed in the subject the final grade of 5 over 10 must be achieved, once the grades gotten in the three parts are added up. The three parts are independent and once a part is passed, the grade is kept for future calls.

The students unable to follow the combined evaluation must justify their reasons with proper documentation sent to the subject lecturers, according to the procedure established by the current regulation in the first two weeks of the course. They also should inform the faculty at least a month before the exam period starts. These students will be able to prove the achievement of the learning results by means of a final evaluation consisting of: a written exam (40%), a laboratory exam (45%) and the development and presentation of a work (15%).

By not showing to the final written exam, the student refuses to take part in the call.

In the event that the sanitary conditions prevent performing a teaching activity and/or face-to-face evaluation, a non-face-to-face modality will be activated. Students will be informed on time about it.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

In the resit attempt, two different tests will be made: an exam for the master classes and another one for the lab practices. Each exam will represent the 50% of the final note and both of them must be passed with at least a 5 over 10.

The students that have presented the written justification to elude the continuous evaluation must prove they have correctly completed the lab practices.

In the event that the sanitary conditions prevent performing a teaching activity and/or face-to-face evaluation, a non-face-to-face modality will be activated. Students will be informed on time about it.

MANDATORY MATERIALS

The students will have available at eGela (http://egela.ehu.eus/) the following materials, needed to correctly follow the course:
- Slides with the theoretical content of the course
- Guide for lab practices, a file for each practice with the corresponding theoretical introduction
- Necessary signals, matlab programs, linux scripts and other tools needed to complete the lab practices
- Guide for the development of the group research work

BIBLIOGRAPHY

Basic bibliography

Detailed bibliography

Journals
- Computer Speech and Language
- Speech Communication
- IEEE Transactions on Audio, Speech & Language Processing
- IEEE Transactions on Systems, Man and Cybernetics-Part B
- IEEE Transactions on Multimedia
- Journal of the Acoustical Society of America
Web sites of interest

- Speech Technologies
  http://www.speech.cs.cmu.edu/
  http://festvox.org/
- Review of Speech Synthesis Technology
- Smithsonian Speech Synthesis History Project (SSHP)
  https://amhistory.si.edu/archives/speechsynthesis/ss_home.htm
- TTS demos
  https://www.acapela-group.com/demos/
  https://cloud.google.com/text-to-speech
  http://aholab.ehu.eus/tts
- ASR demos
  https://huggingface.co/spaces/HiTZ/Demo_Basque_ASR
### COURSE GUIDE

**Faculty** 345 - Faculty of Engineering - Bilbao  
**Degree** INTEL902 - Master in Telecommunication Engineering  
**Cycle**  
**Year** Second year  
**Credits, ECTS:** 4,5

### COURSE DESCRIPTION

**BIOMEDICAL SIGNAL PROCESSING**

**DESCRIPTION AND CONTEXTUALIZATION**

The subject is an introduction to the analysis and digital processing of biomedical signals of different nature. Typical one-dimensional signals such as the electrocardiogram (ECG), the electroencephalogram (EEG) and the electromyogram (EMG), and multidimensional signals, such as biomedical images, are introduced.

The student will learn to interpret the physiological phenomenon represented by the signals, the acquisition and conditioning techniques that allow the digital storage of the signals, as well as techniques aimed to characterize these signals in the time and in the frequency domains. Typical applications of biomedical signal processing, mainly oriented to diagnosis, will be developed during the laboratory sessions.

The subject is conceived as a general introduction to the biomedical engineering discipline. Thus, it introduces the professional skills required for a biomedical engineer, such as maintenance, design and commercialization of electromedical equipment, diagnostic devices, and medical image systems. The subject also introduces some topics related to research in biomedical engineering.

This subject requires prior advanced knowledge on statistical signal processing, design of digital filters, signal representation in the time and frequency domain, and signal acquisition and conditioning.

### COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

**COMPETENCIAS DE LA ASIGNATURA**

- Capacidad para analizar, interpretar y procesar digitalmente señales biomédicas

**RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA**

### Theoretical and Practical Contents

**SYLLABUS:**

- TOPIC 1 - Introduction to biomedical signals
- TOPIC 2 - Biomedical signal acquisition and conditioning
- TOPIC 3 - Characterization of unidimensional biomedical signals
- TOPIC 4 - Applications of biomedical signal processing of unidimensional signals
- TOPIC 5 - Analysis and processing of biomedical images

**LAB SESSION:**

- SESSION 1 - Acquisition of biomedical signals
- SESSION 2 - Basic ECG processing
- SESSION 3 - Respiratory component: tachogram and pressure signal
- SESSION 4 - Detection of shockable rhythms: session I
- SESSION 5 - Detection of shockable rhythms: session II
- SESSION 6 - The electromyogram
- SESSION 7 - The electroencephalogram
- SESSION 8 - Segmentation of medical images
- SESSION 9 - 3-D reconstruction of medical images

Details of the syllabus, laboratory sessions, and the description of the subject methodology are available in the eGela learning platform.
**METODOLOGIA (ACTIVIDADES FORMATIVAS)**

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expository presentation of the contents and discussion</td>
<td>0</td>
<td>0 %</td>
</tr>
<tr>
<td>Presentations and Papers</td>
<td>2</td>
<td>100 %</td>
</tr>
<tr>
<td>Individual work and/or group work</td>
<td>9.25</td>
<td>0 %</td>
</tr>
<tr>
<td>Computer work practice, laboratory, site visits, field trips, external visits</td>
<td>22.5</td>
<td>100 %</td>
</tr>
<tr>
<td>Lectures</td>
<td>22.5</td>
<td>100 %</td>
</tr>
<tr>
<td>Laboratory practicals</td>
<td>56.25</td>
<td>40 %</td>
</tr>
</tbody>
</table>

**TYPES OF TEACHING**

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
<th>GL</th>
<th>GO</th>
<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
<td>22.5</td>
<td>22.5</td>
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<tr>
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<td>33.75</td>
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</tbody>
</table>

Legend:
- M: Lecture-based
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- TA: Workshop
- TI: Industrial workshop
- GCA: Applied fieldwork groups

**Evaluation tools and percentages of final mark**

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical Examination</td>
<td>30 %</td>
<td>30 %</td>
</tr>
<tr>
<td>Written examination (theory)</td>
<td>30 %</td>
<td>30 %</td>
</tr>
<tr>
<td>Internship Report/Summary</td>
<td>25 %</td>
<td>25 %</td>
</tr>
<tr>
<td>Team work (problem solving, project design)</td>
<td>15 %</td>
<td>15 %</td>
</tr>
</tbody>
</table>

**ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

**ORDINARY CALL**

The Evaluation systems comprises three independent parts: theory sessions (MAG), laboratory sessions (LAB), and a research work (TI). The MAG part is graded individually and the other two will be assigned a group grade.

The MAG part will be evaluated through an individual written exam based on short questions (30%).

The LAB part will be evaluated with a group grade, considering the reviewed LAB session reports (25%), and an individual exam consisting of two software programs closely related to those developed for the LAB session reports (30%).

The TI part will be evaluated with a group grade, and the works will be publicly presented in a collective session (15%).

The MAG individual part and the LAB individual part require a minimum grade of 5/10, and the overall grade must be above 5/10, once all the parts are aggregated. MAG, LAB and TI are independent and once the minimum grade (5/10) is achieved in one part, this grade will be kept for the following calls.

**RESIGNATION:**

The students unable to follow the combined evaluation must justify their reasons with proper documentation sent to the subject lecturers, according to the procedure established by the current regulation. They will be able to prove the achievement of the learning results by means of a final evaluation consisting of: (1) a written exam (30%), a laboratory exam (55%) and (3) the work (15%).

If the student does not attend the final written exam and the laboratory exam (both), the resignation will be assumed automatically.

**EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

**EXTRAORDINARY CALL**

The extraordinary call will consist of two exams, corresponding to the MAG and to the LAB parts, respectively. Each exam comprises 50% of the final grade. Both exams require a minimum grade of 5/10.

The students failing to provide an appropriate written documentation to justify their combined evaluation resignation, must prove the adequate development of a work related to biomedical signal processing.
MANDATORY MATERIALS

MATERIALS

Materials for the MAG and the LAB sessions, as well as for the development of the work are available in the eGela platform.

BIBLIOGRAPHY

Basic bibliography

BASIC BIBLIOGRAPHY:


Detailed bibliography

ADVANCED BIBLIOGRAPHY:


Journals

JOURNALS:

IEEE Transactions on Biomedical engineering.
Physiological Measurement.

Web sites of interest

INTERNET LINKS:

http://www.physionet.org/, PhysioBank: a big repository with annotated databases of biomedical signals, including tutorials on signal processing and other software tools for visualization and processing.

NBIA (National Biomedical Image Archive): Biomedical images repository
URL: https://imaging.nci.nih.gov/ncia/login.jsf
COURSE GUIDE 2024/25

Faculty | 345 - Faculty of Engineering - Bilbao
Degree | ININD902 - Master in Industrial Engineering

COURSE
503302 - Design and Product Development Credits, ECTS: 4.5

COURSE DESCRIPTION
Product Design and Development.

The main objectives of the course are:
- To understand the process of design and development of an industrial product.
- To learn, using current tools and methods, applying and sharing existing knowledge, developing group work and improving communication skills.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

Knowledge and ability to project, design and develop industrial products.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

They are specified in:
- Knowledge and ability to project and design industrial products.
- Knowledge of product design methodologies according to its life cycle.

The student who passes the course should be able to:
- Generate conceptual designs and develop the technical specifications of industrial products.
- Design product models in a concurrent engineering environment.
- Manage the product design and development process, taking into account its life cycle, in a collaborative engineering environment.

Theoretical and Practical Contents

The fundamental theoretical contents correspond to the stages of a generic process of design and development of an industrial product:
- Nature of the design of new products.
- Stages and methods of the design process.
- Needs and technical specifications.
- Generation of conceptual solutions.
- Concept testing.
- Comparison and selection of alternatives.
- Ergonomic and aesthetic aspects.
- Materials and manufacturing processes.
- Environmental criteria.
- Design process management.
- Integrated industrial design project in a collaborative environment.

METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures</td>
<td>37.5</td>
<td>40 %</td>
</tr>
<tr>
<td>Laboratory practicals</td>
<td>75</td>
<td>40 %</td>
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</table>

TYPES OF TEACHING

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
<th>GL</th>
<th>GO</th>
<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
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<tbody>
<tr>
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</tbody>
</table>

Legend:
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Evaluation tools and percentages of final mark

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attendance and participation</td>
<td>10 %</td>
<td>30 %</td>
</tr>
<tr>
<td>Written examination</td>
<td>5 %</td>
<td>50 %</td>
</tr>
<tr>
<td>Presentations</td>
<td>10 %</td>
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<tr>
<td>Otros</td>
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<td>50 %</td>
</tr>
<tr>
<td>Practical tasks</td>
<td>20 %</td>
<td>65 %</td>
</tr>
<tr>
<td>Questions to discuss</td>
<td>5 %</td>
<td>15 %</td>
</tr>
</tbody>
</table>

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

A good performance in the course reflected in the collaborative work, carried out sequentially throughout the four-month period, and its final defense, together with the complementary exercises developed in class, may mean that the final exam is unnecessary or has little weight. The student who dispenses with the follow-up of the course will always be able to take the final exam, in this case, with a weight of 100%.

In the event that health conditions prevent the realization of a face-to-face teaching activity and/or evaluation, a non-face-to-face modality will be activated, of which students will be promptly informed.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

In the event that health conditions prevent the realization of a face-to-face teaching activity and/or evaluation, a non-face-to-face modality will be activated, of which students will be promptly informed.

MANDATORY MATERIALS

The use of the materials provided in the eGela is recommended.

BIBLIOGRAPHY

Basic bibliography

- Product Design and Development. < K.T. Ulrich and S.D. Eppinger >
- Metodología del Diseño Industrial. < M. García; V. Cloquell; T. Gómez >
- The Mechanical Design Process. < David G. Ullman >
- Diseño Industrial. Desarrollo de Producto. < F. Sanz y J. Lafargue >.
- Metodología del Diseño Industrial. < F. Aguayo y V.M. Soltero >
- Manual práctico de Ecodiseño. Operativa de implantación en 7 pasos. < IHOBE >
- Breve Historia del Diseño Industrial. < J. Heskett >.
- Diseño Industrial I y II. <Danielle Quarante>.

The following book is highly recommended:

Detailed bibliography

- ¿Cómo nacen los objetos? Apuntes para una metodología proyectual < Bruno Munari >.
- Diseño. Historia, teoría y práctica del diseño industrial. < B.E. Bürdek >
- Estrategias para la Creatividad. <G.A. Davis and J.A. Scott>.
- Color. <Frans Gerritsen>.
- Materials Selection in Mechanical Design. < Michael F. Ashby >
- Plastic Part Design for Injection Molding. < Robert A. Malloy >
- Ingeniería de Diseño (I, II y III). < P. Orlov >.
- Diseño en Ingeniería Mecánica. < J.E. Shigley and C.R. Mischke >.

(*) The books in this category can be used occasionally as a complement in some subjects.

Journals

Web sites of interest
The subject "Integrated Manufacturing Systems" is taught in the 1st Course of the Master's Degree in Mechanical Engineering and is the only compulsory subject directly related to processes and technologies for mechanical manufacturing.

The subject focuses on the study of manufacturing systems from the point of view of their necessary interaction with mechanical manufacturing processes. After having studied the fundamental description of the processes in the Degree of Industrial Technologies, the student is in a position to analyze the equipment, machinery and tools, as well as the technology necessary for the manufacture of a component. It is a subject that contributes fundamentally to the acquisition of the competences related to project, calculate and design integrated manufacturing and dimensional control systems.

The subject has been designed in a way that integrates and interacts with subjects related to materials, calculation of machine elements and production automation. On the other hand, the subject prepares the student to address, if he/she wishes to configure his/her curriculum, the proposed intensifications of Product Design and Manufacturing, and of Mechanical Design. Their programs have been coordinated with the contents of Integrated Manufacturing Systems.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

SLC ¿ Knowledge and ability to project, calculate and design integrated manufacturing systems.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

RA-1 A deep knowledge and understanding of the principles of their specialty.
RA-2 Critical awareness of the vanguard knowledge of their specialty.
RA-3 The ability to solve problems outside the standard guidelines of their engineering branch, defined incompletely or with inconsistent specifications.
RA-4 The ability to formulate and solve problems in new emerging areas of their specialty.
RA-5 The ability to use their knowledge and sufficient understanding to conceive models, systems and engineering processes.
RA-6 The ability to identify, find and obtain data.
RA-7 The ability to design and carry out research based on analysis, modeling and experimental data.
RA-8 The ability to critically analyze the data and reach conclusions.
RA-9 The ability to investigate the application of new technologies in its engineering branch.
RA-10 The ability to use their knowledge and understanding to provide solutions to problems that require knowledge beyond those of their discipline.
RA-11 The creative capacity to develop new and original ideas and methods.
RA-12 The ability to use its technical sense to work with incomplete and complex information; and with technical uncertainty.
RA-13 The ability to integrate knowledge from different fields and manage its complexity.
RA-14 A comprehensive knowledge of applicable methods and techniques and their limitations.
RA-15 Knowledge of all the implications of the practical application of engineering.
RA-16 Demonstrate the generic competences of first-cycle graduates at a higher level characteristic f the master's level.

Theoretical and Practical Contents

Unit 1. General aspects - The interaction between system and mechanical manufacturing process
1. Introduction
2. General rules for manufacturing design (DFM)
3. Automotive sector
4. White line sector
5. Aeronautical sector
6. Other sectors: energy, sport, electronics, ...

Unit 2. Sheet metal forming: material characterization
1. Introduction. Case study: manufacturing a car brake pedal
2. Advanced design of sheet forming operations:
   - Materials characterization
   - Experimental calculation of stamping operations
   - Equipment for sheet metal forming
Unit 3. The machine tool: functions, types and architecture
1. Introduction
2. Main functions of machine tools
3. Types and architectures of machine tools

Unit 4. The machine tool: structural elements and guidance systems
1. Introduction
2. Structural elements
3. Guidance systems
4. Feed drive systems
5. Main spindle drive systems
6. Measuring systems

Unit 5. Multitasking machines and hybrid machines
1. Introduction
2. Milling machine evolution
3. Evolution of the lathe
4. Multitasking machines
5. Hybrid or multi-process machines

Unit 6. Flexible manufacturing systems and transfer machines
1. Definition of Flexible Manufacturing System (FMS)
2. Advantages and disadvantages of FMS
3. Definition of families of parts and compound parts
4. Elements present in a Flexible Manufacturing System
5. Other aspects related to FMS
6. Transfer machines and custom manufacturing systems

Unit 7. Coordinate measuring machines
1. Concept and applications
2. Architectures and choice factors
3. The probe
4. Other components
5. Measurement process

Unit 8. Optical and opto-electronic instruments applied to metrology
1. Optical probes
2. Laser radar
3. Tomography

Unit 9. Measurement by interferometry
1. Fundamentals
2. Machine calibration
3. Sources of error
4. The laser tracker
5. The laser tracer

<table>
<thead>
<tr>
<th>METODOLOGIA (ACTIVIDADES FORMATIVAS)</th>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
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<td>Analytical problems - working groups (report)</td>
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<td>Computer practices - working groups (report)</td>
<td>12.5</td>
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<tr>
<td>Seminars</td>
<td>12.5</td>
<td>40 %</td>
<td></td>
</tr>
<tr>
<td>Theory</td>
<td>37.5</td>
<td>40 %</td>
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</tr>
<tr>
<td>Lectures</td>
<td>37.5</td>
<td>40 %</td>
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</tr>
</tbody>
</table>
### TYPES OF TEACHING

<table>
<thead>
<tr>
<th>Hours of face-to-face teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
<th>GL</th>
<th>GO</th>
<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horas de Actividad No Presencial del Alumno/a</td>
<td>15</td>
<td>6</td>
<td>5</td>
<td>7,5</td>
<td>8,5</td>
<td>22,5</td>
<td>6,5</td>
<td>4</td>
<td>7,5</td>
</tr>
</tbody>
</table>

Legend:  
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### Evaluation tools and percentages of final mark

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written examination</td>
<td>25 %</td>
<td>50 %</td>
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<tr>
<td>Presentations</td>
<td>10 %</td>
<td>25 %</td>
</tr>
<tr>
<td>Practical tasks</td>
<td>35 %</td>
<td>50 %</td>
</tr>
</tbody>
</table>

### ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The evaluation of the theoretical part is carried out by means of a single eliminatory exam. The weight of the final mark of the exam is 50%.

The evaluation of work derived from computer sessions and from the seminars:

The performance of these works is considered mandatory for those students who opt for continuous evaluation. As a whole, the work of the computer sessions together with a two process sheets that the students must deliver will have a relative weight of 40% of the total.

Evaluation of the industrial workshop practices

The positive evaluation of the industrial workshop practices goes through the realization of the two proposed practices. In case of doing them, the total of 10% of the final grade will be available. In each practical session the student must complete some scripts provided by the teacher and some activities in eGela.

The following table summarizes the options available to students to carry out their evaluation.

<table>
<thead>
<tr>
<th>Option 1</th>
<th>Option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-continuous evaluation</td>
<td>Continuous evaluation</td>
</tr>
<tr>
<td>Exam</td>
<td>100%</td>
</tr>
<tr>
<td>Workshop (*)</td>
<td>-</td>
</tr>
<tr>
<td>PamStamp project</td>
<td>20%</td>
</tr>
<tr>
<td>Seminars</td>
<td>-</td>
</tr>
</tbody>
</table>

(*)You must attend all the Industrial Workshop sessions.

The minimum grade in each block of option 2 must be 5 to be able to average. In the written exam (option 1 and 2), you will be asked separately to have a minimum grade of 3.5 both in theory and in the numerical problem.

### EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

In this case, the student can save the marks related to the practices and group-works.

The evaluation of the theoretical part is carried out by means of a single eliminatory exam. The weight of the final mark of the exam is 50%.

The evaluation of work derived from computer sessions and from the seminars:

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<tr>
<td>Seminars</td>
<td>-</td>
</tr>
</tbody>
</table>

(*)You must attend all the Industrial Workshop sessions.

The minimum grade in each block of option 2 must be 5 to be able to average. In the written exam (option 1 and 2), you will be asked separately to have a minimum grade of 3.5 both in theory and in the numerical problem.

**MANDATORY MATERIALS**

Slides projected by the lecturers are available in E-gela platform.

**BIBLIOGRAPHY**

**Basic bibliography**
- Tool and Manufacturing Engineers Handbook
- Society of Manufacturing Engineers
- Varios volúmenes

Fundamentals of machining and machine tools
- G. Boothroyd, W.A. Knight
- CRC Taylor and Francis
- 2006

**Detailed bibliography**
- Mecanizado de Alto Rendimiento
  - L.N. López de Lacalle, J.A. Sánchez, A. Lamikiz
  - Ediciones Técnicas Izaro
  - 2004

- Machine Tools for High Performance Machining
  - L.N. López de Lacalle, A. Lamikiz
  - Springer
  - 2009

- Mecanizado de Alta Velocidad y Gran Precisión
  - Arnone, M.
  - Editorial: El Mercado técnico SL
  - 2000

- Manufacturing Automation: Metal Cutting Mechanics, Machine Tool Vibrations, and CNC Design
  - Y. Altintas
  - Editorial: Cambridge University Press Date Published
  - 2000

**Journals**
- Información de Máquina-Herramienta Española (IMHE)
- Ediciones Técnicas Izaro

**European Tool and Mould Making**

**Web sites of interest**
- www.afm.es
- www.cem.es
- http://machinedesign.com/channel/motion-control-mechatronics
COURSE GUIDE 2024/25

Faculty 345 - Faculty of Engineering - Bilbao
Degree ININD902 - Master in Industrial Engineering

COURSE
503915 - Project Management

COURSE DESCRIPTION
The course focuses on giving an integrated vision of project management, from its genesis to its implementation, contemplating the processes of planning, organization, coordination and control of the project.

In addition to working on the technical skills that a Project Director must have, the subject presents concepts related to personal skills, such as leadership or stakeholder management. Therefore, the subject is understood as an extension of the Grade subject "Engineering Projects".

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA
G7. Knowledge and skills for integrated project management.
G8. Ability to manage research, development and technological innovation.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA
a) Reinforce general concepts of Project Management.
b) Develop the ability to evaluate the success and performance of a project through metrics.
c) To know the capabilities and leadership styles that a Project Manager must have.
d) To know and put into practice techniques for the control and monitoring of projects.
e) To know aspects of R+D+i management and the different financing structures.
f) To develop skills to define, plan, control, etc. a project integrating all the knowledge acquired throughout the degree and the subject.

Theoretical and Practical Contents

GENERAL AGENDA:
1. Project management.
2. The director of the project. The organization of the project. Functional, matrix, mixed organization charts.
3. Management of resources and stakeholders.
4. Economic and financial aspects of the project
5. Project planning.
6. Project control and monitoring
7. Leadership. Teamwork
8. Analysis of the environmental and social impact of the project
9. Legislation
10. How to present a teamwork

METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures</td>
<td>30</td>
<td>33 %</td>
</tr>
<tr>
<td>Computer practicals</td>
<td>30</td>
<td>66 %</td>
</tr>
<tr>
<td>Seminars</td>
<td>90</td>
<td>33 %</td>
</tr>
<tr>
<td>Seminars</td>
<td>90</td>
<td>33 %</td>
</tr>
</tbody>
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TYPES OF TEACHING

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
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<th>GA</th>
<th>GL</th>
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<th>TA</th>
<th>TI</th>
<th>GCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
<td>10</td>
<td>30</td>
<td>20</td>
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</tr>
<tr>
<td>Horas de Actividad No Presencial del Alumno/a</td>
<td>20</td>
<td>60</td>
<td>10</td>
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Evaluation tools and percentages of final mark

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<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written examination</td>
<td>15 %</td>
<td>25 %</td>
</tr>
</tbody>
</table>
The evaluation of the subject is carried out continuously throughout the course. The following factors are taken into account in the grading of the course:

**Exam (20%)**: As in the certification exams of the associations of project management professionals, the exam will be in the form of a test with several answer options. In order to pass the course, the exam must have obtained a grade higher than 5 out of 10.

**Seminar (50%)**: At the beginning of the course, students will be assigned to work teams of 4 to 6 people. Each team will have to deliver a work designated at the beginning of the course. The work will be delivered by uploading it to egela within the defined deadlines. The work will also be defended orally. In order to pass the course, the work must have obtained a grade higher than 5 out of 10.

**Laboratory practices (30%)**: The students will have to carry out the indicated practices and deliver the corresponding report. The work will be delivered by uploading it to egela within the defined deadlines. In order to pass the course, the work must have obtained a grade higher than 5 out of 10.

The grade of the course will be obtained by applying to each of the factors (exam, seminar, laboratory practices) its corresponding weight.

If the exam grade is lower than 5.0, the final grade for the course will be that corresponding to the exam grade.

If any of the other two parts (seminar or laboratory practices) has not passed the established cut-off mark, the final grade for the course will be that corresponding to the grade of the part not passed.

If the student decides to waive the Continuous Evaluation of this subject, he/she must communicate it in writing before the deadline for the presentation of the individual work. This date can be found in the Student Guide handed out in class and available in the eGela platform.

In this case, in order to pass the course, the student will be evaluated through a written exam that may contain additional questions to those posed in the exam to which continuously evaluated students are submitted and that will include all the contents studied throughout the four-month period corresponding to the exam. This evaluation will be completed with an oral exam that will take place on the same day of the written exam, prior appointment to the students enrolled in that call. In the oral exam the students will be asked about the contents studied in the classroom, as well as about the activities carried out during the corresponding four-month period. The student, in order to pass the course, must pass both tests. In the event that health conditions prevent the realization of a teaching activity and/or face-to-face evaluation, a non-face-to-face modality will be activated, of which students will be promptly informed (applicable to all the calls: ordinary, extraordinary and advance).

### ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

<table>
<thead>
<tr>
<th>Presentations</th>
<th>15 %</th>
<th>25 %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical tasks</td>
<td>60 %</td>
<td>80 %</td>
</tr>
</tbody>
</table>

### EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

Those who must submit to the extraordinary call will do so in the same way in which they presented themselves in the ordinary call. That is to say, those who underwent the continuous evaluation, will complete the tests (exam, seminar, laboratory practices) that they did not pass in the ordinary call.

The grade for the course will be obtained by applying the corresponding weight to each of the factors (exam, seminar, laboratory practices).

If the exam grade is lower than 5.0, the final grade of the course will be the one corresponding to the exam grade.

If any of the other two parts (seminar or laboratory practices) has not passed the established cut-off mark, the final grade for the course will be that corresponding to the grade of the part not passed.

Those who waived the continuous evaluation, will be submitted to a written and oral exam as described in the previous section (Ordinary call: orientations and waiver).

### MANDATORY MATERIALS

2. IPMA, National Competence Baselines ICB4, 2015

### BIBLIOGRAPHY

**Basic bibliography**

- IPMA, IPMA Competence Baselines ICB4, 2015
- Fleming Q., Koppelman J., "Earned Value Project Management (Fourth Edition)", Project Management Institute, 2010
Kerzner H., "R&D project management", Wiley, 2015

**Detailed bibliography**

Practice Standard for Earned Value Management, PMI, 2005
Lipke W., Schedule is different, The Measurable News Summer, 31-34, 2003

**Journals**

International Journal of Project Management
Project Management Journal
R&D Management

**Web sites of interest**

PMI https://www.pmi.org/
IPMA http://www.ipma.world/
AEIPRO https://www.aeipro.com/es/
COURSE GUIDE 2024/25

Faculty 345 - Faculty of Engineering - Bilbao
Degree ININD902 - Master in Industrial Engineering
Cycle .
Year First year

COURSE
503922 - Parametric Modelling and Design
Credits, ECTS: 4,5

COURSE DESCRIPTION

In case health conditions prevent a teaching activity or face-to-face evaluation, non-presential options will be enabled and students will be informed immediately.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA
Knowledge and skills to design and calculate integrated manufacturing systems.
Skills to design and test machines.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

Theoretical and Practical Contents
Unit 1. Introduction to industrial graphics. Graphic treatment of information.
Unit 2. CAD Methodology and techniques applied to industrial design.
Unit 3. Fundamentals of Computational Geometry. Treatment of curves, surfaces and volumes with the computer.
Unit 4. Parametric and variational modelling.
Unit 5. Virtual simulations.
Unit 6. Obtaining perspectives and realistic images.
Unit 7. Standardized representation in engineering. Standardization and dimensioning with the computer.
Unit 8. Fulfillment of an industrial design project.
Unit 9.- Industrial applications of CAD systems. Associations with close technological environments (CAM, CAE, GIS, etc.).

METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
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<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures</td>
<td>37,5</td>
<td>40 %</td>
</tr>
<tr>
<td>Laboratory practicals</td>
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TYPES OF TEACHING

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<tbody>
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Evaluation tools and percentages of final mark

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<tr>
<td>Written examination</td>
<td>15 %</td>
<td>40 %</td>
</tr>
<tr>
<td>Otros</td>
<td>15 %</td>
<td>40 %</td>
</tr>
<tr>
<td>Practical tasks</td>
<td>40 %</td>
<td>70 %</td>
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ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

MANDATORY MATERIALS
### BIBLIOGRAPHY

#### Basic bibliography

5. CAD-CAM. <Barry Hawkes>.

#### Detailed bibliography


#### Journals

#### Web sites of interest
COURSE GUIDE 2024/25

Faculty 345 - Faculty of Engineering - Bilbao
Degree ININD902 - Master in Industrial Engineering

COURSE
503923 - Product Life Cycle
Credits, ECTS: 4.5

COURSE DESCRIPTION

In case health conditions prevent a teaching activity or face-to-face evaluation, non-presential options will be enabled and students will be informed immediately.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA
IPCC4. Knowledge and skills to design security installations.
IPCC6. Knowledge and skills to perform verification and control of facilities, processes and products.
IPCC7. Knowledge and skills to perform certifications, audits, verifications, tests and reports.
TI2. Knowledge and skills to design and calculate integrated manufacturing systems.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

Theoretical and Practical Contents
Unit 1. Introduction to product life cycle.
Unit 2. Principles of product life cycle.
Unit 3. Information management systems.
Unit 4. Product structure.
Unit 5. Integration of a PLM system in other applications.
Unit 6. Implementation of a PLM system.
Unit 7. PLM strategies.
Unit 8. Integrative exercise of competencies.

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EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

MANDATORY MATERIALS
BIBLIOGRAPHY

Basic bibliography
- Product Lifecycle Management. <Michael Grieves>.
- Product Lifecycle Management: 21st century paradigm for product realisation. <Stark>.

Detailed bibliography
- The basics of process mapping. <Robert Donelio>.
- Collaborative Design and Manufacturing Methodologies and Applications. <W.D. Li - S.K. Ong>.
- Class A ERP Implementation: Integrating Lean and Six Sigma. <Donald H. Sheldon>.

Journals

Web sites of interest
COURSE GUIDE

Faculty: 345 - Faculty of Engineering - Bilbao
Degree: ININD902 - Master in Industrial Engineering
Cycle: 
Year: Second year

COURSE

COURSE DESCRIPTION


In case health conditions prevent a teaching activity or face-to-face evaluation, non-presential options will be enabled and students will be informed immediately.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA

Knowledge and skills to design and calculate integrated manufacturing systems.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

Theoretical and Practical Contents

Practice 1. Scanning an industrial part.
Practice 2. Processing and meshing of point clouds.
Practice 3. Recognition and reconstruction of parameterizable geometry.
Practice 4. Obtaining and redesigning the CAD model.
Practice 5. Verification/Inspection of real geometries by comparison.
Practice 6. Verification/Inspection of geometric and dimensional tolerances (GD & T).
Practice 8. Prototyping of an industrial assembly.

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ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

MANDATORY MATERIALS
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Basic bibliography

Reverse Engineering, An Industrial Perspective <V. Raja, K.J. Fernandes.>
Curves and surfaces for Computer Aided Design <Farin, G.>
Advance Manufacturing Technologies for Medical Applications <Ian Gibson>
Wohlers Report. Additive Manufacturing State of Industry <Terry Wohlers>

Detailed bibliography

Principles of Computer Automated Fabrication <J. Jhonson.>
Rapid Prototyping System: Fast Track to Product Realization <L. Binstock.>
Automated Fabrication: Improving Productivity in Manufacturing <M. Burns.>
Rapid Automated Prototyping: an Introduction <L. Wood>

Journals

Web sites of interest
COURSE GUIDE 2024/25

Faculty 345 - Faculty of Engineering - Bilbao
Degree ININD902 - Master in Industrial Engineering

COURSE

503955 - Integration of Industrial Systems

COURSE DESCRIPTION

The aim is to provide the student with the fundamentals, techniques and technologies used in the integration of control systems in an automated industrial environment, with emphasis on information exchange and supervision systems.

The course looks for a balance between theoretical, methodological, technological and practical subjects.
- Theoretical regarding basics on industrial systems integration and the necessary elements. It will start from the knowledge acquired in the course "Process Automation" taught in the fourth year of the Degree in Industrial Technology for the pre-intensification in Electrical, Electronics and Control Technologies.
- Methodological regarding on the design of systems for automated production systems.
- Technological regarding on the study of devices and components in industrial communications and monitoring systems.
- Practical regarding on to laboratory sessions that will be held on programmable logic controllers (PLCs) and industrial communications networks, in order to solve real automation issues.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA

Ability to design and plan automated production systems and advanced process control.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

- Use the acquired knowledge to select, design and implement integration systems within automated production environments.
- Use the acquired knowledge to select the strategies for integrating appropriate process control systems, design and validate them as a step prior to their implementation.

Theoretical and Practical Contents

THEORETICAL SUBJECTS:

5th Lesson. Distributed control systems. Monitoring and Monitoring Systems.

TEORICAL SUBJECTS DEVELOPMENT (10 sessions 1,5 hours):

1st BLOCK - Basics in Industrial Communications

1st Lesson. Introduction to Industrial Communications
Basic concepts: Data acquisition and control, transformation of analog signals, data transmission, encoding, communication protocols, basic link protocols.

2nd BLOCK - Network architecture

2nd Lesson. OSI/ISO architecture
Hierarchies of protocols, reference levels, communication between levels, data units, services and primitives, industrial network architectures, plant networks, field buses.

3rd BLOCK - Industrial Communications

3rd Lesson. Actuator/Sensor buses
3.1 Lesson. AS-i Bus: Overview of the AS-i bus, basic bus components, general characteristics, physical level, data link level, active and passive components, frames and services, profiles, functions, network diagnostics, AS-i v2.1 specification.
4th Lesson. Field buses
4.1 Lesson. PROFIBUS: Definition and standards, general features, technical features, PROFIBUS architecture, physical level - PHY (topology, transmission method), link level - FDL (transmission protocol, token passing, times, FDL services), FMA1/2 services.
4.2 Lesson. CAN: General features, data link, broadcast communication, remote frame request, bus arbitration, communication services, CAN frames, error handling.

5th Lesson. Industrial Ethernet
5.1 Lesson. Ethernet Basics: Technical features, Ethernet types, Frame types, Media access method, Ethernet problems in the industry, Network topologies, Bus components, Transmission media, Industrial Ethernet solutions.
5.2 Lesson. Ethernet TCP/IP: General features, IP stack, TCP or ISO, TCP/IP (features, Internet level, Transport level, Application level), programming interfaces.
5.3 Lesson. PROFInet: Transmission types, real-time communication, decentralized field devices, motion control, decentralized automation, network installation, IT standards, network access security, safety, process.

4th BLOCK - Distributed control systems. Monitoring and Monitoring Systems.

6th Lesson. OPC
6.1 Lesson. Classic OPC: Purpose, situation, architecture, OPC databases, objects and interfaces, OPC applications, general architecture and components, local and remote servers, OPC standards.
6.2 Lesson. OPC UA: Main Features, fundamental components, architecture levels, specifications set, transport protocols, data model, information model, services, profiles, security, information modelling (space address, nodes and references, events, historical access), applications development.

7th Lesson. Supervisory Systems

SEMINAR SUBJECTS: DEVELOPMENT (10 sessions 1,5 hour):
- 1st Seminar: Industrial communications basics - Serial communications
- 2nd Seminar: SIMATIC communications
- 3rd Seminar: AS-i
- 4th Seminar: PROFIBUS-DP
- 5th Seminar: DeviceNet
- 6th Seminar: TCP/IP
- 7th Seminar: PROFInet-IO
- 8th Seminar: OPC-DA
- 9th Seminar: OPC-UA
- 10th Seminar: SCADA systems

PRACTICAL SUBJECTS: DEVELOPMENT (8 sessions):
- 1st Practice: S7 communications (1,5 hours)
- 2nd Practice: I/O communications - PROFIBUS-DP 1/2 (2 hours)
- 3rd Practice: I/O communications - PROFIBUS-DP 2/2 (2 hours)
- 4th Practice: IE communications - TCP/IP (2 hours)
- 5th Practice: I/O communications - PROFInet-IO 1/2 (2 hours)
- 6th Practice: I/O communications - PROFInet-IO 2/2 (2 hours)
- 7th Practice: OPC-DA communications (2 hours)
- 8th Practice: Supervisory systems (2 hours)

METODOLOGIA (ACTIVIDADES FORMATIVAS)

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<tr>
<td>Seminars</td>
<td>37.5</td>
<td>40 %</td>
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<td>Laboratory practicals</td>
<td>37.5</td>
<td>40 %</td>
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<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
<td>15</td>
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<tr>
<td>Horas de Actividad No Presencial del Alumno/a</td>
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### Evaluation tools and percentages of final mark

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<tbody>
<tr>
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<td>70 %</td>
</tr>
<tr>
<td>Otros</td>
<td>0 %</td>
<td>10 %</td>
</tr>
<tr>
<td>Practical tasks</td>
<td>30 %</td>
<td>60 %</td>
</tr>
</tbody>
</table>

### ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

- Written Test: 70% (Pass score 40%)
- Seminar/Laboratory: 30% (Continuous Assessment, PS 50%)
- Disposition for Seminar Sessions: 5% (Independent work - Pass score 70%)
- Laboratory Reports: 10% (Independent work - Pass score 50%)
- Laboratory Practices: 15% (Group work - Pass score 50%)

The renounce to the ordinary call or to the continuous assessment will be notified personally and in the format agreed at the start of the course, to the coordinator or teacher of the course, 2 weeks before the end of the quarter in which the subject is taught.

In case of renounce to the continuous assessment, a seminar/laboratory test will be made.

### EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

- Written Test: 70% (Pass score 50%)
- Laboratory Test: 30% (Pass score 50%)

The renounce to the ordinary call will be notified personally and in the format agreed at the start of the course, to the coordinator or teacher of the course, 2 weeks before the date of the resist exam of the subject.

### MANDATORY MATERIALS

- Documentation corresponding to the transparencies supporting the theory, seminars and laboratory is in the virtual classroom of the subject.
- Students will be equipped with the informatics (software) needed for the development of the different works:
  - Tools for hardware devices configuration
  - Programming tools for the devices
  - Programming tools for communications
- Hardware equipment:
  - Personal computers
  - Programmable controllers - SIMATIC-S7-1500
  - Communications processors - PB-DP, PN-IO
  - Frequency inverters SINAMIC G120
  - Manufacturing cells - FESTO MecLab
  - Heterogeneous platforms - Arduino UNO / Ethernet Shield
BIBLIOGRAPHY

Basic bibliography
Title: Comunicaciones Industriales: Principios básicos
Authors: M. A. Castro Gil, G. Díaz Orueta, F. Mur Pérez, R. Sebastián Fernández, etc.
Publisher: UNED Year of Publication: 2007

Title: Comunicaciones Industriales: Sistemas Distribuidos y Aplicaciones
Authors: M. A. Castro Gil, G. Díaz Orueta, F. Mur Pérez, R. Sebastián Fernández, etc.
Publisher: UNED Year of Publication: 2010

Title: Redes de Computadoras
Authors: A. S. Tanenbaum
Publisher: Pearson Universidad. 5ª edición Year of Publication: 2013

Title: Comunicaciones Industriales. Una visión práctica con Simatic S7
Authors: V.M Sempere, J. Silvestre, J.A. Martínez
Publisher: Publisher de la Universidad Politécnica de Valencia Year of Publication: 2002

Title: Profibus. The Fieldbus for Industrial Automation
Authors: K. Bender. Carl Hanser Verlag
Publisher: Prentice Year of Publication: 1993

Title: Automating with PROFINET (2nd edition)
Authors: R. Pigan, M. Metter
Publisher: Wiley Year of Publication: 2008

Title: OPC - From Data Access to Unified Architecture
Authors: J. Lange, F. Iwanitz, T.J. Burke
Publisher: Vde Verlag Gmbh, 4ªEdición Year of Publication: 2010

Title: Sistemas de Supervisión (2ª Edición)
Authors: J. Colomer, J. Meléndez, J. Ayza.
Publisher: Cuadernos CEA-IFAC. Cetisa / Boixareu Editores Year of Publication: 2001

Detailed bibliography
Title: Comunicaciones Industriales. Guía Práctica
Authors: Aquilino Rodríguez Penín
Publisher: Marcombo, Ediciones Técnicas Year of Publication: 2008

Title: Communication Networks for Manufacturing
Authors: J.R. Pimentel
Publisher: Prentice &#8211; Hall International Year of Publication: 1990

Title: Comunicaciones Industriales
Authors: V. Guerrero, L. Martínez y R.L. Yuste
Publisher: Marcombo Year of Publication: 2010

Title: AS-Interface. The Actuator-Sensor-Interface for Automation
Authors: W.R. Kriesel, O.W. Madelung
Publisher: Publisher Hanser. 2ª edición Year of Publication: 1999

Title: Decentralization with Profibus-DP. Architecture and Fundamentals
Authors: J. Weigmann, G. Kilian
Publisher: Siemens Year of Publication: 2000

Title: Profibus PA. Instrumentation Technology for the Process Industry
Authors: Ch. Diedrich, Th. Bangemann.
Publisher: Oldenbourg Industrieverlag GmbH Year of Publication: 2002

Title: Controller Area Network. Basic, Protocols, Chips and Applications
Authors: K. Etschberger
Publisher: IXXAT Press Year of Publication: 2001
Title: OPC Unified Architecture 
Authors: W. Mahnke, S.-H. Leitner, M. Damm 
Publisher: Springer Year of Publication: 2009

Title: Sistemas SCADA (2ª Edición) 
Authors: Aquilino Rodríguez Penín 
Publisher: Marcombo, Ediciones Técnicas Year of Publication: 2007

Title: Aprenda WinCC 
Authors: J. Martínez Torres, J.M. Diez Aznar 
Publisher: Publisher de la Universidad Politécnica de Valencia Year of Publication: 2011

Journals
Automática e Instrumentación http://www.tecnipublicaciones.com/automatica/

Web sites of interest
Comité Español de Automática. http://www.cea-ifac.es/ 
PI - PROFIBUS & PROFINET International http://www.profibus.com/ 
Open DeviceNet Vendor Association http://www.odva.org
EtherCAT Technology Group http://www.ethercat.org
OPC Foundation http://www.opcfoundation.org
Robotics is a multidisciplinary subject, that deals with the elements composed by a robotic system, its design and programming. Hence, this subject covers all these areas, from the modelling, control and programming of a robot, to the integration of a robot in an automated system, providing tools to evaluate the convenience of installing a robot and the most suitable way to do it.

The subject is composed by 6 ECTS credits (60 lecture hours and 90 personal working hours). From these credits, 3 ECTS (30 hours) correspond to theory, 1.5 ECTS to seminars and 1.5 ECTS to laboratory sessions.

This subject is given in the 2nd course of the Industrial Engineering Master.

**COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT**

**COMPETENCIAS DE LA ASIGNATURA**

Ability to design and plan automated production systems and advanced process control.

**RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA**

- Use the acquired knowledge to formulate the kinematic and dynamic model of an industrial robot, design the high-level control system (trajectory generator) and low-level control system (control strategies to ensure with the established specifications), as well as knowing how to programme any given task at robot level.

- Use the acquired knowledge to design robotised cells in which the integration of industrial robots is appropriate.

**Theoretical and Practical Contents**

The contents of the subject are divided in 7 themes:

1. Introduction to automated processes using robotics
   1.1. Robot introductory aspects
   1.2. Components and subsystems of a robot

2. Kinematics
   2.1. Introduction
   2.2. Spatial location tools
   2.3. Position problem
   2.4. Velocity Problem

3. Dynamics
   3.1. Introduction
   3.2. Dynamic Modelling approaches
   3.3. Direct and Inverse Dynamics

4. Industrial Robot Programming
   4.1. Introduction
   4.2. Programming methods
   4.3. Programming system requirements
   4.4. Programming languages
   4.5. Programming examples

5. Trajectory generation - Cinematic control
   5.1. Introduction
   5.2. Trajectory generation algorithms
   5.3. Joint Interpolators
   5.4. Trajectory in task space

6. Control Strategies
   6.1. Introduction
   6.2. Monoarticular control
   6.3. Multiarticular control
6.4. Position/Hybrid/Force control

7. Selection of the robot and design of an automated cell (3 h)
7.1. Elements of a cell
7.2. Considerations in the design of a cell
7.3. Robotic cell simulators
7.4. Safety aspects of robotic cells
7.5. Case study examples
7.6. Case study:
   7.6.1. Specifications and functionality. Definition of working substations
   7.6.2. Selection of robots, peripherals and sensors
   7.6.3. Control system design
   7.6.4. Layout development Simulations

Practical/Laboratory sessions

Practical sessions on Automation in Robotised Cells
- PL-C1: Design of the robotic cell (I)
- PL-C2: Design of the robotised cell (II)
- PL-C3: Robotisation in the automotive sector. Visit to Mercedes Benz

Simulation
PL1-Position problem
PL2-Velocity problem and dynamic model
PL3-Kinematic and Dynamic Control

Programming
PL4- Industrial Robot Programming I
PL5- Industrial Robot Programming II

METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
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<td>Lectures</td>
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Evaluation tools and percentages of final mark

<table>
<thead>
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<th>Denominación</th>
<th>Ponderación mínima</th>
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<tr>
<td>Practical tasks</td>
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<td>60 %</td>
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</table>

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The following evaluation tools are used to evaluate this subject:
1.-Midterm exam. Robotised Cell Work. Written report and oral presentation to be given halfway through the course. Marking 25%.
2.-Laboratory work. Practical session preparation works and calculations will be evaluated using eGela. Marking 15%
3.-Final exam. Written exam that will be carried out in the official dates defined by the Faculty, with short question and problems. Marking 60%

In order to pass the subject it will be required to obtain at least the 50% the value of the Final Exam. If this is achieved, then the points obtained in the midterm exam and the laboratory work will be added.
In order to pass the subject it will be required to obtain at least the 50% the value of the Final Exam. If this is achieved, then the points obtained in the midterm exam and the laboratory work will be added.

RESIGNATION TO THE CALL
A no-show in the final exam will be considered a resignation to the call.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The same tools defined for the ordinary call will be defined:
1.-Laboratory work. Practical session preparation works and calculations will be evaluated using eGela. Marking 15%.
2.-Final exam. Written exam that will be carried out in the official dates defined by the Faculty, with short question and the development of several problems both on the robotic cell part and on the industrial robot part. Marking 85%.

The evaluation tools 1 and 2 will be maintained from the ordinary call, being part of the continuous evaluation of the subject.

In order to pass the subject it will be required to obtain at least the 50% the value of the Final Exam. If this is achieved, then the points obtained in the midterm exam and the laboratory work will be added.

RESIGNATION TO THE CALL
A no-show in the final exam will be considered a resignation to the call.

MANDATORY MATERIALS

Support documentation for the theory, seminars and laboratory can be found in the virtual classroom of the course.

"Automatización y Robótica" (2024). I. Cabanes, A. Mancisidor, A. Zubizarreta. Documentación de apoyo a la teoría y seminarios. Sección de Publicaciones; también disponible en el aula virtual de la asignatura.

"Laboratorio Automatización y Robótica" (2024) A. Mancisidor, I. Cabanes, A. Zubizarreta. Documentación de apoyo al Laboratorio. También disponible en el aula virtual de la asignatura.

BIBLIOGRAPHY

Basic bibliography
- INTRODUCTION TO ROBOTICS: MECHANICS AND CONTROL. Ed. Addison Wesley. 2005
- INSTRUMENTACIÓN INDUSTRIAL. A. Creus. Ed. Marcombo, 2005

Detailed bibliography

Journals
- ADVANCED ROBOTICS
- IEEE ROBOTICS & AUTOMATION MAGAZINE
- INTERNATIONAL JOURNAL OF ROBOTICS & AUTOMATION
- ROBOTICS AND COMPUTER-INTEGRATED MANUFACTURING
- INTERNATIONAL JOURNAL OF COMPUTER VISION
- JOURNAL OF VISION
- VISION RESEARCH

Web sites of interest
- Grupo de Visión por Computador CEA-IFAC http://ceavision.unileon.es/
- UKIVA - Información Visión http://www.ukiva.org/
- OpenCV - Software libre Visión
  o http://sourceforge.net/projects/opencv/
  o http://opencv.willowgarage.com/wiki/Welcome
COURSE GUIDE 2024/25

Faculty 345 - Faculty of Engineering - Bilbao
Degree ININD902 - Master in Industrial Engineering

COURSE
503959 - Management of Hydraulic Resources and Hydro-Electric Plants

Credits, ECTS: 6

COURSE DESCRIPTION
With this subject the student will be provided with an elementary theoretical base to solve specific problems, typical within engineering, in the management of hydraulic resources and hydroelectric facilities.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA
Knowledge and skills to perform verification and control of facilities, processes and products.
Knowledge and skills for the design and analysis of thermal machines and engines, hydraulic machines and industrial heating and cooling facilities.
Knowledge and skills to project and design electrical and fluid facilities, lighting, air conditioning and ventilation, energy saving and efficiency, acoustics, communications, home automation and intelligent buildings and security facilities.
Project, calculate, design and manage hydraulic resources and hydroelectric plants.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

Theoretical and Practical Contents


Topic 2. Physical principles of hydroelectric exploitation. Review of the principles of fluid mechanics.

Topic 3. Hydraulic systems for the use of resources. Regulation and energy accumulation. Description of the works to be done in order to take advantage of the different resources.


Topic 5. Hydroeconomy and master plan for the design of an exploitation. Integral water resources the cost, price and value of water. The cost of a hydroelectric power station. Complete master plan.

METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
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<tbody>
<tr>
<td>Computer practicals</td>
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<td>Field practicals</td>
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<td>Classroom practicals</td>
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<td>Lectures</td>
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TYPES OF TEACHING

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<td>Hours of face-to-face teaching</td>
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<tr>
<td>Horas de Actividad No Presencial del Alumno/a</td>
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<th>Denominación</th>
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</thead>
<tbody>
<tr>
<td>Otros</td>
<td>50 %</td>
<td>50 %</td>
</tr>
<tr>
<td>Practical tasks</td>
<td>50 %</td>
<td>50 %</td>
</tr>
</tbody>
</table>
Continuous evaluation will be done, valuing the attendance to class (25%), the participation (25%) and the delivery of the works on the subjects of the subject (50%).

In the ordinary convocatory, the student can be evaluated through the final evaluation system (exam for 100% of the subject), if requested to the teacher responsible for the Group in which he / she has enrolled (in writing, by email, within the established term of the first 9 weeks of the course). In this case, the structure of the final exam for 100% of the subject will maintain identical percentages and criteria for calculating the final grade (through specific exercises of each task).

Failure to perform the face-to-face task and not request a final evaluation means a waiver of the call.

Note.- in case sanitary conditions do not allow carrying out one face-to-face teaching task and/or evaluation, a non face-to-face modality will be activated and students will be informed punctually (applicable to all calls: ordinary, extraordinary and advance of call).

In the extraordinary convocatory, the student will be assessed by exam for 100% of the subject maintaining identical percentages and criteria for calculating the final grade.

Failure to submit to the final examination of the extraordinary call supposes the resignation to this convocatory.

**MANDATORY MATERIALS**

- Energía Minihidráulica. Publicación del Ente Vasco de la Energía. (Bilbao).
- Tratado básico de presas y obras hidráulicas. Eugenio Vallarino

**BIBLIOGRAPHY**

**Basic bibliography**

- Centrales Hidroeléctricas. Ediciones Paraninfo
- Saltos de agua y presas de embalse. Gómez Navarro.

**Detailed bibliography**


**Journals**

- Tecnología del agua
- Ingeniería del agua

**Web sites of interest**

- ftp://ftp.ehu.es/cidirb/profs/inpibbeg/material_08_09/08_09_3_adicional_bestelakoa/Fernando_Santos_MH_07-08.pdf
- http://www.youtube.com/watch?v=htT_8sFJx1w
a) The objective of “Fluid power” is to study the generation, transmission and control of motions and forces by pressurized oil. This liquid is an incompressible fluid capable of transmitting high forces at a very high pressure level. This subject completes the core knowledge about hydraulic pumps by introducing the positive displacement machines. This way, the students can perceive a complete perspective of the group of hydraulic machinery.

The subject is developed with a high experimental and practical orientation, so that the student will be able to design a wide variety of fluid power circuits, with the corresponding computational simulation and experimental testing in the hydraulic benches of the laboratory.

The abilities acquired in the subject of fluid power will permit to apply this technique in different industrial fields such as heavy machinery, aircrafts, watercrafts or programmed manufacturing processes. All the necessary components for the fluid power systems will be selected according to the criteria studied in the subject.

b) “Fluid Power” contributes significantly to the development of the competencies under the Industrial Technology Module, in all the subjects related with the positive displacement machinery and its application in any industrial generic projects, integrated manufacturing processes, process control systems or automatic manufacturing systems.

c) The horizontal and vertical coordination of the subject with others is assured by the internal relationship of all the subjects in the Hydraulic Engineering majoring studies and the collaborative work developed by the lecturers in relation to the common competencies developed by the students in the master’s degree and the module (of Industrial Technologies in this case).

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA

TI5. Knowledge and capacities for the design and analysis of thermal machinery and motors, hydraulic machinery and industrial heat and cooling facilities.

TI8. Capacity to design and project automated manufacturing systems and advanced control of processes.

IH3. To project, calculate and design fluid networks and fluid power (pneumatic and oil hydraulic) components.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

- Understanding the operation of the machinery and facilities of oil hydraulics by means of the design of its components, basic physical fundamental laws and characteristic curves.
- Planning and designing oil hydraulic facilities.
- Understanding the regulation and control of the processes related to the field of the oil hydraulic machinery and facilities for their optimum management.
- Performing the operation, management, experimental testing and analysis of oil hydraulic facilities.
- Developing technical and diagnostic reports.

Theoretical and Practical Contents

CHAPTER 1: INTRODUCTION TO FLUID POWER

1.1. Definition of Fluid Power
1.2. Properties of oil
1.2.1. Viscosity
1.2.2. Density
1.2.3. Fluency point
1.2.4. Compressibility
1.2.5. Vapour pressure, saturation pressure, cavitation
1.2.6. Emulsion removing capacity
1.2.7. Foam generation
1.2.8. Flammability
1.3. Fundamental laws
1.3.1. Conservation of mass
1.3.2. Conservation of energy
1.3.3. Positive displacement principle
1.3.4. Hydrostatic law and Pascal principle
1.4. Energy transformation
1.5. Advantages and disadvantages of pressurized oil
1.6. Comparison between fluid power pneumatic systems and fluid power hydraulic systems.

CHAPTER 2: THE HYDRAULIC GROUP

2.1. Introduction
2.2. Hydraulic tanks
2.3. Hydraulic pumps
2.3.1. General concepts
2.3.2. Alternative pumps: radial pistons, axial pistons (aligned pistons, inclined swash-plate type, oscillating wobble-plate type, bent axis type), oscillating pistons.
2.3.3. Rotary pumps: external gear, lobe type, screw pump, internal gear (gerotor type and crescent seal type), vane pump

2.4. Filters

CHAPTER 3: ACTUATORS

3.1. Introduction
3.2. Cylinders
3.3. Limited rotation actuators
3.4. Rotary motors
3.5. Hydraulic grippers

CHAPTER 4. VALVES AND HYDRAULIC ACCESORIES

4.1. Introduction
4.2. Pressure valves
4.2.1. Safety relief valves
4.2.2. Sequence valves
4.2.3. Reducing valves
4.2.4. Counterbalance valves
4.2.5. Unloading valve
4.3. Valves for fluid distribution
4.3.1. Directional control valves
4.3.2. Check valves
4.4. Valves for flow regulation
4.4.1. Flow restrictor (uncompensated)
4.4.2. Pressure compensated flow control valve
4.4.3. Flow divider valve
4.5. Proportional valves
4.5.1. Directional (flow control)
4.5.2. Relief valves
4.5.3. Reducing valves
4.6. Servo valves
4.6.1. Feedback signal by pressure
4.6.2. Feedback mechanical signal
4.6.3. Feedback electrical signal
4.7. Cartridge valves
4.8. Other valves
4.9. Accumulators
4.10. Hydraulic-Pneumatic systems
4.10.1. Hydraulic-neumatic converter
4.10.2. Oil breking cylinder
4.10.3. Pressure multiplier
4.11. Other accessories
4.11.1. Manometers
4.11.2. Flowmeters
4.11.3. Pressure switch
4.11.4. Heat exchanger
4.11.5. Joining elements

CHAPTER 5: FLUID POWER HYDRAULIC CIRCUITS

5.1. Differential circuit
5.2. Circuit with actuator in series
5.3. Circuit with actuator in parallel
5.4. Circuit with heavy traction loads
5.5. Sequence control in two cylinders
5.6. Hydraulic press
5.7. Drill with different forward velocities
5.8. Circuits for a rotary hydraulic motor
5.9. Hydraulic maintenance

CHAPTER 6: CALCULATIONS IN A HYDRAULIC CIRCUIT

6.1. Cylinder selection
6.2. Directional valve
6.3. Pipes
6.4. Pump selection
6.5. Safety valve
6.6. Accumulator
6.7. Tank
6.8. Refrigerator

LAB EXPERIMENTS
Practical 1: Gear pump, blocking valve, manometer
Practical 2: Pressure relief valve
Practical 3: Directional valve
Practical 4: Simple effect cylinder
Practical 5: Double effect cylinder
Practical 6: Check valve
Practical 7: Flow restrictor valve
Practical 8: Compensated flow control valve
Practical 9: Fluid flow resistance
Practical 10: Differential circuit
Practical 11: Pressure counterbalance
Practical 12: Flow control as a function of the stroke
Practical 13: Flow restrictor with check valve in parallel
Practical 14: Pilot operated check valve
Practical 15: Inflow control
Practical 16: Outflow control
Practical 17: Pressure operated sequence of actuators
Practical 18: Pressure reducing valve
Practical 19: Pilot operated pressure relief valve
Practical 20: Hydraulic motor
Practical 21: Accumulator
Practical 22: Circuit with fast/slow motion

METODOLOGIA (ACTIVIDADES FORMATIVAS)

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<thead>
<tr>
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<tr>
<td>Otros</td>
<td>40 %</td>
<td>60 %</td>
</tr>
<tr>
<td>Practical tasks</td>
<td>40 %</td>
<td>60 %</td>
</tr>
</tbody>
</table>

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

GRADING POLICY AND TASKS: the grading system corresponds to "continuous assessment".

T1: 40% practical tasks
T2: 60% Laboratory experiments

The attendance to classes (either theoretical or practical) is part of the evaluation of each task within the continuous evaluation.

In the ordinary call the student can be evaluated by the final exam system (by an exercise on 100% of the subject), providing they claim for it to the teacher responsible of the group where they are enrolled in. The request must be
forwarded by electronic mail during the 9 first weeks of the year. In this case the structure of the exam will maintain the same percentages and calculation method to obtain the final mark from the 2 tasks of the subject T1 and T2 (assessed through specific exercises).

The absence of in-person task T2 and not having requested the final exam will be considered a withdrawal from the ordinary call.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

In the extraordinary call, the student has to sit an exam with a grading weight of 100% with the same percentages and calculation criterion of the final mark as in the ordinary call.

Not sitting the final exam T1 in the extraordinary call will be considered a withdrawal from that call.

MANDATORY MATERIALS

- HRE-HIDRAULIC, COMPENDIUM OF LAB PRACTICALS. 2018.

BIBLIOGRAPHY

Basic bibliography
4. Roldán Viloria, José. NEUMÁTICA, HIDRÁULICA Y ELECTRICIDAD APLICADA. Editorial Thomson-Paraninfo. 2001

Colección de películas:
1. Introduction to Fluid Power, Meridian Education Corporation (19 min)
2. Fluid Power Technology: At Work, Meridian Education Corporation (23 min)
3. Fluid Power Technology: Pumps, Lines, Filters, Meridian Education Corporation (28 min)
4. Fluid Power Technology: Actuators, Meridian Education Corporation (22 min)
5. Fluid Power Technology: Control Mechanisms, Meridian Education Corporation (25 min)

Detailed bibliography

Journals

FLUIDOS: Oleohidráulica, Neumática y Automoción. PUBLICA S. A., Barcelona, España. ISSN 0211-1136

Web sites of interest

Videos de clases (nível básico, generalista):
1) Will Durfee and James D. Van de Ven
Dpt. Mechanical Engineering, University of Minnesota
https://www.youtube.com/playlist?list=PL_onPhFCKVqhN-72royiGW36C-kFBpY1S

2) Jim Pytel
Bigbadtech channel (funded by National Science Foundation)
https://www.youtube.com/playlist?list=PLdnqjKaksr8ruhw85YYSOS6EWLhVVmSKm

Casas comerciales:

GLUAL:
http://www.glual.es/es/home.html
HINE:
http://www.hine.es/

ROQUET:

ENERPAC:
http://www.enerpac.com/es

Bosch Rexroth:
http://www.boschrexroth.com/es/es/

PARKER:
http://www.parker.com/

EATON: (VICKERS, AEROQUIP IBÉRICA, & #8230;)
http://www.eaton.com/

Danfoss:
http://powersolutions.danfoss.com/home/

WALVOIL:
http://www.walvoil.com/

HIDRAM
http://www.hidram.com/

MOOG:
http://www.servovalve.com/
This course provides a global perspective on the mechanical behavior of engineering materials (including Fracture Mechanics) in current knowledge. In it, a comparative analysis is carried out between metallic, ceramic, polymeric and composite materials, and their mechanical properties are related to the atomic-crystalline structure, the manufacturing and processing of the materials and the service conditions of the materials.

The elastic, plastic, viscous characteristics and behavior against brittle fracture are studied, analyzing these situations based on variables such as service temperature or external aggressive agents. With all this, interesting conclusions are obtained regarding the design, use and selection of materials in their engineering applications.

### COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

**COMPETENCIAS DE LA ASIGNATURA**

- IM8-Know the principles and mechanisms that govern the deterioration processes of materials as well as the methods to combat them.
- IM7-Select materials for precise applications taken away the corresponding specifications.
- IM3-Understand the structure, properties and applications of the different families of materials: metallic, polymeric, ceramic (including glass), composite and functional.
- IM10-Analyze complex and multidisciplinary problems.

**RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA**

Knowledge and understanding of the mechanical behavior of materials
- Correctly interpret results.
- Ability to carry out bibliographic searches, consults and judiciously use of databases and other information sources.
- Ability and skill to interpret results and reach conclusions in the field of materials engineering.
- Ability to effectively communicate information, ideas, problems and solutions in the field of engineering.
- Ability to cooperate with people from other disciplines.

### Theoretical and Practical Contents

Types of materials versus mechanical behavior. Failures, economic importance. Possibilities of improvement of the current materials.


### METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory practicals</td>
<td>12</td>
<td>50 %</td>
</tr>
<tr>
<td>Classroom practicals</td>
<td>30</td>
<td>40 %</td>
</tr>
<tr>
<td>Lectures</td>
<td>70,5</td>
<td>38 %</td>
</tr>
</tbody>
</table>
**TYPES OF TEACHING**

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
<th>GL</th>
<th>GO</th>
<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
<td>27</td>
<td>12</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horas de Actividad No Presencial del Alumno/a</td>
<td>43.5</td>
<td>18</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

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 tools and percentages of final mark**

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentations</td>
<td>20 %</td>
<td>40 %</td>
</tr>
<tr>
<td>Practical tasks</td>
<td>40 %</td>
<td>60 %</td>
</tr>
<tr>
<td>Questions to discuss</td>
<td>10 %</td>
<td>20 %</td>
</tr>
</tbody>
</table>

**ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

- The evaluation system will be continuous with a final exam. The weighting will be as detailed below:
  - Exhibitions: 40% mark
  - Practical work: 40% mark
  - Theory written exam: 20% mark
- Evaluation of the comprehensive ability to use theoretical-practical knowledge to solve open problems on materials.
- Evaluation of the communicative capacity of knowledge both in writing and speaking.
- Evaluation of the ability to work in a team making proposals, analyzing contributions from others, discussing ideas and executing pertinent actions. Interpersonal skills.
- Degree of use of the lessons taught in the syllabus and in the practical exercises in the classroom. Assessment of the ability to work autonomously.

The student has the right to waive the continuous assessment and will have to inform the teacher as soon as possible and always before 3 weeks from the start of the course.

In the case in which the student wants to resign, the final exam will be carried out with the rest of his classmates and it will be appropriate to add more questions.

By default, the student who does not appear for the exam will be considered to have resigned.

All this is properly reported on the master's website:

http://www.ehu.eus/es/web/masteringenieriamaterialesavanzados/egutegia-eta-ordutegia

In the web section "Schedule and calendar/SCHEDULE" in May of the previous year, the schedules for the following year are already posted, including the dates of the ordinary calls.

In addition, the 3rd and 4th call courts are posted on the following link:

http://www.ehu.eus/es/web/masteringenieriamaterialesavanzados/aurkezpena

On the other hand, in the first commented link you can download the Word file with the necessary explanations to proceed to make a resignation (section "Schedule and calendar / TEACHING CALENDAR") according to its section (first page):

CANCELLATION OF CALL.

**EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

In the case in which the student wants to resign, the final exam will be carried out with the rest of his classmates and it will be appropriate to add more questions.

In addition, it is adequately informed on the master's website:

http://www.ehu.eus/es/web/masteringenieriamaterialesavanzados/egutegia-eta-ordutegia

In the web section "Schedule and calendar/SCHEDULE" in May of the previous year, the schedules for the following year are already posted, which include the dates of the extraordinary calls.
### MANDATORY MATERIALS

Todo el material docente necesario para seguir la asignatura es facilitado por el profesorado en el servicio de reprografía de la escuela. Así mismo si algún alumno quisiera el formato digital también podrá ser puesto a su alcance en caso de que así se lo haga saber a la profesora.

### BIBLIOGRAPHY

**Basic bibliography**

**Detailed bibliography**

**Journals**
- Theoretical and Applied Fracture Mechanics
- Engineering Fracture Mechanics
- International Journal of Fracture

**Web sites of interest**
- www.sciencedirect.com
COURSE DESCRIPTION

Contrary to popular belief, space is a place full of activity. Although the density of matter is very low, we have a plasma consisting of charged particles of very different energies. The behavior of this plasma is influenced by the variable behavior of the sun's magnetic field, which in turn is also the main source of charged particles, emitted in what is known as the solar wind. The interaction of this complex system of particles and fields with the Earth's magnetic field gives rise to the appearance of radiation belts and auroras.

The enormous amount of energy released by the sun in the form of radiation and particles can damage and even destroy satellites, and it affects life very seriously, limiting the possibilities of space travel. Knowledge of the properties of the space environment is therefore essential in the development of any space program, and must be part of any space science and technology program.

As a compulsory subject, Space Physics will be taught in the first term. The subject is related and reinforce contents taught in other compulsory subjects, such as Orbital Movement (different orbits cross different space environments) and Spaceships II (in relation to the peculiarities of the propagation of the EM waves in the space environment and communication problems related to disturbances in this environment). The subject provides a basis for the study of elective subjects such as Astronomy and Astrophysics, Solar System, and from a more technological point of view, Materials for space II.

The prerequisites for this course are a basic knowledge of electromagnetism and calculus including differential equations. These prerequisites are guaranteed by the required undergraduate qualifications.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA

Knowledge of the physical properties of the space environment, and the implications of this medium on space development programs.

Ability to deduce quantitative properties of the behaviour of space plasmas and their interactions with objects in space.

Ability to analyse, working as a team with people of different training, the different aspects of the influence of the spatial environment on a project, effectively communicating the competences of their field of specialization to other team members.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

At the end of the course the student should be able to:

<ol>
<li> Define a plasma and the most important parameters that define its behavior.</li>
<li> Describe the basic characteristics of the solar atmosphere, the solar cycle, the solar wind and the Earth's magnetosphere.</li>
<li> Explain through physical models some of these characteristics (for example, the position of the magnetopause, the direction of the interplanetary magnetic field, the temperature of sunspots...)</li>
<li> Know the different types of waves that propagate in the interplanetary medium and their basic properties.</li>
<li> Describe the different Space Weather phenomena of technological relevance.</li>
<li> Know some information databases about the space environment and the Space Weather prediction portals.</li>
<li> Know different packages of models frequently used in the study of the spatial environment.</li>
</ol>

Theoretical and Practical Contents

<ol>
<li> Introduction to the space environment.</li>
</ol>
**Part I: Plasma Theory**
- Electromagnetism. Review of concepts.
- Physics of Plasmas.
- Magnetohydrodynamics.
- Movement of charged particles in electromagnetic fields.
- Waves in plasmas

**Part II: The space environment**
- The sun: Interior and atmosphere. Variable activity in the sun..
- The solar wind and the interplanetary magnetic field
- The Earth's magnetosphere
- The ionosphere
- Influence of solar activity on the magnetosphere: Magnetic storms
- Space weather. Current status and technological impact

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**METODOLOGIA (ACTIVIDADES FORMATIVAS)**

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utilization of Computer Programs</td>
<td>2</td>
<td>50 %</td>
</tr>
<tr>
<td>Individual work and/or group work</td>
<td>10</td>
<td>40 %</td>
</tr>
<tr>
<td>Exercises</td>
<td>28</td>
<td>36 %</td>
</tr>
<tr>
<td>Expositive classes</td>
<td>35</td>
<td>43 %</td>
</tr>
</tbody>
</table>

**TYPES OF TEACHING**

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
<th>GL</th>
<th>GO</th>
<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
<td>15</td>
<td>4</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>16</td>
<td>18</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Legend:
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- GCL: Applied clinical-based groups
- TA: Workshop
- TI: Industrial workshop
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**Evaluation tools and percentages of final mark**

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written examination</td>
<td>10 %</td>
<td>60 %</td>
</tr>
<tr>
<td>Essay, Individual work and/or group work</td>
<td>0 %</td>
<td>30 %</td>
</tr>
<tr>
<td>Exhibition of work, readings...</td>
<td>0 %</td>
<td>10 %</td>
</tr>
<tr>
<td>Realización de prácticas (ejercicios, casos o problemas)</td>
<td>20 %</td>
<td>60 %</td>
</tr>
</tbody>
</table>

**ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

**Problems:** 50% of the final grade. There will be three hand-outs consisting of a set of problems that will be marked and returned to the students. The correct solutions will be published in EGELEA as feedback. The grading of problems will take into account whether the answers are correct (when they are closed answers) or the depth of the analysis (when they are open answers). In addition, precision of notation, adequate use of physical laws and correct use of units and significant figures will be valued.

**Minitests:** 10% of the final grade. The minitests will consist of a short question related to content of previous lectures and hand-outs. They will be answered individually in approximately 10 minutes during lectures.

**Essay:** 30% of the final grade. They will be assessed taking into account the rigor and quality of writing, its adjustment to the contents of the subject, and the correct reference to used sources. Failure to comply with formal requirements, particularly those related to essay length, will lower the final grading. Plagiarism will be penalized with a no pass.

**Oral presentation of the essay:** 10% of the final grade. It will be assessed taking into account the quality of the support material, the precision of speech and correct body language. Very long or very short presentations will be penalized.

**No-show**
People who do not submit at least two of the three problem sets and/or do not present the essay will be considered as "no show" in the ordinary call.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

To pass the subject in the extraordinary call, the students will have to present the problem sets and a written essay. They will also be offered the possibility of taking a short exam to improve the grading of the mini-tests.

MANDATORY MATERIALS

BIBLIOGRAPHY

Basic bibliography
<ul>
<li>Basic Space Plasma Physics, W. Baumjohann y R.A. Treumann, Imperial College Press 1997</li>
<li>Space Weather, environment and societies, J.Lilensten J.Bornarel, Springer</li>
</ul>

Detailed bibliography
<ul>
<li>The Space Environment, A.C. Tribble, Princeton University Press 2003</li>
</ul>

Journals

Web sites of interest
<ul>
<li>Space Weather: </li>
<li>http://www.swpc.noaa.gov/</li>
<li>http://www.esa-spaceweather.net/spweather/current_sw/index.html</li>
<li>http://sohowww.nascom.nasa.gov/spaceweather/</li>
<li>http://spaceweather.com/</li>
<li>A few relevant missions</li>
<li>SDO http://sdo.gsfc.nasa.gov/</li>
<li>SOHO http://sohowww.nascom.nasa.gov/</li>
<li>TRACE http://trace.lmsal.com/</li>
<li>HINODE http://solarb.msfc.nasa.gov/</li>
<li>ULYSSES http://ulysses.jpl.nasa.gov/</li>
<li>Summary of NASA and ESA missions</li>
<li>http://orbits.esa.int/science/index.htm</li>
</ul>
COURSE GUIDE 2024/25

Faculty 345 - Faculty of Engineering - Bilbao
Degree CITEC401 - Master in Space Science and Technology

COURSE

501991 - Fundamentals of Optical Instrumentation Credits, ECTS: 3

COURSE DESCRIPTION

This is a compulsory subject as it is one of the master’s backbones. It provides the foundations for more specific optional courses such as "Design of Optical Systems and Adaptive Optics" and "Space Interferometry". It is also a good starting point for "Antennas and Radio-Telescopes". As a basic compulsory course, "Fundamentals of Optical Instrumentation" will be taught before these optional courses, which secures strong foundations to proceed with the masters studies.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

The students are expected to know and explain the origin of laws and theorems in Optics.

The students are expected to understand how optical instruments work, based on Optics laws and theorems.

The students are expected to solve mathematical problems related to complex optical systems, as well as present the results in a clear and comprehensive manner.

The students are expected to be able to take, analyze and interpret data on instrumentation-related magnitudes, as well as present conclusions.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

1. Knowledge, understanding and application of Geometrical Optics laws in image formation by optical systems
2. Knowledge and understanding of the different types of optical aberrations in image formation by optical systems
3. Knowledge, understanding and application of Physical Optics in the formation of interference and diffraction patterns.
4. Understanding of diffraction-limited optical quality of images.
5. Deep understanding of the following optical systems: eye, magnifying glass, telescopes and cameras.
6. Usage of experimental set-ups to take data on images provided by complex optical systems.
7. Usage of experimental set-ups to take data on interference and diffraction patterns.
8. Ability to write laboratory reports in a clear, comprehensive and concise manner.

Theoretical and Practical Contents

1. Ray Optics
2. Paraxial Optics
3. Aberrations
4. Aperture and Field Limitations
5. Interference and diffraction
6. The eye
7. Magnifying glasses and eyepieces
8. Telescopes
9. Cameras

METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utilization of Computer Programs</td>
<td>4</td>
<td>50 %</td>
</tr>
<tr>
<td>Laboratory/Field</td>
<td>6</td>
<td>67 %</td>
</tr>
<tr>
<td>Exercises</td>
<td>22</td>
<td>45 %</td>
</tr>
<tr>
<td>Expositive classes</td>
<td>43</td>
<td>33 %</td>
</tr>
</tbody>
</table>

TYPES OF TEACHING

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
<th>GL</th>
<th>GO</th>
<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
<td>14</td>
<td></td>
<td>10</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horas de Actividad No Presencial del Alumno/a</td>
<td>29</td>
<td></td>
<td>12</td>
<td>4</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

The assessment will be as follows:
- For each chapter, the students will solve a number of problems and hand them in in one week. The problems will be graded on a 10 scale and handed out to the students. Students can return an amended version of the solutions in one week, but with a maximum available grade of 7. The average grade of all problems in the course will contribute 25% to the final grade.
- Students will complete two laboratory sessions (in groups of two or three). Following the laboratory instructions, each group will hand in a laboratory report for each session. The average grade in the laboratory work will contribute 25% to the final grade.
- At the end of the course the students will take a written exam, with all exercises equally weighted. The exam grade will contribute 50% to the final grade. A minimum exam grade of 3.5 is required to pass the course.

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written examination (theory)</td>
<td>35 %</td>
<td>70 %</td>
</tr>
<tr>
<td>Internship Report/Summary</td>
<td>15 %</td>
<td>35 %</td>
</tr>
<tr>
<td>Realización de prácticas (ejercicios, casos o problemas)</td>
<td>15 %</td>
<td>35 %</td>
</tr>
</tbody>
</table>

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

- The extraordinary exam will be a written exam covering 100% of the contents, including the laboratory work. All exercises will be equally weighted to compute the final grade.

MANDATORY MATERIALS

"Physics": vol II. Typler, Ed. Freeman & Co. 2008
"Física" Alonso Finn, Ed Addison-Wesley 1995.
"Principios de Instrumentación optica" Alberto Oleaga, 1998

BIBLIOGRAPHY

Basic bibliography
"Physics": vol II. Typler, Ed. Freeman & Co. 2008
"Física" Alonso Finn, Ed Addison-Wesley 1995.
"Principios de Instrumentación optica" Alberto Oleaga, 1998

Detailed bibliography
"Optica" Hecht-Zajac, Ed. Addison-Wesley.
"Optica" J. Casas, Ed. Univ Zaragoza.
"How to make a telescope", J. Texereau, Ed. William Bell.
"The design and Construction of Large Optical telescopes" P. Bely, Springer-Verlag 2003
"Reflecting Telescope Optics I y II", R.N. Wilson, Springer.
"Color and Light in Nature" D. Lynch, Cambridge Univ. Press.

Journals

Web sites of interest
<b>Simulación óptica geométrica y óptica física:</b>
http://www.enciga.org/taylor/lv.htm
http://www-optics.unine.ch/education/optics_tutorials/optics_tutorials.html

<b>Óptica y ondas en general:</b>
http://www.cordonline.net/laserapplets/

<b>Instalaciones de Telescopios en general:</b>
http://www.gemini.edu/
http://hubblesite.org/the_telescope/hubble_essentials/
http://www.keckobservatory.org/
http://keckobservatory.org/gallery
http://www.gtcdigital.net/

<b>VLTI</b>
http://www.eso.org/sci/facilities/paranal/instruments/overview.html
http://www.eso.org/sci/facilities/paranal/telescopes/vlti/index.html

<b>LISA-Pathfinder</b>
http://www.esa.int/esaSC/120376_index_0_m.html

<b>Telescopio de Rayos X; XMM-Newton</b>
http://www.esa.int/esaSC/120385_index_0_m.html

<b>ESA con todas las misiones</b>
http://sci.esa.int/science-e/www/area/index.cfm?fareaid=1
COURSE DESCRIPTION
This course presents the fundamentals of the internal structure of materials and their relationship with their properties, emphasizing the materials used in space technology. These fundamentals will be useful in subjects of later courses such as "Space Mechanical Structures", "Non Destructive Testing: Space Materials", "Materials for Space: II. Applications" and "Detectors and Sensors".

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA
Provide the student with well-founded knowledge related to heat transfer mechanisms and the thermal properties of the materials used in space technology.

To acquire the needed knowledge to solve complex problems related to thermal behaviour and heat transfer on materials.

To understand the mechanics of the measurements of thermal properties in materials in the high and low temperature range.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA
The learning outcomes that students are expected to achieve by the end of the subject are:
- Demonstrate detailed understanding of the basic concepts related to Material Science and Technology, as well as their application for the reasoned resolution of problems related to space technology.
- Mastery of instrumentation related to the measurement of thermal properties of all types of materials.

Theoretical and Practical Contents
1.- Materials for space: metal alloys, ceramics and composites
2.- Heat diffusion mechanisms: conduction, convection and radiation
3.- Thermal properties of space materials: conductivity, specific heat, thermal expansion
4.- Thermal properties at low temperatures: cryogenics
5.- Thermal properties at high temperatures: furnaces

METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory/Field</td>
<td>10</td>
<td>50 %</td>
</tr>
<tr>
<td>Exercises</td>
<td>25</td>
<td>40 %</td>
</tr>
<tr>
<td>Expositive classes</td>
<td>40</td>
<td>38 %</td>
</tr>
</tbody>
</table>

TYPES OF TEACHING

<table>
<thead>
<tr>
<th>Types of teaching</th>
<th>M</th>
<th>S</th>
<th>GA</th>
<th>GL</th>
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<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
<td>15</td>
<td>10</td>
<td>5</td>
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<td></td>
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<tr>
<td>Horas de Actividad No Presencial del Alumno/a</td>
<td>25</td>
<td>15</td>
<td>5</td>
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</tr>
</tbody>
</table>

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 tools and percentages of final mark

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written examination</td>
<td>40 %</td>
<td>100 %</td>
</tr>
<tr>
<td>Realización de prácticas (ejercicios, casos o problemas)</td>
<td>0 %</td>
<td>60 %</td>
</tr>
</tbody>
</table>

ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT
In order for the students to achieve the learning results, they must correctly carry out the exercises/tests proposed throughout the course. These exercises will be scored out of 10 and their average will be the resulting mark for the course. To pass the subject it will be necessary to obtain at least a 5.

EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT
A single examination will be carried out in order to measure the learning achievements of the student. To pass the subject it will be necessary to obtain at least a 5.
MANDATORY MATERIALS

BIBLIOGRAPHY

Basic bibliography
- "Fundamental University Physics: Quantum and Statistical Physics Volume III", N. Alonso, E.J. Finn
- "Physics for Scientists and Engineers" P.A. Tipler, G. Mosca, 6th Ed
- "Materials Science and Engineering: An Introduction" W.D. Callister Jr., D.G. Rethwisch, 10th Edition
- "The Feynman Lectures on Physics" R.P. Feynman; M. Sands , Ed. Basic Books
- "Foundations of Materials Science and Engineering" W.F. Smith, J. Hashemi Mc Graw Hill. 7th Ed, 2022

Detailed bibliography
- "Transferencia De Calor", Yunus A. Cengel, Macgraw-Hill, 2004

Journals
- International Journal of Thermophysics
- International Journal of Heat Transfer
- Infrared Physics and Technology

Web sites of interest
European Space Agency Website: http://www.esa.int/esaCP/Spain.html
NASA Website: http://www.nasa.gov
COURSE GUIDE 2024/25

Faculty 345 - Faculty of Engineering - Bilbao
Degree CITEC401 - Master in Space Science and Technology

COURSE

502005 - Space Interferometry

Credits, ECTS: 3

COURSE DESCRIPTION

This course develops the main theoretical and practical knowledge of interferometry applied to Space Science and Technology that allows the resolution of problems and the development of real projects in the field. The course is related to the mandatory subjects of Basis of Optic Instrumentation, Detectors & Sensors and Space Data Processing, as it makes use of a wide range of concepts and tools developed in those subjects. The course is also related with the optional course of Optic System Design and Adaptative Optics, as the knowledge taught in optics is also used in interferometry technologies.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA

That students acquire knowledge of the basic and theoretical aspects of interferometry, with special emphasis on the concept of coherence.
That students know how to identify and analyze the constituent components of basic interferometers.
That students are able to solve problems applied to interferometry in an orderly and justified manner.
That students have knowledge of the techniques, methods and systems used in interferometry stellar.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

The learning outcomes that students are expected to achieve at the end of the semester are:
To acquire knowledge of the basic and theoretical aspects of interferometry, with emphasis on the concept of coherence.
To identify and analyze the constituent components of basic interferometers.
To be able to resolve in an orderly and justified manner, problems applied to interferometry.
To possess basic knowledge of the techniques, methods and systems used in space interferometry.

Theoretical and Practical Contents

UNIT 1: INTRODUCTION TO SPACE INTERFEROMETRY
UNIT 2: FOUNDAMENTS OF SPACE INTERFEROMETRY
UNIT 3: IMAGE FORMATION
UNIT 4: OPTICAL EFFECTS OF THE ATMOSPHERE
UNIT 5: INSTRUMENTAL TECHNIQUES
UNIT 6: INTERFEROMETRY OBSERVATION PLANNING

METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
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<tbody>
<tr>
<td>Laboratory/Field</td>
<td>10</td>
<td>100 %</td>
</tr>
<tr>
<td>Exercises</td>
<td>20</td>
<td>50 %</td>
</tr>
<tr>
<td>Preparation of works</td>
<td>20</td>
<td>0 %</td>
</tr>
<tr>
<td>Expositive classes</td>
<td>25</td>
<td>40 %</td>
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</table>

TYPES OF TEACHING

<table>
<thead>
<tr>
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<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
<td>18</td>
<td>2</td>
<td>10</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Horas de Actividad No Presencial del Alumno</td>
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<td>0</td>
<td>15</td>
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Evaluation tools and percentages of final mark

<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internship Report/Summary</td>
<td>50 %</td>
<td>60 %</td>
</tr>
<tr>
<td>Realización de prácticas (ejercicios, casos o problemas)</td>
<td>40 %</td>
<td>50 %</td>
</tr>
</tbody>
</table>
### ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

A) The following tools will be used for continuous evaluation:
- Mid-term tests consisting on problem resolutions:
  The following will be valued: The knowledge degree of the basic principles of interferometry, the precision in the use of arguments, the obtention of exact numerical values, the completeness of the solutions, the correct use of the verbal, mathematical and/or graphical language. The serious conceptual errors will be penalized.
- Evaluation of laboratory reports. The students must hand in a complete report for each practice carried out, which will be assessed with a grade from 0 to 10. These reports will assess the application of knowledge to practical applications as well as the calculation of errors and their interpretation. The practice mark will be the average of the marks obtained in the practices carried out.

The final grade will be calculated according to the following percentages:
- Midterm exam marks: 40%
- Practice report marks: 60%.

It is a necessary condition to pass the course to have passed the practices and to have obtained an overall mark equal to or greater than 5.

In the case of continuous assessment, students may waive the call within a period that, at least, will be up to one month before the end of the teaching period for the subject. This resignation must be submitted in writing to the teaching staff responsible for the subject.

B) The students who want to be evaluated through the final exam must present for the subject a waiver of continuous evaluation in written form, for which they will have a period of 9 weeks, starting from the beginning of the semester. In this case, the learning outcomes will be evaluated through a test, consisting of:
- A final written exam that will include the resolution of exercises and the development of a theoretical topic:
  The following will be valued: the degree of knowledge of the basic principles of interferometry, the precision in the arguments, the obtaining of exact numerical values, the appropriate use of units, the completeness of the solutions, the correct use of verbal, mathematical and/or graphical language. Serious conceptual errors will be penalized in the correction.
- A practical exam that will be carried out in the laboratory. In this exam, the students must make a report of a practice that must contain: obtaining and mathematical treatment and graphing of experimental data, calculation of errors, discussion of results and the conclusions of the work.

The final mark will be calculated according to the following percentages:
- Written exam mark: 40%
- Practice report marks: 60%

It is a necessary condition to pass the course to have passed the practices and to have obtained an overall mark equal to or greater than 5.

In the case of the final evaluation, the no attendance to any exam will entail the automatic waiver of the evaluation call and will appear as Not Presented.

### EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The following evaluation tools will be used:
- A final exam that will include the resolution of exercises and the development of a theoretical topic. The following will be valued: the degree of knowledge of the basic principles of Interferometry, the precision in the arguments, the obtaining of exact numerical values, the appropriate use of units, the completeness of the solutions, the correct use of verbal, mathematical and/or graphic language. Serious conceptual errors will be penalized in the correction.
- A practical exam that will be carried out in the laboratory. In this exam, the students must make a report of a practice that must contain: obtaining and mathematical treatment and graphing of experimental data, calculation of errors, discussion of results and the conclusions of the work.

The final mark will be calculated according to the following percentages:
- Written exam mark: 40%
- Practice report marks: 60%

It is a necessary condition to pass the course to have passed the practices and to have obtained an overall mark equal to or greater than 5.

In the case of the final evaluation, the no attendance to any exam will entail the automatic waiver of the evaluation call and will appear as Not Presented.

### MANDATORY MATERIALS

BIBLIOGRAPHY

Basic bibliography


Detailed bibliography


Journals

- American Journal of Physics
- European Journal of Physics
- European Journal of Engineering Education

Web sites of interest

- Tutorials European Southern Observatory
  https://www.eso.org/sci/facilities/paranal/telescopes/vlti/tuto.html
COURSE GUIDE

2024/25

Faculty 345 - Faculty of Engineering - Bilbao
Degree CITEC401 - Master in Space Science and Technology

COURSE

502006 - Astronomy and Astrophysics

Credits, ECTS: 3

COURSE DESCRIPTION

This course provides a theoretical and practical scientific background to the physical processes operating in the Universe at very different scales (interstellar, intergalactic and cosmological scales).

This knowledge is required for both a scientific career and for the implementation of technological projects in the field of Space Sciences.

A basic knowledge of the celestial coordinate systems and of the apparent movement of the stars is also very important for telemetry and positioning technologies.

We also intend to provide the students familiarity with the astronomical instrumentation and the most common astrophysical techniques.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

This course provides a theoretical and practical scientific background to the physical processes operating in the Universe at very different scales (interstellar, intergalactic and cosmological scales).

This knowledge is required for both a scientific career and for the implementation of technological projects in the field of Space Sciences.

A basic knowledge of the celestial coordinate systems and of the apparent movement of the stars is also very important for telemetry and positioning technologies.

We also intend to provide the students familiarity with the astronomical instrumentation and the most common astrophysical techniques.

COMPETENCIAS DE LA ASIGNATURA

To acquire scientific knowledge on Astronomy and Astrophysics to provide a background for the development of technical applications and/or for the development of a scientific career.

To know and handle with confidence the basic astronomical instrumentation and software, as well as to be able to process common astronomical data.

To be able to solve scientific problems by determining an adequate strategy for the gathering and processing of scientific data.

To get familiar with team work in a scientific context, assuming the adequate role depending on each team member’s background.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

Theoretical and Practical Contents


Observation techniques: imaging and photometry, long-slit spectroscopy. Astronomical data processing using MATLAB.

METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Horas</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory/Field</td>
<td>20</td>
<td>25 %</td>
</tr>
<tr>
<td>Utilization of Computer Programs</td>
<td>20</td>
<td>25 %</td>
</tr>
<tr>
<td>Expositive classes</td>
<td>35</td>
<td>57 %</td>
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TYPES OF TEACHING

<table>
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<tr>
<th>Types of teaching</th>
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<th>S</th>
<th>GA</th>
<th>GL</th>
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<th>GCL</th>
<th>TA</th>
<th>TI</th>
<th>GCA</th>
</tr>
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<tbody>
<tr>
<td>Hours de Actividad No Presencial del Alumno/a</td>
<td>15</td>
<td>5</td>
<td>10</td>
<td></td>
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</table>

Evaluation tools and percentages of final mark

<table>
<thead>
<tr>
<th>Denominacion</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice Memory</td>
<td>10 %</td>
<td>25 %</td>
</tr>
<tr>
<td>Solving practical cases</td>
<td>75 %</td>
<td>90 %</td>
</tr>
</tbody>
</table>
The course will be evaluated through four problem lists given by the teacher. These will be proposed at the end of the topics 2, 4 and 6 and at the end of the course for the astrophysical techniques.

The students are allowed to opt for a final written exam at the end of the course covering all the topics in the program.

**ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

The students are evaluated with a final written exam covering all the topics in the program.

**EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

**MANDATORY MATERIALS**

**BIBLIOGRAPHY**

**Basic bibliography**


**Detailed bibliography**

**Journals**

**Web sites of interest**
COURSE GUIDE 2024/25

<table>
<thead>
<tr>
<th>Faculty</th>
<th>345 - Faculty of Engineering - Bilbao</th>
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</thead>
<tbody>
<tr>
<td>Degree</td>
<td>CITEC401 - Master in Space Science and Technology</td>
</tr>
</tbody>
</table>

COURSE

502007 - Physics of the Solar System  Credits, ECTS: 3

COURSE DESCRIPTION

This subject gives a general context of scientific and technological activities in the field of Solar System research. The study of the Solar System forms a fundamental part of scientific knowledge of the Universe. This knowledge is in fast revision and expansion as space agencies develop large projects to explore the solar system that regularly revolutionize our knowledge in this area. For these reasons, this subject is intended to introduce the student to the basic aspects of the physics of the Solar System, studying it as a whole, and in detail for each of the main groups of bodies that constitute it (except the Sun) in a comparative way.

One of the fundamental challenges of this subject is to provide a modern and complete vision of the solar system in an area of knowledge in permanent conceptual revolution thanks to the space exploration programs of the main space agencies (NASA, ESA, JAXA). Although this elective course has a scientific orientation, the practical part develops common activities in the processing of data from space and may be of interest to students whose subsequent professional activity is linked to the development of instrumentation or the exploitation of scientific data.

Prerequisites for this course are a basic knowledge of general physics and mathematical tools of calculus and differential equations. These prerequisites are guaranteed by the entrance qualifications. In the context of the Master in Space Science and Technology, this subject is directly linked to the compulsory subjects: "Orbital movement" and "Space physics" and has contents of interest in the study of the subjects "Spaceships I", "Space data processing and Fundamentals of optical instrumentation". All of them are subjects that students have previously taken before the start of this subject. Among the elective subjects of the Master in Space Science and Technology, this subject is largely related to the subjects of "Astronomy and Astrophysics" and "Planetary atmospheres". It also has a lesser relationship with the subjects: "Physics of the Earth's Atmosphere" and "Design of optical systems and adaptive optics". The final professional scope of this subject is framed both in scientific activities for entry into a doctoral program, as well as in technological activities in companies in the sector such as collaborators in the Master in Space Science and Technology (Deimos Space, AVS, SENER, IDOM, Satlantis).

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA

Possess a general knowledge of the Solar System that provides context for technological applications or development of a research career.

Know the basic characteristics of astronomical instrumentation and elementary astronomical software, as well as basics of astronomical data.

Being able to solve the problems associated with the need to obtain a certain series of scientific data, establishing the appropriate methodological and instrumental strategies.

Have a basic experience in carrying out a scientific and technical task, working as a team and establishing a productive work chain.

That students are able to present their ideas and knowledge on a scientific or technological subject clearly and precisely.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

At the end of the course the student should be able to:

1.- Know and describe the general characteristics of the different objects in the solar system, their similarities and differences.
2.- Solve simple physics problems associated with objects in the solar system.
3.- Manage the basic elements of scientific literature in the field of the solar system, being able to analyze the general content of research articles in the area of the Solar System.
4.- Relate the general knowledge that we have of the Solar System with the aspects that we begin to learn about planetary systems around other stars.
5.- Know the elemental aspects related to the formation of the Solar System.

Theoretical and Practical Contents

1.- Introduction to the Solar System: Structure of the Solar System (2 hr).
2.- Terrestrial planets and icy satellites: Interiors and surfaces (3 hr). Task: Journal Club (topic 2).
3.- Planetary atmospheres (2 hr).
4. Minor bodies of the Solar System (3 hr). First list of problems (topic 3 and 4).
5. Recent discoveries in the field of the Solar System. Second list of problems (topic 5).
6. The magnetic environment of the planets (3 hr). Group task: Basic design of a mission proposal (to be developed over the course).
7. Formation of the Solar System and planetary systems (5 hr). Third list of problems (topic 6).
9. Introduction to astrobiology (2 hr).
10. Classroom and observation practices. The astronomical observation will depend on the meteorological conditions and of the priority use of the facilities by the subject "Astronomy and Astrophysics”.

### METODOLOGIA (ACTIVIDADES FORMATIVAS)

<table>
<thead>
<tr>
<th>Actividad Formativa</th>
<th>Hours</th>
<th>Porcentaje presencialidad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual work and/or group work</td>
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<td>0 %</td>
</tr>
<tr>
<td>Laboratory/Field</td>
<td>4</td>
<td>50 %</td>
</tr>
<tr>
<td>Utilization of Computer Programs</td>
<td>4</td>
<td>50 %</td>
</tr>
<tr>
<td>Teamwork</td>
<td>10</td>
<td>15 %</td>
</tr>
<tr>
<td>Exercises</td>
<td>20</td>
<td>20 %</td>
</tr>
<tr>
<td>Expositive classes</td>
<td>37</td>
<td>55 %</td>
</tr>
</tbody>
</table>

### TYPES OF TEACHING

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<tr>
<th>Types of teaching</th>
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<th>TA</th>
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<th>GCA</th>
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<tbody>
<tr>
<td>Hours of face-to-face teaching</td>
<td>18</td>
<td>5</td>
<td>3</td>
<td>4</td>
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<table>
<thead>
<tr>
<th>Denominación</th>
<th>Ponderación mínima</th>
<th>Ponderación máxima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentations</td>
<td>10 %</td>
<td>10 %</td>
</tr>
<tr>
<td>Reading and Analysis of the Report</td>
<td>15 %</td>
<td>15 %</td>
</tr>
<tr>
<td>Questions to discuss</td>
<td>15 %</td>
<td>15 %</td>
</tr>
<tr>
<td>Practice</td>
<td>10 %</td>
<td>10 %</td>
</tr>
<tr>
<td>Realización de prácticas (ejercicios, casos o problemas)</td>
<td>35 %</td>
<td>45 %</td>
</tr>
<tr>
<td>Writing up the teamwork</td>
<td>15 %</td>
<td>15 %</td>
</tr>
</tbody>
</table>

### ORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT

The subject will be evaluated by the tasks proposed throughout the course. The evaluation will follow the following criteria for the different tasks set:

Individual comment work on a scientific article (Journal Club): 15%

Evaluation from 0 to 10:

- <5: Serious errors in understanding the article selected by the student. Serious errors in the scientific context of the situation.
- 5-7: Light understanding of the article and statement of its conclusions without showing a critical analysis.
- 7-10: Understanding of the article and its main conclusions together with a critical analysis of the ideas raised and possible research that may support the conclusions of the selected article.

Problems: 50%

Individual evaluation of each problem from 0-10.

- <5: Conceptual and planning errors with lack of understanding of the situation raised
- 5-7: Reasonably posed problems but with conceptual errors.
- 7-8: Problems well solved.
- 9-10: Problems well solved, reasoned and justified in detail.

 Observation and image processing practices: 10%
(Given the difficulties inherent to the variable quality of astronomical observation, it is not considered possible to assign a larger section to this section).

0 - No attendance
7-10: Depending on the results presented at the end of the session.

Group work (space mission proposal): 25% (15% work + 10% presentation of the work)

<5 Not taking into account the scientific context of the proposed mission and previous advances made by similar missions. Serious planning errors.
5-7: Correct scientific approach but without giving a sufficient description of the technology and instrumentation required.
7-8: Correct scientific approach with a realistic approach to the technology and instrumentation necessary to address the selected scientific questions.
9-10: Correct scientific approach with a realistic approach to the technology and instrumentation necessary to address the selected scientific questions along with creativity and originality of the proposal.

**EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

Students who have not passed in the ordinary call may take an exam in the extraordinary call where questions related to the tasks posed during the course will be asked.

**MANDATORY MATERIALS**

Classes will be taught in the Espazio Gela classroom equipped with a digital projector and individual PC computers for each student (25 seats). There will be access to the different telescopes and instruments of the Aula Espazio Gela including, among others, a 50 cm diameter telescope equipped with deep field cameras and a 36 cm robotic telescope installed in the Calar Alto astronomical observatory and accessible online through the classroom computers. In addition, students will be able to consult scientific journals and online publications through the Aula Espacio PCs. The Aula Espazio library contains copies of the recommended bibliography for this subject. The content of all classes are available as pdf documents to students through the page on the eGela platform (digital plattaform at UPV/EHU for online teaching). Additional journal articles to be read will be posted in eGela.

**BIBLIOGRAPHY**

**Basic bibliography**

Main references:

---


Basics:

---


Intermediate:

---

Planets and Moons (Geophysics), Spohn and Schubert, Elsevier (2009).

**Detailed bibliography**


**Journals**

* Nature
* Science
* Nature Geosciences
* Nature Astronomy
Web sites of interest

(Only as introductory for general search of concepts)

Sky & Telescope http://www.skyandtelescope.com/
Astronomy http://www.astronomy.com/

Only available in Spanish:
Eureka: El blog de Daniel Marín (Astronomía y Espacio) (http://danielmarin.naukas.com/)
COURSE GUIDE

<table>
<thead>
<tr>
<th>Faculty</th>
<th>345 - Faculty of Engineering - Bilbao</th>
<th>Cycle</th>
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<tr>
<td>Degree</td>
<td>INCAR902 - Master in Control Engineering, Automation and Robotics</td>
<td>Year</td>
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COURSE

504137 - Industrial Robotics  
Credits, ECTS: 4.5

COURSE DESCRIPTION

An interesting aspect of robotics is its character as an integrative subject in the training of an engineer, dealing in detail with the constitution, design and use of a machine that involves the integration of numerous disciplines. For all these reasons, the contents selected to develop the subject RI establish a balance between the topics related to the detailed knowledge of a robot and its design (modelling, control and programming), and those in which the knowledge is provided to integrate them in a larger automation process, providing criteria to evaluate the convenience of installing a robot and the way to do it.

The Industrial Robotics subject consists of 4.5 ECTS credits (45 classroom hours and 67 non-classroom hours), of which 2.5 ECTS (25 hours) correspond to theoretical credits, 1 ECTS (10 hours) correspond to classroom practice and 1 ECTS (10 hours) to practical laboratory credits, all of them spread over 14 weeks. It is taught in the second four-month period of year 1 of the Master's Degree in Control, Automation and Robotics Engineering.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA

Afrontar el modelado de sistemas y procesos.
Afrontar el diseño y desarrollo de sistemas utilizando herramientas de automatización y control

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

Theoretical and Practical Contents

THEORETICAL CONTENT:
The content of the subject programme has been structured into 6 topics. The theoretical content is presented below:

1. Introduction to automated processes using robotics
   1.1. Robot introductory aspects
   1.2. Components and subsystems of a robot

2. Kinematics
   2.1. Introduction
   2.2. Spatial location tools
   2.3. Position problem
   2.4. Velocity Problem

3. Dynamics
   3.1. Introduction
   3.2. Dynamic Modelling approaches
   3.3. Direct and Inverse Dynamics

4. Industrial Robot Programming
   4.1. Introduction
   4.2. Programming methods
   4.3. Programming system requirements
   4.4. Programming languages
   4.5. Programming examples

5. Trajectory generation - Kinematic control
   5.1. Introduction
   5.2. Trajectory generation algorithms
   5.3. Joint interpolators
   5.4. Trajectory in task space

6. Control Strategies - Dynamic control
   6.1. Introduction
   6.2. Monoarticular Control
   6.3. Multiarticular Control
6.4. Position/Hybrid/Force control

PRACTICAL CONTENT:

This subject consists of 10 hours to carry out practical activities which are essential to learn skills and settle the concepts taught in theory classes. Thus, the practical programme detailed below has been designed to guarantee an adequate practical learning of the subject, and has been structured in three types of activities:

- Simulation practices under the Matlab/EduBot environment, which are carried out in groups. Specifically, the EduBot Toolbox (Educational Robotics Toolbox) will be used, with a graphic interface to solve problems related to the kinematics, trajectory generation and dynamics of a manipulator robot, as well as its control. In this modality of practices are carried out those related to the modelling and control of robots, corresponding to the practices: PL1, PL2 and PL3 of the syllabus of the subject.

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- Robot programming practices, which are carried out in groups using the Mitsubishi RV-3SB industrial robot with 6 degrees of freedom, with the RT Toolbox offline programming software. In the two planned sessions, students must program the robot using guidance and textual language and solve typical situations that arise in the development of a robotic task (vision, movement planning, object localisation, configuration selection, analysis of the workspace and singular configurations, Cartesian trajectories close to singularities, etc.). PL4 and PL5 correspond to this modality.

Therefore, the practical content is listed in these 5 practices:

PL1: Position problem of serial robots.
PL2: Velocity problem and dynamic model of serial robots.
PL3: Kinematic and dynamic control of serial robots.
PL4: Programming of an Industrial Robot I.
PL5: Programming of an Industrial Robot II.

- Practical visit, carried out with the whole class group and in which the teacher leads the visit "Robotisation in the automotive sector" to the Mercedes Benz company. In this case, the student's work is not as active, but their degree of motivation is greater, so that a reasonable amount of learning is achieved.

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<td>Actividad Formativa</td>
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<td>Acquiring basic instrumental skills</td>
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<td>Laboratory practicals</td>
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Legend:
- M: Lecture-based
- S: Seminar
- GA: Applied classroom-based groups
- GL: Applied laboratory-based groups
- GO: Applied computer-based groups
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<td>Denominación</td>
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<td>Presentations</td>
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<td>Practical tasks</td>
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The different evaluation instruments (and their score out of 10) to be used in this subject are as follows:

Instrument 1: Laboratory work. The practical part will be evaluated by means of the previous work and the performance in the laboratory. Marking: 20%.

Instrument 2: Final exam. Written exam to be held at the end of the course and consisting of short questions and the development of one or more problems. score: 80%.

In order to pass the course, the student must achieve a score equal to or higher than 5 points (out of 10) in the final exam. Once this mark has been exceeded in the final exam, the student will add the points obtained in the laboratory reports.

The points obtained in the laboratory reports will be kept for the two examinations (ordinary and extraordinary) of a course.

In order to waive the assessment of an exam period, it will be sufficient not to take the final exam of that period.

In the case of waiving the continuous assessment, a laboratory test will be taken (with a maximum evaluation of 20%). The method for requesting such a waiver will be to write to the teaching team notifying the waiver before week 9 from the start of the course.

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"Industrial Robotics Laboratory" (2024) A. Mancisidor, I. Cabanes, A. Zubizarreta. Support documentation for the Laboratory. Also available in the virtual classroom of the subject.

MANDATORY MATERIALS


"Industrial Robotics Laboratory" (2024) A. Mancisidor, I. Cabanes, A. Zubizarreta. Support documentation for the Laboratory. Also available in the virtual classroom of the subject.

BIBLIOGRAPHY

Basic bibliography

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Journals

IEEE Transactions on Robotics and Automation.
Control Engineering Practice.

Web sites of interest

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Detailed bibliography

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Journals

IEEE Transactions on Robotics and Automation.
Control Engineering Practice.

Web sites of interest

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COURSE GUIDE 2024/25

Faculty 345 - Faculty of Engineering - Bilbao
Degree INCAR902 - Master in Control Engineering, Automation and Robotics

COURSE
504140 - Industrial System Integration Credits, ECTS: 4,5

COURSE DESCRIPTION
The general objective of the subject is to train the student in the most common technologies used in the automation and control of industrial processes. Knowledge of the available technologies should allow the student to select the most appropriate one based on the specific characteristics of the process to be automated. Likewise, the practical sessions will train the student to design and implement the different solutions. To achieve this objective, the student will be offered the possibility of studying and using technologies and products related to communications in manufacturing environments, supervision and control of industrial processes.

COMPETENCIES/LEARNING RESULTS FOR THE SUBJECT

COMPETENCIAS DE LA ASIGNATURA

- Conocer y aplicar estructuras de control a sistemas y procesos
- Afrontar el diseño y desarrollo de sistemas utilizando herramientas de automatización y control
- Conocer la estructura y operativa de los diferentes dispositivos utilizados en el control y automatización de procesos.

RESULTADOS DE APRENDIZAJE DE LA ASIGNATURA

- Use the knowledge acquired to select, design and implement integration systems within automated production environments.
- Use the knowledge acquired to select the appropriate process control system integration strategies, design and validate them as a prior step to their implementation.

Theoretical and Practical Contents

THEORETICAL SUBJECTS:

2nd Lesson. Serial and parallel communications. Most common standards. Serial protocols frequently used in manufacturing environments.
5th Lesson. Introduction. Network architecture of these systems. Characteristics of the physical level. Link layer characteristics. Methods of access to the medium. Link level services. Application level services. Temporal behaviour. Control-oriented systems in the continuous process.

TEORICAL SUBJECTS DEVELOPMENT (18 sessions 1.5 hours):

1st BLOCK - Basic concepts of industrial communications

1st Lesson. Introduction to Industrial Communications: Goals; Historical vision; Hierarchy of industrial communications; Communications in manufacturing environments; Automation levels; Industry 4.0.
2nd Lesson. Principles of Industrial Communications: Data acquisition and control: Analog signal transformation; Data Transmission: Basic Concepts, Bit Coding, Communication Protocols; Serial Communication.

2nd BLOCK - Industrial network architecture

3rd Lesson. Architecture of Industrial Communications Systems: Protocol hierarchies; ISO OSI Reference Model, reference levels, communication between levels, data units, services and primitives; Architectures of industrial networks, plant networks, field buses; Industry 4.0: Communications System, IIoT Architecture, RAMI 4.0 Architecture.
3rd BLOCK - Industrial Communications
3.1 SUBLOCK - Field Buses

4th Lesson. PROFIBUS: Definition and standards, general features, technical features, PROFIBUS architecture, physical level - PHY (topology, transmission method), link level - FDL (transmission protocol, token passing, times, FDL services), FMA1/2 services.

4.1 Lesson. PROFIBUS-DP: Characteristics; Types of devices; Access to the medium; Communication functions; Description of devices; Applications development; Master-slave interactions; Profiles; Synchronization.

5. Lesson. CAN: CAN: General characteristics; History; CAN bus types; CAN nodes; physical level; Link level: Access to the medium, Arbitration, Services, Frame types; Application level: CAN based protocols.

3.2 SUBLOCK - Industrial Ethernet

6.1 Lesson. Industrial Ethernet: Basic Concepts of Ethernet: Technical characteristics, Types of Ethernet, Network topologies, Bus components, Transmission media, Types of frames, Medium access method; Ethernet problems in industry: Solutions in Industrial Ethernet.

6.2 Lesson. Industrial Ethernet - TCP/IP: General characteristics, TCP/IP stack, TCP/IP vs. OR IF; TCP/IP levels: Network access, Internet - IP, Transport - TCP/UDP, Application; Programming interfaces.

7. Lesson. PROFINet: Transmission modes; Communication in real time; Decentralized field devices; Movement control; Decentralized automation; Network installation; IT standards, network access security; Security; Process.

7.1 Lesson. PROFINet IO: Device classes; Communication model; Setting; Device model; Diagnosis.

4th BLOCK - Monitoring and Monitoring Systems.


PRACTICAL SUBJECTS: DEVELOPMENT (9 sessions):
- 1st Practice: S7 communications 1/2 (2 hours)
- 2nd Practice: S7 communications 2/2 (2 hours)
- 3th Practice: I/O communications - PROFIBUS-DP 1/2 (2 hours)
- 4th Practice: I/O communications - PROFIBUS-DP 2/2 (2 hours)
- 5th Practice: IE communications - TCP/IP 1/2 (2 hours)
- 6th Practice: IE communications - TCP/IP 1/2 (2 hours)
- 7th Practice: I/O communications - PROFINet-IoT 1/2 (2 hours)
- 8th Practice: I/O communications - PROFINet-IoT 2/2 (2 hours)
- 9th Practice: Supervisory Systems - WinCC (2 hours)

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<th>Written Test: 70% (Pass score 40%)</th>
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<td>Laboratory: 30% (Continuous Assessment, PS 50%)</td>
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<td>Completion of Practices: 15% (Group work, PS 50%)</td>
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<tr>
<td>Laboratory Reports: 10% (Group work, PS 50%)</td>
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<tr>
<td>Session Use: 05% (Independent work, PS 70%)</td>
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The renounce to the ordinary call or to the continuous assessment will be notified personally and in the format agreed at the start of the course, to the coordinator or teacher of the course, 2 weeks before the end of the quarter in which the subject is taught.

In case of renounce to the continuous assessment, a seminar/laboratory test will be made.

**EXTRAORDINARY EXAMINATION PERIOD: GUIDELINES AND OPTING OUT**

<table>
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<tr>
<th>Written Exam: 70% (Pass score 50%)</th>
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<tr>
<td>Laboratory Exam: 30% (Pass score 50%)</td>
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The renounce to the ordinary call will be notified personally and in the format agreed at the start of the course, to the coordinator or teacher of the course, 2 weeks before the date of the resist exam of the subject.

**MANDATORY MATERIALS**

Documentation corresponding to the transparencies supporting the theory, seminars and laboratory is in the virtual classroom of the subject.

Students will be equipped with the informatics (software) needed for the development of the different works:
- Tools for hardware devices configuration
- Programming tools for communications

Hardware equipment:
- Personal computers
- Programmable controllers - SIMATIC-S7-1500
- Heterogeneous platforms: motors, drives, etc.
- Network devices and equipment

**BIBLIOGRAPHY**

**Basic bibliography**

- **Title:** Comunicaciones Industriales: Principios básicos
  - **Authors:** M. A. Castro Gil, G. Díaz Orueta, F. Mur Pérez, R. Sebastián Fernández, etc.
  - **Publisher:** UNED Year of Publication: 2007

- **Title:** Comunicaciones Industriales: Sistemas Distribuidos y Aplicaciones
  - **Authors:** M. A. Castro Gil, G. Díaz Orueta, F. Mur Pérez, R. Sebastián Fernández, etc.
  - **Publisher:** UNED Year of Publication: 2010

- **Title:** Redes de Computadoras
  - **Authors:** A. S. Tanenbaum
  - **Publisher:** Pearson Universidad. 5ª edición Year of Publication: 2013

- **Title:** Comunicaciones Industriales. Guia Práctica
  - **Authors:** Aquilino Rodríguez Penín
  - **Publisher:** Marcombo, Ediciones Técnicas Year of Publication: 2002

- **Title:** Profibus. The Fieldbus for Industrial Automation
  - **Authors:** K. Bender. Carl Hanser Verlag
  - **Publisher:** Prentice Year of Publication: 1993

- **Title:** Automating with PROFINET (2nd edition)
  - **Authors:** R. Pigan, M. Metter
  - **Publisher:** Wiley Year of Publication: 2008
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Title: AS-Interface. The Actuator-Sensor-Interface for Automation
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Publisher: Siemens Year of Publication: 2000

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Title: Controller Area Network. Basic, Protocols, Chips and Applications
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Publisher: IXXAT Press Year of Publication: 2001

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Authors: A. Rodríguez
Publisher: Marcombo, Ediciones Técnicas Year of Publication: 2007

Title: Aprenda WinCC
Authors: J. Martínez Torres, J.M. Díez Aznar
Publisher: Editorial de la Universidad Politécnica de Valencia Year of Publication: 2011

Journals
Automática e Instrumentación http://www.tecnipublicaciones.com/automatica/
IEEE Industrial Electronics Magazine http://ieeiees.org/

Web sites of interest
Comité Español de Automática. http://www.cea-ifac.es/
PI - PROFIBUS & PROFINET International http://www.profibus.com/
Open DeviceNet Vendor Association http://www.odva.org
EtherCAT Technology Group http://www.ethercat.org